

Article

Science–Policy Interfaces Related to Biodiversity and Nature Conservation: The Case of Natural Capital Germany—TEEB-DE

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Abstract: Responding to the UN programme “The Economics of Ecosystems and Biodiversity” (TEEB), TEEB-DE (2012–2018) was a science–policy interface (SPI) set up in Germany with the objective of mobilising scientific expertise for a better consideration of biodiversity and ecosystem services in political and corporate decision-making. The aim of this paper is to contribute to an assessment of TEEB-DE by analysing its objectives, structure, processes and outputs. The analysis is guided by a theoretical framework that takes credibility, relevance and legitimacy (CRELE) as normative criteria for examining SPIs. Methodologically, the paper relies on a fine-grained analysis of published documents and interviews with key figures of TEEB-DE. The results allow for a preliminary assessment of TEEB-DE in regard to CRELE and illuminate how its conceptual foundation—namely the ecosystem services concept—was discussed in the public realm. We also consider a number of trade-offs which the coordinators of TEEB-DE had to negotiate. In conclusion, we identify some proposals for designing future SPIs in the domain of biodiversity and nature conservation in Germany such as paying greater attention to policy windows, broadening the thematic scope beyond economics and providing better opportunities for debate and contestation.

Keywords: ecosystem services; biodiversity; credibility; relevance; legitimacy; policymaking; environmental economics; trade-offs; social sciences

1. Introduction

In recent decades, there has been a proliferation of collaborative endeavours involving large numbers of researchers aimed at providing policymakers with scientific evidence on complex sustainability issues such as climate, land-use and biodiversity. The United Nations Convention to Combat Desertification’s Science–Policy Interface (UNCCD SPI), the Intergovernmental Panel on Climate Change (IPCC) and the Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES) are well-known examples at the international level. A great deal of experimentation is going on to try to resolve the complex challenges facing such co-operative organisations and projects at the science–policy interface (SPI). This has sparked discussions about the design and assessment of SPIs, for instance regarding the participating researchers who have to weigh personal neutrality against advocacy and adopt an appropriate role in this respect [1,2], find mechanisms to deal with uncertainties and divergent viewpoints [3,4] and present their findings as knowledge that can be understood and used by policymakers [5,6].

Economic concepts such as Ecosystem Services (ES) and Natural Capital figure prominently in many of these collaborative efforts. Cases in point are the UN-led Millennium Ecosystem Assessment [7]; the programme “The Economics of Ecosystems and Biodiversity” (TEEB), which was commissioned in

2007 by the G8+5 group of nations [8]; a range of TEEB country studies as well as National Ecosystem Assessments (NEAs) around the globe [9]; and the already mentioned IPBES [10]. Generally speaking, Natural Capital is “an economic metaphor for the limited stocks of physical and biological resources found on earth” [11]. It is said to pay dividends in the form of ecosystem services, which have been defined as the “services rendered by nature and used by humankind” [12]. Such terminology has been adopted by conservationists and environmentalists from the late 1990s in the hope of exerting greater influence on decisions made by governments, businesses as well as private citizens.

Here, we concentrate on “Natural Capital Germany—TEEB DE” (henceforth, TEEB-DE), which ran from 2012 to 2018. Involving more than 300 individuals, its objective was “to make visible the many and varied services of nature in Germany” and to help integrate these “into private and public decision-making” [13]. Germany is of particular interest as a highly industrialised and densely-populated country with strong environmental non-governmental organisations (NGOs) and a well-established sustainability discourse [14]. Moreover, the German government has a proven history of championing economic approaches to biodiversity policies, especially with regard to the international TEEB study [15]. It was also a strong supporter of the Green Economy concept at the Rio+20 conference and hosts the secretariat of IPBES.

Although some participating scientists have published their insights on TEEB-DE [16,17] as well as discussed its political thrust [18], TEEB-DE as an SPI has not yet been analysed from an external perspective. It is the aim of the present paper to contribute to such an assessment by relating the objectives and structural features of TEEB-DE to its main outputs and arguments. We summarise how key figures of TEEB-DE as well as external observers judge the success of TEEB-DE while presenting some reflections of our own. Our intention is to compare and discuss different views on TEEB-DE as well as raising questions concerning the design of similar initiatives in the future.

We were not involved in any direct way in TEEB-DE, although we are acquainted with some of the contributors, who in a few cases are colleagues in the same research institution. However, this article is the result of an independent research project, funded by the German Research Foundation, which dealt with conservation politics.

Regarding methodology, the study was based on a content analysis of published documents as well as six semi-structured interviews. To ensure sufficient source material, we established a comprehensive corpus of texts published in the period from 2011 (shortly before TEEB-DE’s inception) to 2018, including publications documented on the TEEB-DE website, other publications making explicit reference to TEEB-DE and any German-language publication engaging with the ES concept from a critical point of view. This corpus ultimately comprised more than 200 publications, from which we selected a subset of 30 documents for fine-grained analysis (see Supplementary Materials, Table S1). The aim of the selection was to cover a maximum variation within the corpus and thus the broadest possible spectrum of views; moreover, we preferred elaborated texts with rich articulations over short pieces which only briefly mentioned TEEB-DE or the ES concept. The contents of both the 30 selected documents and the interview transcripts were analysed in detail.

The interviews, conducted in 2017 and 2018, were originally intended to yield contextual information for a content analysis of TEEB-DE publications; later, however, we understood their additional value in assessing this specific SPI more broadly. We interviewed representatives of the involved government agencies, the overall study leader and three scientific report leaders responsible for the thematic reports.

In the following, we briefly review the literature on SPIs, highlighting a number of normative criteria for such cooperative approaches. Next, we present our empirical results concerning the aims and organisation of TEEB-DE, its contents and outcomes as well as perceptions and assessments of TEEB-DE. Then, we discuss the findings in the light of the normative criteria drawn from the literature on SPIs. The paper concludes by considering what this tells us about sustainability-related SPIs as well as identifying promising avenues for further research.

2. Criteria for Designing and Assessing Science–Policy Interfaces

In a seminal paper, van den Hove [19] defines SPIs as “social processes which encompass relations between scientists and other actors in the policy process, and which allow for exchanges, co-evolution, and joint construction of knowledge with the aim of enriching decision-making”. In stressing the co-production of knowledge, this definition defies linear conceptions whereby SPIs are thought to produce objective knowledge and to speak truth to power. Instead, it highlights the aspect of deliberation and assumes that there can be a multitude of perspectives and values [20]. In this view, SPIs are sensitive to “different, and conflicting, understandings and expectations about knowledge use amongst politicians, scientists, NGOs and industry groups”, implying that their shape and character ultimately result from “processes of power, bargaining and negotiation in different contexts” [5].

This complexity makes it difficult to establish general criteria for designing and assessing SPIs. However, many authors refer to an overarching normative framework comprising three dimensions: credibility, relevance (or salience) and legitimacy (CRELE). Together, these are treated as a prerequisite for scientific findings to become “effective in influencing the evolution of social responses to public issues” [21]. Credibility refers to the perceived “quality, validity and adequacy and reliability of the knowledge, evidence and arguments exchanged at the interface” [22]. Relevance refers to the “relevance for users, including the link to agendas of decision makers, the accessibility of knowledge, the right timing, and a clear connection with the choices available to actors” [23]. Finally, legitimacy “reflects the perception that the production of information and technology has been respectful of stakeholders’ divergent values and beliefs, unbiased in its conduct, and fair in its treatment of opposing views and interests” [21].

To operationalise these general criteria, it is helpful to distinguish between objectives, structures, processes and outputs of an SPI. Borrowing from Sarkki et al. [22], these can be defined as follows:

- Objectives are “the stated aims of the SPI, and in some cases also ‘realised’ functions that depart from the stated objectives. Objectives provide basis and scope for SPIs to influence selected target audiences”.
- Structures are “the institutional arrangements that have been set up and developed to achieve the objectives or functions of an SPI”.
- Processes are “the actions and interactions through which SPIs produce outputs and endeavour to influence behaviour”.
- Outputs are “the specific products developed through the processes, including reports, recommendations, meetings, scenarios, indicators, databases, websites, press releases, and so on”.

All four of these features of SPIs should conform to the CRELE framework. Beginning with the objectives, these should be clear and transparent. For example, to achieve policy relevance, the objectives must take national policy contexts into account. It is important to identify and utilise existing policy windows to facilitate the uptake of knowledge which would otherwise be ignored [22,24–26].

Regarding an SPI’s structures, the selection of participating experts and stakeholders is subject to all three dimensions of CRELE. The panel of experts should ensure not only a multitude of perspectives, disciplinary backgrounds and forms of knowledge, but also high levels of competence and reputation. The selection process should be transparently documented and communicated. Potentially relevant stakeholders should be involved in adequate roles, preceded by a stakeholder analysis [3,22,27]. Some authors also recommend the active management of stakeholder involvement and intense communication from the earliest stages, especially regarding TEEB country studies. This can be facilitated by establishing a formal governance structure with elements such as a steering group, an advisory board, author teams and stakeholder groups [9,25].

As for the process dimension, the CRELE of an SPI can be enhanced by iterative multi-directional dialogues among scientists, policymakers and stakeholders, by constant reflection on the plurality of knowledge and values as well as consideration of limitations, ambiguities and uncertainties. To foster legitimacy, SPI processes need to facilitate trust building and mutual learning and to provide for

conflict management and the disclosure of values and motivations. Finally, SPIs must be adaptable and flexible in their response to changing contexts, thereby strengthening their relevance [2,19,22].

Concerning the outputs of SPIs, the relevance dimension of CRELE requires the formulation of “strong and clear messages” [25], the assessment of “scientific outputs in light of users’ needs and other knowledges” [19] as well as the appropriate communication of results [25]. Regarding credibility and legitimacy, it is essential to expose the pros and cons of different policy options, to secure the “traceability of the evidence for arguments presented in the outputs, and independent scientific and extended peer review processes” [22].

However, designing an SPI is not simply a matter of running through a checklist of criteria. Some requirements may be found to be incompatible, resulting in difficult choices and trade-offs. At a general level, it may prove necessary to compromise between credibility, relevance and legitimacy: “For example, a strong focus on credibility can pose a threat to legitimacy if credibility is interpreted in a relatively strict scientific way that excludes other forms of knowledge and limits participation and engagement” [23]. Other more specific trade-offs may also arise in regard to funding vs. independence, speed vs. quality, clarity vs. complexity or transparency vs. trust [25]. These theoretical considerations inform our empirical analysis and the ensuing discussion.

3. Results

3.1. Objectives of TEEB-DE

The official overarching objective of TEEB-DE was “to produce four topic-based reports presenting the economic case for nature conservation as a complement to ethical and ecological arguments” [28]. By integrating scientific expertise with the views of “important stakeholder groups from politics, public administration and civil society”, TEEB-DE was supposed to create an “effective stimulus for a more sustainable management of our natural capital” [29]. More specifically, the goal was “to make visible the manifold services of nature in Germany” and to contribute to a better “consideration of nature’s services in private and public decisions” [13].

While basically endorsing these official aims, our interviewees rephrased them in particular ways. Specifically, they mentioned four distinct though overlapping objectives. Firstly, they aimed for a societal and political impact in the sense of “political attention” in order to “promote nature conservation more strongly” (Interviewee 5, I-5): “Ultimately we wanted to have some impact. [. . .] We really wanted to make a difference for the benefit of nature conservation and the protection of biodiversity. This was the starting point” (I-2). Secondly, they hoped to stimulate support for “a rigorous, good conservation policy”, meaning a strengthening of the existing statutory and regulatory policy instruments. This “body of conservation policy” is threatened by “attacks, which we have to fight off again and again” (I-5). Therefore, TEEB-DE should provide “additional arguments for nature conservation” (I-6). Thirdly, by resorting to the language of economics and logic, TEEB-DE was designed to reach other societal groups and policy sectors beyond nature conservation: “We wanted to present case studies of the costs of destroying nature. [. . .] And, in so doing, one can send out signals to [. . .] policy sectors such as climate, energy, transport and housing policy [. . .]. That was the expectation” (I-5). The main target group did not include conservationists, i.e., “those who are already convinced [laughs]” but rather “the disbelievers, who [. . .] make decisions—to reach them in a language they haven’t heard yet [. . .]. Well, land users, the farmers’ association, [. . .] or municipal treasurers and economic development officers” (I-2). Hence, one keyword is “mainstreaming”: The economic approach to nature “has to be integrated in decision-making processes. People who do river basin management should stop and think: ‘Wait a minute, we need to consider nature and nature’s services in our measures’” (I-2). Finally, TEEB-DE was supposed to involve “as many people as possible” (I-2), bringing together experts from “different communities [. . .]: Environmentalists, planners, agricultural economists, forest economists. [. . .] recreation and health. [. . .] climate protection. [. . .] energy”

(I-3). The vision was to “establish a German TEEB network involving as many researchers and experts as possible” [30].

3.2. Structure of TEEB-DE

TEEB-DE’s structure reflects its objectives. Primarily, it constituted a huge endeavour: more than 300 individuals were involved as coordinators and authors [13]. Most were unpaid volunteers, with only a small number of project staff receiving remuneration. Being Germany’s response to the international TEEB initiative, TEEB-DE was funded by the Federal Ministry for the Environment (BMU) through the subordinated Federal Agency for Nature Conservation (BfN) (see Figure 1). Both organisations actively participated in coordinating the programme together with an overall study leader, who was affiliated with the Helmholtz Centre for Environmental Research (UFZ). Financed mainly by the German federal government, the UFZ had also been coordinating the scientific work of the international TEEB initiative.

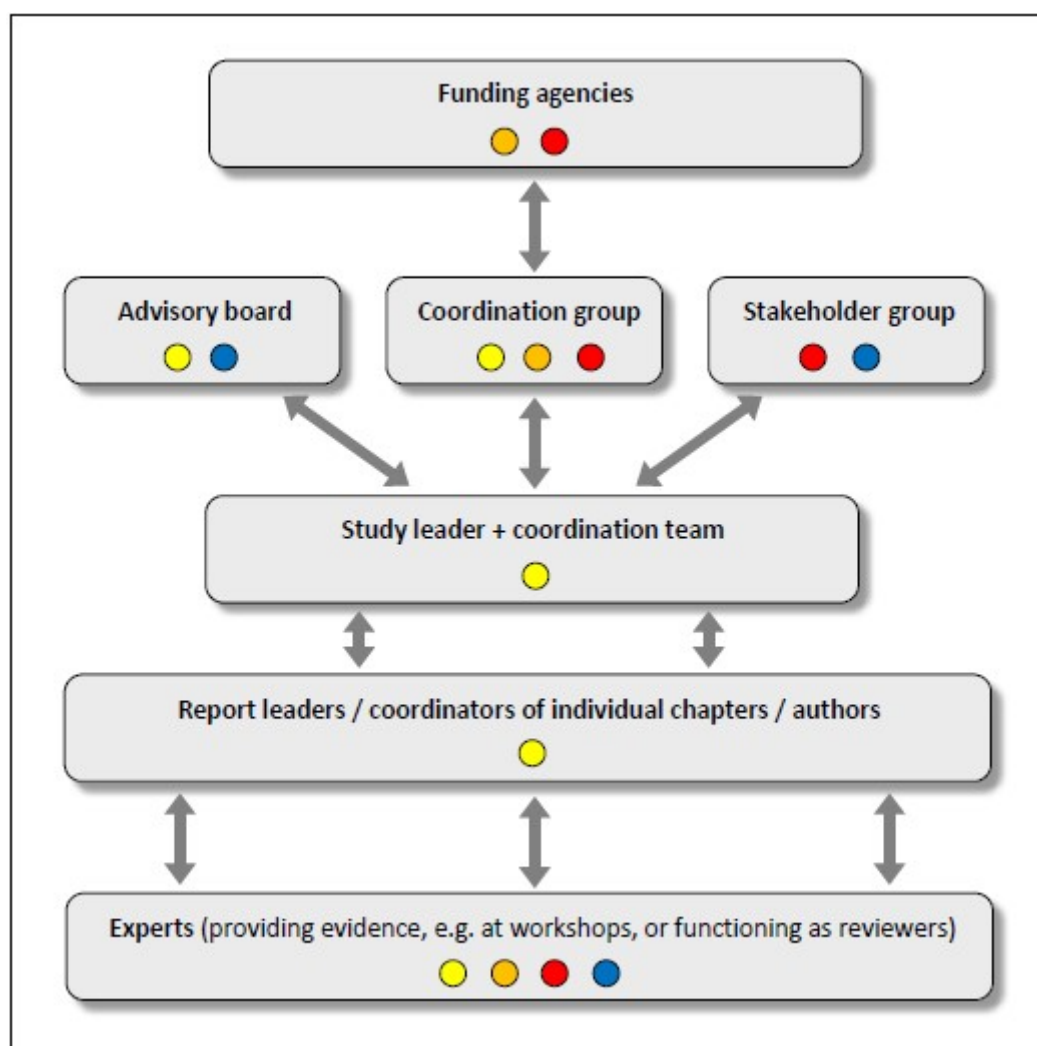


Figure 1. Organisational structure of TEEB-DE [28]. Legend: yellow circles, researchers; orange circles, intermediaries, i.e., researchers working in government agencies, e.g., BfN; red circles, policymakers, i.e., members of federal, state or municipal governments, e.g., BMU; and blue circles, representatives of non-governmental organisations, businesses and industry associations.

The reports were coordinated by scientific report leaders, namely university professors of economics, landscape and spatial planning or urban ecology. The individual, peer-reviewed chapters within each report also had coordinating authors. This already sophisticated structure was complemented by a coordination group (including representatives of the BMU and the BfN),

an advisory board (comprising nine prominent representatives from the spheres of science, media, business and civil society) and a stakeholder group (consisting of about 20 people, mainly representatives from different levels of government but also from ENGOs and industry organisations). All of these individuals provided feedback on the process. Furthermore, over 150 reviewers “from academia, associations and politics” [13] were involved in preparing the reports. The rationale underlying this governance structure was to “collate existing knowledge” by establishing a “network of voluntary participants” [29]. Figure 1 illustrates the structure of TEEB-DE as an SPI by considering the various tasks assigned to researchers, intermediaries, policymakers and non-governmental organisations.

The study leader was appointed by the funding agencies. Collaborating closely with the coordination group, he selected the report leaders who, amongst other tasks, were responsible for “inviting scientists as well as experts with practical experience and representatives of interest groups” to get involved [30]. The study leader and his team also assisted in choosing the coordinators of individual chapters. The particular mechanism for recruiting participants was generally referred to as “open architecture” [29]. Specifically, many invitations were sent out to take part in workshops: “All interested parties should be given the opportunity to contribute and exchange their knowledge bases and experiences, in order to subsequently prepare the respective TEEB-DE report” [30]. If a report leader felt that some kind of expertise was lacking, s/he “identified and involved additional persons” (I-4). As the contributors were not remunerated, only people “who had a job and got their working hours paid” and who were usually working in “universities and major research institutions” (I-3) could participate.

The members of the stakeholder group were carefully selected in order to involve not only environmental organisations and governmental departments, but also representatives “with a critical attitude towards nature conservation: well, the department of trade and industry, the federation of German industries, the department of agriculture, the farmers’ association” (I-2).

3.3. Processes of TEEB-DE

The structure of TEEB-DE formed the basis for a range of interactions. The process of developing the thematic reports involved intense communication among the authors, report leaders, coordination team, stakeholder group, advisory board and external reviewers in “all possible constellations” (I-6). This was “a very, very complex process” (I-4) with the need for compromise on all sides: “And everyone was forced to be willing to compromise, so to speak; that was the central aspect” (I-3; similarly: I-4 and I-6). While acknowledging the many sources of feedback, the (lead) authors retained authority over the contents of the respective reports. Due to this “scientific independence of the lead authors”, the coordination group “could not correct” every statement they disagreed with (I-2; similarly: I-4). When any technical disagreements arose within the author teams, “the report leader decided what was to be included or not” (I-4).

“Scientific independence” was repeatedly emphasised as being “highly important” (I-5) for the process of writing the reports. The report coordinators adopted an “internal scientific viewpoint” (I-3) and—drawing on their “knowledge of the community”—invited specific scientists to contribute (I-2; also I-3, I-4, and I-5). The structure of each report was closely coordinated with the funding agencies: “The UFZ always had to consult with the BfN and the BMU. And this was, as it were, the next area of conflict. [. . .] There was always the question: Where could the contracting authorities exert criticism or argue their position? That was always an area of conflict” (I-3). The shortened “summaries for decision-makers” were largely edited by the study and report leaders, receiving “very detailed commentary” by representatives of the BMU and the BfN (I-2). Further, several author workshops were organised “in which the structure of the individual reports was created and refined, content was pre-structured and versions of individual sections were circulated and discussed” [13].

Taking a closer look at Figure 1, we note that TEEB-DE utilised two types of SPI. The first set of interactions took place inside TEEB-DE’s structure, specifically:

- within the coordination group and the advisory board;
- among the funding agencies, the advisory board, the coordination group and the stakeholder group, on the one hand, and between the study leader and his coordination team, on the other hand; and
- among the reviewing experts, some of whom were from “associations and politics” [13], and the report leaders, chapter coordinators and authors.

The second type of SPI straddles the boundaries of the governance structure and refers to relations between TEEB-DE and its policy environment as well as the wider societal environment. Such relations transpired through the media, public events and the manifold interactions among participants of TEEB-DE, policymakers and other societal actors such as representatives of NGOs. While TEEB-DE did not result in legislative initiatives, was not otherwise formally institutionalised and did not trigger other political decisions in an obvious way, it did attract a lot of public and political attention. There was extensive media coverage in newspapers, public radio and TV stations [31]; the study leader took part in several public debates with critics [32]; TEEB-DE was recognised in the federal parliament [33]. Finally, following the inception of TEEB-DE, the notions of ES and NC were frequently mentioned in publications and policy papers of the BMU and the BfN [34].

3.4. Outputs of TEEB-DE

The main outputs were the following reports, some of which were issued in both German and English.

- “Natural Capital and Climate Policy” [35] and the accompanying summary for decision-makers [36];
- “Ecosystem Services in Rural Areas” [37] and the accompanying summary for decision-makers [38];
- “Ecosystem Services in the City” [39] and the accompanying summary for decision-makers [40]; and
- “The Value of Nature for Economy and Society. A Synthesis of Natural Capital Germany–TEEB DE” [13].

Moreover, several scientific articles [17] were published along with workshop reports [41], a compilation of case studies [42] as well as popular scientific material [43].

A core discourse runs through all four reports, which we briefly summarise here. The argument begins by invoking familiar problems such as the ongoing loss of biodiversity. These ills are said to have their causes *inter alia* in agricultural intensification, soil sealing, soil loss and the fragmentation of landscapes as well as air pollution and noise. The narrative continues by depicting environmental degradation as an issue of costs: “High follow-up costs of the loss of ecosystem services become manifest especially in health effects, production losses and end-of-the-pipe costs for cleaning and restoration” [44]. These statements are behind calls for the long-term preservation of natural resources and biological diversity, including specific measures such as the restoration of fens and bogs as well as raising the habitat diversity of farmland. Both environmental degradation and protection are framed in economic terms: as nature represents a form of capital, “the protection and sustainable use of nature and biological diversity pay off” [30]—not only for the economy in general, but also for businesses.

Further, the line of argumentation focuses on the interlinked notions of rendering the invisible visible and recognising values. As the value of nature is often hidden and nature’s services remain invisible, these factors are frequently ignored in decision-making processes. Therefore, economic assessments should be embraced because “the ecosystem services concept and the economic perspective offer many options to better clarify the importance of nature and landscape for humans and to consider them better in discussion and decision-making processes” [45]. The authors of TEEB-DE advocate a broad economic approach, which they defend against alleged misunderstandings: “Some [. . .] objections are important and essentially right, while others are characterised by insufficient knowledge of the economic approach, misunderstandings and wrong interpretations” [46]. While an assessment

of natural capital in monetary terms is welcomed, it is articulated as representing only one method among many others. The authors stress that “the economic perspective should complement existing environmental assessments in communication and decision-making processes only when it makes sense to do so” [45]. Thus, the vital question is to determine “in which contexts and in which decision-making situations an economic perspective can be appropriate and helpful to better protect and foster the sustainable use of nature and its services” [47].

Beyond this core discourse, which is most apparent in the introductory and concluding chapters of the reports, TEEB-DE is characterised by a plurality of voices and political demands. The TEEB-DE reports differ significantly in the kind of linkages they establish between analyses and recommendations. In particular, the 216-page report on “Natural Capital and Climate Policy” [35] most consistently uses economic terminology and applies economic argumentation. Here, the authors investigate the extent to which ecosystems services are provided by different types of land use and land cover [35]—especially the level of CO₂ emissions [35]—and what this means in financial terms [35]. They conclude that climate protection measures would be particularly cheap to realise in the farming sector and to a lesser degree in the forestry sector, before discussing a number of political proposals. Some of these are economically oriented, e.g., conservation by contract schemes and changes to agricultural subsidies, while others refer to non-economic measures such as awareness-raising, the designation of protected areas or a better coordination of regulatory laws and land use planning [35]. In short, the authors make an economic case for the closer consideration of climate protection in land-use policies, explaining which measures they deem most suitable to achieve this goal in the German context.

By contrast, the voluminous 367-page report on “Ecosystem Services in Rural Areas” [37] concentrates on demonstrating the added value of integrating the ES concept in Germany’s land-use policies, arguing in favour of the environmental protection this would generate. There are many thematic overlaps with the climate report due to the same types of land use and land cover considered, i.e., farmland, fens, forests, riparian and coastal areas, although the range of ecosystem services discussed in the rural areas report is broader [37]. The authors extensively analyse the current state of land-use policies in Germany, identifying weaknesses such as an ignorance of cumulative effects and neglect of human well-being, while showing how the ES concept could help remedy these shortcomings (inter alia [37]). Examining the entire toolbox of land use-related environmental policies in Germany, they argue that the ES concept could strengthen these [37]. The identification and quantification of ES is said to not just promote a more nature-friendly agriculture but also make private investments in nature conservation more attractive [37], give nature conservation greater clout, highlight trade-offs between different types of land use and increase local approval rates for conservation projects [37]. While the authors also discuss possible risks of applying an economic perspective (inter alia [37]), their primary goal is to present the ES concept and “Natural Capital as solution approach for rural development” [37].

The main body of the 300-page report on “Ecosystem Services in the City” [39] scrutinises the various ecosystem services provided by urban green such as climate adaption, improved human health and social cohesion, an experience of nature, some food production, higher real estate values and the enhanced attractiveness of a site for investors [39]. The chapter on policy seeks to identify how the ES concept could enrich informal approaches to urban planning and development such as visioning, civic participation, municipal biodiversity strategies or city marketing as well as inform elements of statutory landscape and urban planning [39]. Finally, the report discusses options for using financial (dis-)incentives to safeguard and enhance the provision of urban ES such as payments for ecosystem services and tradable development rights [39]. Although the authors of this report basically adopt a similar approach to that of the rural areas report, they pay less attention to either the deficits of existing instruments or the potential drawbacks of the ES concept (except for the discussion about statutory landscape planning on page 237). Instead, their primary focus is on identifying urban ES as well as ways of integrating the ES concept into urban planning and policymaking. Interestingly, the reports

on rural areas and cities both only sporadically give quantitative figures or even monetary values of ecosystem services, whereas the climate policy report draws on numbers throughout.

The 134-page synthesis report [13] has three main chapters, the first of which presents a selection of case studies, most being taken from the other three reports and highlighting the economic relevance of nature [13], followed by a compilation of TEEB-DE's core messages [13] and concluding with a chapter on political recommendations [13]. The core messages consist of relatively succinct statements that illustrate and corroborate the economic perspective underpinning TEEB-DE. The recommendations in the third chapter synthesise many proposals named in the other reports such as improved policy integration, the strengthening of regulatory policies and financial incentives. However, additional ideas are also introduced, especially that of global interconnections and interdependencies [13]. At this point the authors of the report abandon their strictly economic argumentation to include some ethical considerations. For instance, they appeal to corporate responsibility in a global context: "Protecting natural capital [. . .] while Germany's consumption and production contribute to the loss of natural capital in other countries" is said to be "inacceptable on ethical grounds and can cause reputational loss of the companies in question" [13]. The report goes on to refer to Germany's oversized ecological footprint, stressing the need to take better account of Germany's environmental externalities abroad, e.g., in the agricultural sector. In their conclusion, the authors call for sustainable food consumption, the curbing of food waste as well as a better integration of economic policies, development cooperation and international conservation policies.

3.5. Perceptions and Assessments of TEEB-DE in Interviews with Report Leaders and Members of the Coordination Group

The interviews conducted with the report leaders and members of the coordination group provide interesting perceptions of TEEB-DE relating to all four features of SPIs named above—objectives, structure, processes and outputs.

Concerning the objectives of TEEB-DE, one of the interviewees explained the political context: "There were links to politics, or to other processes" (I-5). Then, s/he refers to the federal government's Green and White Books on urban nature, commenting that "all this coalesced and it was a wonderful coincidence. [The] TEEB Germany [report on ecosystem services in the] city fitted timewise very well into those processes, because they [i.e., the authors] brought forward the same arguments" (I-5). However, according to another interviewee, the political context was rather unsupportive in not offering a pertinent policy window: "It's not just the quality of a scientific product that plays a role, but also the entire context and whether there is a window of opportunity [. . .]. And that was probably not forthcoming in our case" (I-6).

In discussing TEEB-DE's structure, one interviewee opined that the commissioning by the BMU and the BfN was "not very beneficial" because this meant that the project was "readily perceived as belonging to environmental protection and nature conservation"—a possible obstacle with regard to "reach[ing] other decision-makers" (I-2). Furthermore, the self-nomination of experts via an open call for participation was described as being "a loose cannon" (this English expression was used in the original) (I-2), because it was unclear how this would end up. One interviewee commented on the actual composition of the participants in light of the original idea of initiating a wider political debate, which in fact did not develop: "Had we really wanted to induce a public debate, which maybe was intended to stimulate a political debate, then other people should have been invited to achieve that" (I-6).

Regarding the processes within TEEB-DE's structure, one interviewee concluded as follows: "It can be seen as one of the biggest achievements of TEEB[-DE] that [. . .] there is a relatively large consensus within this community about the opportunities, but also the risks, the possibilities of the concept" (I-6). Another painted an equally bright picture, believing that TEEB-DE "has inspired many researchers to continue to deal with this topic, which is a good thing given the gaps that still exist" (I-3). Others, however, were rather disillusioned: "We had expected more, a kind of TEEB community,

so that several authors would continue collaborating in projects after having finalized the TEEB-DE reports in order to maintain this way of thinking" (I-2).

The other type of SPI-related process refers to interactions between TEEB-DE and its environment. While TEEB-DE elicited "positive response from nature conservation organizations with a pragmatic orientation" (I-3), the hope of more directly communicating the ES approach to actors in other policy sectors was frustrated: "Because the term is relatively bulky. The hope that it would be easier to communicate, I don't think it has really been fulfilled" (I-5). The evidence regarding the quality and results of science–policy interactions is not clear-cut. One interviewee lamented the lack of support from high-ranking politicians: "It would have needed a minister or head official, [. . .] somebody who would have taken a stand at federal level for this kind of thing" (I-3). Another reported difficulties in giving politicians an understanding of the economic approach: "I met with a senator [. . .] and told him [. . .] 'Well, we want new residential areas [. . .] and we should implement the ecosystem services approach to show that we can build densely and also optimise natural functions.' And what did he say? 'Rents must not rise.' And then I tried to explain [. . .]. Yet he wasn't particularly thrilled" (I-4). The same seems to apply to the practical processes of policy integration: "[. . .] these arguments don't make it much easier for us. [. . .] It is simply another argument, while we would need a different kind of thing in these debates, in the coordination of policies" (I-5) in order to make nature conservation more influential: "Because the question of power is not really solved—I openly admit that. It is simply another argument" (I-5). One interviewee also hypothesised that TEEB-DE and the ES concept did not make a more significant impression because Germany already has in place a highly developed system of environmental protection policies. Otherwise, "the ES concept would have fallen on better, more fertile ground and would have had a greater impact. So for many, it was nothing new" (I-6). Finally, TEEB-DE encountered some unexpected resistance: "Maybe we were a bit naïve [. . .]. Maybe we did underestimate the strength of interest groups in Germany" (I-2). In general, alongside the interviewees' evident pride in the accomplishments of TEEB-DE, there was a prevailing sense of disappointment. According to one: "Well, I do believe that this still attracts the interest of decision-makers", although s/he had previously remarked: "Our report did not find resonance commensurate with the amount of work and financial funds that had been invested" (I-6). This was echoed by another interviewee: "We had hoped that we would develop even greater impact, both in the political arena and in the field of science" (I-2).

Limitations in the knowledge base were addressed: "We only realised in hindsight how few [existing economic] studies there were" (I-6). The same person also reckoned: "We would have achieved this [i.e., attracting public attention] if we had presented large numbers. But this was not our intention; or we felt it would not have been scientifically appropriate, simply because we were lacking a respective empirical basis" (I-6). Here, the interviewee is referring to the difficulty in making a convincing economic case for nature conservation due to the almost complete lack (at that time) of any economic assessments of Germany's ecosystem services or natural capital. Therefore, s/he guessed it might have been better to "join forces and generate fresh data instead of hoping to [. . .] just synthesize" (I-6).

Some of the quotations above already refer in part to outputs. The interview records actually testify to some degree of ambivalence regarding the merits of TEEB-DE and the ES concept. As a whole, TEEB-DE is acknowledged as being "a progress report that reflects the best state of knowledge" (I-6). The ES approach is said to be "very helpful with regard to housing projects, because it shows that an economic benefit can be realised" (I-4). At a more pragmatic level, however, one interviewee sees the risk "that we end up in such trade-offs where we suddenly see agricultural products as an ecosystem service—something that many in nature conservation strongly dislike" (I-6).

3.6. Comments on TEEB-DE and the ES Concept by Persons Who Do Not Fully Subscribe to TEEB-DE's Core Discourse, and How They Were Dealt with by Representatives of TEEB-DE

Apart from the perceptions and assessments of those intensively involved in TEEB-DE, there are also relevant comments by persons who do not fully subscribe to TEEB-DE's core discourse. These concerns, which are expressed in the literature, deal solely with the contents and the output of TEEB-DE. As it is important to understand how such concerns were handled, we also examine the ensuring interactions between the critics and representatives of TEEB-DE.

Several researchers from the fields of nature conservation, landscape development and environmental sciences raised concerns about TEEB-DE and the underlying ES concept. The respective publications query the methodology of classifying and assessing ecosystem services as well as expressing more fundamental reservations about the appropriateness and expediency of economic assessments. Rather than focus merely on the substance of these critiques, we intend here to examine how they were dealt with by representatives of TEEB-DE and, hence, which kind of SPI-related interactions (if any) they triggered. In so doing, we identify three types of comments.

The first type comprises contributions that were directly addressed in the TEEB-DE reports or even incorporated into them. For instance, Haber [48] noted that those who champion the ES concept “prefer to relate it to natural ecosystems [. . .], linking it with a constrained notion of biodiversity (reduced to species diversity), and emphasizing it economically as natural ‘capital’”. He articulates doubts about the underlying classification scheme: “insect pollination is often mentioned as the contribution of natural ecosystems to provisioning services, but wind pollination, which is essential for cereals, meadow grasses (and many forest trees), is ignored” [48]. Thus, he is generally suspicious of the ES concept, exploring the possibility that it could be “based on a scientific misjudgement” [48]. The coordinators of TEEB-DE reports gave Haber, who is a highly respected professor emeritus of landscape ecology, the opportunity to contribute a 1.5-page textbox [49] to one of the reports in which he repeated some of his doubts. In a similar vein, the fundamental critique by Fatheuer [50] was taken up in two TEEB-DE reports. He previously discussed the ES concept as a component of “The New Economy of Nature”—a perspective which “falsely” assumes that we live “in a world of rational decisions”, that environmental destruction is “the result of a lack of information and false price signals” and that this is “a world without interests and power structures” [50]. With an eye to so-called payments for ecosystem services in countries such as Costa Rica, he also criticised attempts at monetisation and marketisation, arguing that “nature’s services” are “too complex” and “usually bound to a specific local context” [50]. TEEB-DE counters his critique by insisting that “the economic perspective should complement existing environmental assessments in communication and decision-making processes only when it makes sense to do so” [37]. While the authors of another TEEB-DE report [39] agree with Fatheuer that monetisation and marketisation should not be applied prematurely and hastily, they assert that economic approaches to nature conservation and environmental protection should not be rejected wholesale.

A second group of commentaries prompted the study leader to publish replies in scientific journals. In one of these responses, Hansjürgens [51] vehemently rejects the view of Jungmeier [52], who had linked the ES concept to neoliberal economic theories and described a number of conceptual, empirical and methodological problems, leading to a plea for additional, more systematic research. A similar controversy arose before the start of TEEB-DE, following the publication of a review article by Ekardt [53] in which he argued against the economic assessment of climate policies, claiming, for example, that the costs and benefits of climate change could not be captured economically and that cost-benefit analyses were rooted in an assumption of economic growth. Here, again, the study leader, together with a colleague [54], complained that economic assessments and monetisation should not be conflated, and that economists should not be depicted as opposed to climate protection.

The third type includes comments critical of TEEB-DE or the ES concept but which were not considered by the TEEB-DE consortium, at least not publicly. This applies, for instance, to an editorial by Jedicke [55] in which he questions the rationalities behind the ES approach: “Whoever has money has

power. Is it this popular wisdom that drives scientists, policymakers and practitioners to quantify and monetize ecosystem services?" He also asks whether the conservation community was "well advised to participate in promoting this change in values" or should not rather stress "emotional values"? Another paper by Kühne [56] criticises the growing hegemony of economic—and especially monetary—values, resulting in the marginalisation of alternative ways of framing the natural environment. In a more recent paper, Ekardt [57] articulated doubts about the methodology of economic assessments: "The 'clear figures' of the economic valuation hide complex assumptions [. . .]. If these assumptions are wrong, the result is by no means as objective and rational as economists often claim". Nevertheless, Ekardt is very much in favour of economic policy instruments such as ecological taxation and emissions trading, which he perceives as being "by and large the sharpest sword in environmental and nature conservation policy" [57]. In a similar vein, Heiland et al. [58] list a number of fundamental restrictions and possible counterproductive effects when the ES concept is applied to conservation planning. They contend that economic assessments do not necessarily lead to a closer consideration of natural capital and biodiversity in public decision-making, either because the decisions are not primarily guided by economic thinking or because alternative options, such as an industrial development, promise high short-term benefits while the benefits of, say, preserving green spaces only accrue in the longer term. They assert that, in practice, the economic benefits of different policy options are often not accorded the same weight "due to power imbalances and the influence of vested interests" [58]. Again, we did not find any public response by representatives of TEEB-DE to these publications.

4. Discussion

In this section, we juxtapose the theoretical reflections on SPIs with our empirical findings on TEEB-DE. As stated in the introduction, while we intend to contribute to an external assessment of TEEB-DE, this by no means constitutes a fully-fledged evaluation.

There is little doubt that TEEB-DE was an impressive initiative. Although individual studies on economic approaches to nature conservation had been published before [59–62], the comprehensive economic perspective on which it relied was innovative in German nature conservation politics. Furthermore TEEB-DE enjoyed much greater media resonance than other nature conservation topics. It was successful not only in presenting nature conservation as something positive and economically beneficial, but also in bringing together a large number of experts. As more or less everybody was welcome to contribute, no one could decry TEEB-DE's setup, claiming to have been excluded. This might be one reason why hardly any public criticism was expressed about the objectives, structure or processes of TEEB-DE. However, as the initiators and participants of an SPI always have to manage difficult trade-offs, we discuss these in regard to TEEB-DE at the end of this section.

At first sight, the objectives of TEEB-DE seem clear, transparent and straightforward: "to make visible the many and varied services of nature in Germany" and to help integrate them "into private and public decision-making" [13]. However, on closer examination, it is evident that TEEB-DE pursued multiple and partly contradicting goals. Some of these referred to the interface of science and policy, for instance giving nature conservation greater clout by supplying additional arguments, lobbying stakeholders from other policy sectors and pleading for the integration of the ES concept in existing policy instruments. By contrast, other objectives addressed fellow scientists, for instance in aiming to establish an ES- and NC-related community in Germany. This implied a strengthening of the relative importance of economics vis-à-vis disciplines such as landscape ecology, geography and planning. TEEB-DE was supposed to function both defensively and offensively: fighting off attacks against the body of conservation policy while also mainstreaming nature conservation (and especially the economic approach to it) into other policy sectors. As for national policy contexts, the wider discursive environment was seemingly conducive to such a study, although a particular policy window neither existed beforehand nor opened during the process. This constrained the political relevance of TEEB-DE.

The structural design of TEEB-DE profited from experiences gained through the international TEEB study, which was also coordinated by the UFZ, and followed the textbook recommendations

for country studies [25]. By welcoming a wide range of participating experts, TEEB-DE encompassed a multitude of perspectives and disciplinary backgrounds. The fact that many participants were renowned university professors ensured high levels of competence and a solid reputation. However, it is rather difficult to find information on the selection process for the experts. No information is given about those who were invited and those who were self-nominating. Clearly, the open architecture reduced the possibility of steering the selection of participants. These aspects of selection can be viewed as undermining TEEB-DE's credibility. Further, the fact that TEEB-DE was funded by the department of the environment made it difficult to reach decision-makers from other policy fields and to be perceived as an unbiased scientific assessment; instead, TEEB-DE was inadvertently—and not without good reason—regarded as an advocacy initiative of the conservation sector, again denting its credibility. Although we did not find indications of a formal stakeholder analysis, the coordinators of TEEB-DE thoroughly reflected on whom to include in the stakeholder group. The members of this group were involved in a structured and appropriate way, all of which contributed positively to TEEB-DE's relevance and legitimacy.

As we did not practice participant observation or other forms of action research, our information on the processes of TEEB-DE is limited. However, from the statements of our informants, we can identify multi-directional dialogues both among researchers themselves and between researchers, intermediaries, policymakers, representatives of NGOs and other societal actors. However, it seems as if the interactions with policymakers *sensu stricto*, i.e., with lawmakers, were much less intensive. This is problematic given that TEEB-DE aimed both to mainstream nature conservation into other sectoral policies and integrate the ES concept into existing environmental policies. Although our interviewees stressed the importance of scientific independence, the boundary between science and politics is at times difficult to discern in TEEB-DE—especially when it comes to the summaries for decision-makers found in each report, which were jointly drawn up by scientific experts and representatives of the funding agencies. TEEB-DE acknowledges a plurality of knowledge and values insofar as the official publications emphasise that economic assessments are merely intended to complement rather than exclude or replace other perspectives and arguments.

According to the literature, conflict management within processes is important to secure an SPI's legitimacy. In the case at hand, the study leader engaged in several public debates, in person as well as in writing. While some criticisms were mentioned in the TEEB-DE reports, many others were not publicly considered. Regarding potential disagreement among the participants, the study leader stated that the extensive network of experts “formed the basis for the broad coverage and analysis of the existing knowledge, the balanced presentation of it and the derivation of recommendations for action” [29]. Unfortunately, the reader learns nothing about any conflicts among the experts and how these may have been resolved. Furthermore, it is often unclear which alternative policy options were identified in a specific thematic field and how decisions were made about the proposals to be drawn up.

This brings us to the outputs of TEEB-DE. Although the many recommendations from TEEB-DE, considered individually, are formulated in a clear and straightforward manner, their relevance may still be questioned. Indeed, the overall picture includes a number of contradictions and inconsistencies, namely:

- While TEEB-DE advocates an economic approach to nature conservation and environmental protection policies, it calls for a specific application only to those cases in which economic assessments corroborate the ambitions of conservationists and environmentalists. This can be explained by TEEB-DE's origin and funding structure. However, such an inconsistent strategy is a potential cause of misunderstandings.
- The first three reports are heterogeneous in their orientation: in contrast to the climate report, which draws on economic arguments to propose policy reforms for a closer consideration of financial and other economic instruments in environmental policies, the reports on rural areas and

cities mainly recommend the inclusion of an analytical lens, specifically the ES concept and related economic assessments, in all types of environmental policy. This constitutes a marked difference.

- Finally, the synthesis report calls the entire economic approach into question by invoking ethical and moral considerations, e.g., appealing to corporate responsibility and calling for sustainable food consumption. While we by no means disagree with these claims, they do shed light on the limitations of economic thinking in nature conservation and environmental protection. Moreover, these conclusions are not supported by evidence from the previous reports and thus hardly represent a synthesis.

Regarding the credibility and legitimacy of TEEB-DE's output, the balance is again mixed. One of the major strengths of this initiative was certainly to establish a thorough scientific peer-review process. However, credibility and legitimacy were compromised by a lack of debate on the pros and cons of different policy options and by weak links between scientific arguments and political recommendations. For instance, the finding that urban green space provides many ecosystem services does not necessarily justify the demand to include the ES concept explicitly in pertinent policies and planning instruments.

It is obvious that the initiators and coordinators of TEEB-DE faced a number of trade-offs. While they were successful in acquiring funding from the Federal Ministry of the Environment, this affiliation jeopardised their independence and hence the credibility of TEEB-DE. Then, there was an apparent trade-off between transparency and trust: the fact that the TEEB-DE reports rarely mention conflicting views, disagreements or uncertainties creates an image of unanimity and solidity, thereby fostering trust between the participants. However, it simultaneously manifests a lack of transparency. Finally, a trade-off emerged between inclusiveness and clarity: the key figures of TEEB-DE adopted an open approach, striving to include everybody who was interested in participating; however, this hampered their ability to produce a consistent set of messages and to convey a clear economic perspective on biodiversity and natural capital.

5. Conclusions

Clearly, biodiversity is a core factor in sustainability [63]. TEEB-DE was a major initiative at Germany's science-policy interface with the aim of fostering the protection of ecosystem services and biodiversity. It tried to make visible the services of nature and to help integrate them into political and corporate decision-making pathways. In this paper, we analyse TEEB-DE as a science-policy interface (SPI), specifically in terms of its credibility, relevance and legitimacy (CRELE), based on document analyses and interviews with key figures. In particular, we operationalise the CRELE framework by distinguishing four aspects of TEEB-DE as an SPI, namely its objectives, structure, processes and outputs. The main findings are that, on the one hand, TEEB-DE was highly successful in involving a large number of experts and stakeholders, in integrating different kinds of knowledge under the umbrella of its so-called broad economic approach, in attracting public attention and in producing an impressive set of reports and other outputs. On the other hand, we also show TEEB-DE to be characterised by a number of ambiguities: the objectives were overly ambitious and not obviously linked to a policy window; although TEEB-DE's structure is clear and in accordance with recommendations we found in the literature, there is little publicly-available information on its processes and there is no mention of mechanisms for conflict resolution, for instance. The contents of the outputs are hard to pinpoint, because they include many messages that are, in part, conflicting. Most strikingly in this regard, the authors of TEEB-DE are not *generally* in favour of giving economic arguments greater weight but *only* in those cases in which such arguments support the aims of nature conservation. Furthermore, one report provides economic arguments for a revision of environmental policies, while other reports revolve around the idea of advocating the ES concept and integrating it into existing policy instruments. After fundamental concerns were expressed by German scholars in regard to TEEB-DE, in particular, and the ES concept in general, some of these criticisms were addressed by representatives of TEEB-DE, while others did not receive any public response.

The CRELE framework proved useful for scrutinising an SPI such as TEEB-DE. Its sub-criteria and parameters were well suited to guide our analysis. Our research adds some insights to the CRELE framework, namely in regard to trade-offs: While confirming some trade-offs previously described in the literature, for instance between funding and independence, we identified a further compromise between inclusiveness and clarity. At the same time, our research is limited in several ways: for instance, we only considered published material; the interviews focused on a few key persons while ignoring potential or actual participants and recipients of TEEB-DE in politics, civil society and business; finally, the fact that we did an ex post analysis rather than a participant or systemic evaluation [64] excluded the possibility of a comparative before-after assessment of TEEB-DE's impact.

What lessons can be drawn from these insights? Although they may prove difficult to follow, we would like to offer some suggestions. First, TEEB-DE has demonstrated the considerable potential for pooling the expertise of Germany's many environmental and conservation scientists, who otherwise work in relative isolation, notwithstanding the various types of academic networks and other scholarly ties. However, the relevance of a future SPI in this domain could benefit from a more explicit consideration of existing or emerging policy windows in order to acquire greater policy relevance than TEEB-DE. This should also be funded by an independent agency such as the Federal Ministry of Education and Research (BMBF) to increase its credibility. Secondly, the legitimacy of such a potential future SPI could be enhanced by broadening the thematic focus and by abandoning the predominantly economic orientation. This view resonates with previous observations that the notions of ES and NC are not particularly suited to spurring political action towards conservation [65]. Hence, a future SPI in the field of biodiversity and nature conservation in Germany should be more open to different types of scientific approaches or paradigms—whether rooted in the natural sciences, in the humanities and social sciences or in economics [66–68]. Thirdly, with regard to improved credibility as well as legitimacy, a future SPI should facilitate and allow for more public debate, for contestation and an unrestricted exchange of ideas, thereby separating scientific evidence more clearly from political demands and agendas. Finally, such a platform should be constantly and comprehensively evaluated by social scientists who observe the processes and interactions as they happen.

Besides monitoring upcoming SPIs more closely and continuously, future research by social scientists could examine successful political projects in Germany such as the citizens' initiative for the protection of bees and more robust conservation laws in the state of Bavaria from 2019 [69] and elucidate the role played here by scientific findings as well as how scientists interacted with policymakers and activists.

Supplementary Materials: The following are available online at <http://www.mdpi.com/2071-1050/12/9/3701/s1>, Table S1: A list of the 30 documents that were analysed in detail.

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References

- Spierenburg, M. Getting the message across. Biodiversity science and policy interfaces—A review. *Gaia-Ecol. Perspect. Sci. Soc.* **2012**, *21*, 125–134. [[CrossRef](#)]
- Crouzat, E.; Arpin, I.; Brunet, L.; Colloff, M.J.; Turkelboom, F.; Lavorel, S. Researchers must be aware of their roles at the interface of ecosystem services science and policy. *Ambio* **2018**, *47*, 97–105. [[CrossRef](#)] [[PubMed](#)]
- Beck, S.; Borie, M.; Chilvers, J.; Esguerra, A.; Heubach, K.; Hulme, M.; Lidskog, R.; Lövbrand, E.; Marquard, E.; Miller, C.; et al. Towards a Reflexive Turn in the Governance of Global Environmental Expertise. The Cases of the IPCC and the IPBES. *Gaia-Ecol. Perspect. Sci. Soc.* **2014**, *23*, 80–87. [[CrossRef](#)]
- Kowarsch, M.; Flachsland, C.; Garard, J.; Jabbour, J.; Rioussel, P. The treatment of divergent viewpoints in global environmental assessments. *Environ. Sci. Policy* **2017**, *77*, 225–234. [[CrossRef](#)]
- Russel, D.; Jordan, A.; Turnpenny, J. The use of ecosystem services knowledge in policy-making. Drawing lessons and adjusting expectations. In *Routledge Handbook of Ecosystem Services*; Potschin, M., Haines-Young, R., Fish, R., Turner, K.R., Eds.; Routledge: London, UK; New York, NY, USA, 2016; pp. 586–596.
- Jordan, A.; Russel, D. Embedding the concept of ecosystem services? The utilisation of ecological knowledge in different policy venues. *Environ. Plan. C Gov. Policy* **2014**, *32*, 192–207. [[CrossRef](#)]
- MEA. *Ecosystems and Human Well-Being: Synthesis*; Island Press: Washington, DC, USA, 2005.
- TEEB. About TEEB: Making Nature's Values Visible. Available online: <http://www.teebweb.org/about/> (accessed on 13 November 2018).
- Hedden-Dunkhorst, B.; Braat, L.; Wittmer, H. TEEB emerging at the country level: Challenges and opportunities. *Ecosyst. Serv.* **2015**, *14*, 37–44. [[CrossRef](#)]
- Díaz, S.; Demissew, S.; Carabias, J.; Joly, C.; Lonsdale, M.; Ash, N.; Larigauderie, A.; Adhikari, J.R.; Arico, S.; Báldi, A.; et al. The IPBES Conceptual Framework—Connecting nature and people. *Curr. Opin. Environ. Sustain.* **2015**, *14*, 1–16. [[CrossRef](#)]
- Sukhdev, P.; Wittmer, H.; Schröter-Schlaack, C.; Neßhöver, C.; Bishop, J.; Brink, P.t.; Gundimeda, H.; Kumar, P.; Simmons, B. The Economics of Ecosystems & Biodiversity. Mainstreaming the Economics of Nature. A Synthesis of the Approach, Conclusions and Recommendations of TEEB. Available online: <http://www.unep.org/pdf/LinkClick.pdf> (accessed on 9 October 2014).
- Grunewald, K.; Bastian, O. Ecosystem services (ES): More than just a vogue term? In *Ecosystem Services—Concept, Methods and Case Studies*; Grunewald, K., Bastian, O., Eds.; Springer: Berlin/Heidelberg, Germany, 2015; pp. 1–11.
- Hansjürgens, B.; Schröter-Schlaack, C.; Berghöfer, A.; Wittmer, H.; Moesenfechtel, U. *Werte der Natur aufzeigen und in Entscheidungen integrieren: Eine Synthese*; UFZ: Leipzig, Germany, 2018.
- The Federal Government. German Sustainable Development Strategy: New Version. 2016. Available online: <https://www.bundesregierung.de/breg-en/issues/sustainability> (accessed on 1 November 2019).
- Jessel, B. Ökosystemdienstleistungen: Potenziale und Grenzen eines aktuellen umweltpolitischen Konzepts. In *Frischer Wind und weite Horizonte—Jahrbuch Naturschutz und Landschaftspflege, Band 58/3*; BBN: Bonn, Germany, 2011; pp. 72–87.
- Albert, C.; Schröter-Schlaack, C.; Hansjürgens, B.; Dehnhardt, A.; Döring, R.; Job, H.; Köppel, J.; Krätzig, S.; Matzdorf, B.; Reutter, M.; et al. An economic perspective on land use decisions in agricultural landscapes: Insights from the TEEB Germany Study. *Ecosyst. Serv.* **2017**, *25*, 69–78. [[CrossRef](#)]
- Bösch, M.; Elsasser, P.; Franz, K.; Lorenz, M.; Moning, C.; Olschewski, R.; Rödl, A.; Schneider, H.; Schröppel, B.; Weller, P. Forest ecosystem services in rural areas of Germany: Insights from the national TEEB study. *Ecosyst. Serv.* **2018**, *31*, 77–83. [[CrossRef](#)]
- Leibenath, M. Ecosystem services and neoliberal governmentality—German style. *Land Use Policy* **2017**, *64*, 307–316. [[CrossRef](#)]
- van den Hove, S. A rationale for science–policy interfaces. *Futures* **2007**, *39*, 807–826. [[CrossRef](#)]
- van der Sluijs, J.P.; van Est, R.; Riphagen, M. Beyond consensus: Reflections from a democratic perspective on the interaction between climate politics and science. *Curr. Opin. Environ. Sustain.* **2010**, *2*, 409–415. [[CrossRef](#)]
- Cash, D.W.; Clark, W.C.; Alcock, F.; Dickson, N.M.; Eckley, N.; Guston, D.H.; Jäger, J.; Mitchell, R.B. Knowledge systems for sustainable development. *Proc. Natl. Acad. Sci. USA* **2003**, *100*, 8086. [[CrossRef](#)] [[PubMed](#)]

22. Sarkki, S.; Tinch, R.; Niemelä, J.; Heink, U.; Waylen, K.; Timaeus, J.; Young, J.; Watt, A.; Neßhöver, C.; van den Hove, S. Adding 'iterativity' to the credibility, relevance, legitimacy: A novel scheme to highlight dynamic aspects of science–policy interfaces. *Environ. Sci. Policy* **2015**, *54*, 505–512. [[CrossRef](#)]
23. Tuinstra, W.; Turnhout, E.; Halffman, W. Usable knowledge. In *Environmental Expertise: Connecting Science, Policy and Society*; Turnhout, E., Tuinstra, W., Halffman, W., Eds.; Cambridge University Press: Cambridge, UK, 2019; pp. 126–140.
24. Rose, D.C.; Mukherjee, N.; Simmons, B.I.; Tew, E.R.; Robertson, R.J.; Vadrot, A.B.M.; Doubleday, R.; Sutherland, W.J. Policy windows for the environment: Tips for improving the uptake of scientific knowledge. *Environ. Sci. Policy* **2017**, in press. [[CrossRef](#)]
25. Wittmer, H.; van Zyl, H.; Brown, C.; Rode, J.; Ozdemiroglu, E.; Bertrand, N.; ten Brink, P.; Seidl, A.; Kettunen, M.; Mazza, L.; et al. Guidance Manual for TEEB Country Studies. Version 1.0. Available online: http://www.teebweb.org/media/2013/10/TEEB_GuidanceManual_2013_1.0.pdf (accessed on 27 October 2014).
26. Sarkki, S.; Balian, E.; Heink, U.; Keune, H.; Nesshöver, C.; Niemelä, J.; Tinch, R.; Van Den Hove, S.; Watt, A.; Waylen, K.A.; et al. Managing science-policy interfaces for impact: Interactions within the environmental governance meshwork. *Environ. Sci. Policy* **2019**, in press. [[CrossRef](#)]
27. Heubach, K.; Lambini, C.K. Distribution and selection of experts in the intergovernmental science-policy platform on biodiversity and ecosystem services (IPBES): The case of the regional assessment for Africa. *Innov. Eur. J. Soc. Sci. Res.* **2018**, *31*, S61–S77. [[CrossRef](#)]
28. UFZ. About TEEB DE. Available online: <https://www.ufz.de/teebde/index.php?en=43778> (accessed on 18 January 2019).
29. Hansjürgens, B. Danksagung des Studienleiters. In *Werte der Natur aufzeigen und in Entscheidungen integrieren: Eine Synthese*; Hansjürgens, B., Schröter-Schlaack, C., Berghöfer, A., Wittmer, H., Moesenfechtel, U., Eds.; UFZ: Leipzig, Germany, 2018; pp. 16–19.
30. Marzelli, S.; Moning, C.; Daube, S.; Offenberger, M.; Grêt-Regamey, A.; Rabe, S.-E.; Köllner, T.; Poppenborg, P.; Hansjürgens, B.; Ring, I.; et al. *Der Wert der Natur für Wirtschaft und Gesellschaft: Eine Einführung*; Ifuplan: München, Germany; UfZ: Leipzig, Germany; BfN: Bonn, Germany, 2012.
31. UFZ. Pressespiegel. Available online: <https://www.ufz.de/teebde/index.php?de=43792> (accessed on 24 January 2020).
32. VolkswagenStiftung. Wie viel ist Natur uns wert? Lässt sich der Wert der Natur und ihrer "Dienstleistungen" für uns monetär beziffern? Das Herrenhäuser Forum am 14. April gibt Antworten. Available online: <https://www.volkswagenstiftung.de/en/node/690> (accessed on 24 January 2020).
33. Deutscher Bundestag—19. Wahlperiode. Antwort der Bundesregierung auf die Kleine Anfrage der Abgeordneten (. . .) und der Fraktion BÜNDNIS 90/DIE GRÜNEN—Drucksache 19/7393—Zum Stand der Erfassung des Wertes der Natur in Gesellschaftlichen Berichtssystemen. Available online: <http://dipbt.bundestag.de/dip21/btd/19/079/1907971.pdf> (accessed on 24 January 2020).
34. BfN. *Bundeskonzept Grüne Infrastruktur: Grundlagen des Naturschutzes zu Planungen des Bundes*; BfN: Bonn, Germany, 2017.
35. Hartje, V.; Wüstemann, H.; Bonn, A. *Naturkapital und Klimapolitik—Synergien und Konflikte*; TU Berlin: Berlin, Germany; UfZ: Leipzig, Germany, 2015.
36. Wüstemann, H.; Hartje, V.; Bonn, A.; Hansjürgens, B.; Bertram, C.; Dehnhardt, A.; Döring, R.; Doyle, U.; Elsasser, P.; Mehl, D.; et al. Naturkapital und Klimapolitik—Synergien und Konflikte. In *Kurzbericht für Entscheidungsträger*; TU Berlin: Berlin, Germany; UfZ: Leipzig, Germany, 2014.
37. von Haaren, C.; Albert, C. *Ökosystemleistungen in Ländlichen Räumen: Grundlage für menschliches Wohlergehen und nachhaltige wirtschaftliche Entwicklung*; Universität Hannover: Hannover, Germany; UfZ: Leipzig, Germany, 2016.
38. Schröter-Schlaack, C.; Albert, C.; von Haaren, C.; Hansjürgens, B.; Krätzig, S.; Albert, I. *Ökosystemleistungen in Ländlichen Räumen: Grundlage für menschliches Wohlergehen und nachhaltige wirtschaftliche Entwicklung. Schlussfolgerungen für Entscheidungsträger*; Universität Hannover: Hannover, Germany; UfZ: Leipzig, Germany, 2016.
39. Kowarik, I.; Bartz, R.; Brenck, M. Ökosystemleistungen in der Stadt. In *Gesundheit schützen und Lebensqualität erhöhen*; TU Berlin: Berlin, Germany; UFZ: Leipzig, Germany, 2016.

40. Kowarik, I.; Bartz, R.; Brenck, M.; Hansjürgens, B. Ökosystemleistungen in der Stadt. In *Gesundheit schützen und Lebensqualität erhöhen: Kurzbericht für Entscheidungsträger*; TU Berlin: Berlin, Germany; UFZ: Leipzig, Germany, 2016.
41. Der Nutzen von Ökonomie und Ökosystemleistungen für die Naturschutzpraxis. *Workshop II: Gewässer, Auen und Moore (=BfN-Skripten 319)*; Hansjürgens, B., Herkle, S., Eds.; BfN: Bonn, Germany, 2012.
42. TEEB-DE. *Neun Fallbeispiele zur ökonomischen Bedeutung der Natur*; UFZ: Leipzig, Germany, 2017.
43. Hansjürgens, B.; Moesenfechtel, U. *Ökonomische Inwertsetzung zur Erhaltung des Naturkapitals: Wie eine ökonomische Perspektive helfen kann*; Springer Fachmedien: Wiesbaden, Germany, 2017. [[CrossRef](#)]
44. Hansjürgens, B.; Schröter-Schlaack, C.; Berghöfer, A.; Wittmer, H.; Moesenfechtel, U. Kernbotschaften aus ‚Naturkapital Deutschland–TEEB DE‘. In *Werte der Natur aufzeigen und in Entscheidungen integrieren. Eine Synthese*; Hansjürgens, B., Schröter-Schlaack, C., Berghöfer, A., Wittmer, H., Moesenfechtel, U., Eds.; UFZ: Leipzig, Germany, 2018; pp. 66–73.
45. von Haaren, C.; Albert, C.; Albert, I.; Döring, R.; Hansjürgens, B.; Job, H.; Krätzig, S.; Schröter-Schlaack, C.; Trepel, M.; Wiggering, H. Ökosystemleistungen und die Entwicklung ländlicher Räume: Wie eine neue Perspektive Handlungsoptionen eröffnet. In *Ökosystemleistungen in Ländlichen Räumen: Grundlage für Menschliches Wohlergehen und Nachhaltige Wirtschaftliche Entwicklung*; von Haaren, C., Albert, C., Eds.; Leibniz-Universität Hannover: Hannover, Germany; UFZ: Leipzig, Germany, 2016; pp. 326–357.
46. Hansjürgens, B. Wider Irrläufer und Fehlinterpretationen: Ökonomische Bewertung der Natur revisited. *Ökologisches Wirtsch.* **2015**, *30*. [[CrossRef](#)]
47. Hansjürgens, B.; Schröter-Schlaack, C.; Berghöfer, A.; Wittmer, H.; Moesenfechtel, U. Vorwort der Autorin und Autoren. In *Werte der Natur aufzeigen und in Entscheidungen integrieren. Eine Synthese*; Hansjürgens, B., Schröter-Schlaack, C., Berghöfer, A., Wittmer, H., Moesenfechtel, U., Eds.; UFZ: Leipzig, Germany, 2018; pp. 12–15.
48. Haber, W. Ökosystemleistungen—Strapaziertes Modewort oder neues Naturverständnis? *Nat. Und Landsch.* **2014**, *2014*, 50–55.
49. Haber, W. Zur Vorgeschichte der Ökosystemleistungen. In *Ökosystemleistungen in Ländlichen Räumen: Grundlage für Menschliches Wohlergehen und Nachhaltige Wirtschaftliche Entwicklung*; von Haaren, C., Albert, C., Eds.; Leibniz-Universität Hannover: Hannover, Germany; UFZ: Leipzig, Germany, 2016; pp. 39–40.
50. Fatheuer, T. *Neue Ökonomie der Natur. Eine kritische Einführung (Schriften zur Ökologie, Bd. 35, 2. Auflage)*; Heinrich Böll Stiftung: Berlin, Germany, 2014.
51. Hansjürgens, B. Diskussion: Wider den Koloss auf tönernem Fundament! Die Frage der Monetarisierung von Ökosystemleistungen. *Nat. Und Landsch.* **2016**, *48*, 328–332.
52. Jungmeier, M. 42!—Zur Monetarisierung von Ökosystemleistungen aus planerischer und naturschutzpraktischer Perspektive. Das Konzept auf dem Prüfstand und der Bedarf an Forschung. *Nat. Und Landsch.* **2016**, *48*, 241–247.
53. Ekardt, F. Umweltökonomik, Wachstum, Ethik und die Klimadaten. *Gaia Ecol. Perspect. Sci. Soc.* **2011**, *20*, 80–83. [[CrossRef](#)]
54. Hansjürgens, B.; Lienhoop, N. Wider das Zerrbild von der ökonomischen Bewertung. Reaktion auf F. Ekardt. 2011. Umweltökonomik, Wachstum, Ethik und die Klimadaten. GAIA 20/2: 80–83. *Gaia Ecol. Perspect. Sci. Soc.* **2011**, *20*, 229–231. [[CrossRef](#)]
55. Jedicke, E. Editorial: Geld regiert die Welt . . . —Aber ist es auch das richtige Maß für die Bewertung von Ökosystemleistungen? *Nat. Und Landsch.* **2016**, *48*, 237.
56. Kühne, O. Das Konzept der Ökosystemdienstleistungen als Ausdruck ökologischer Kommunikation: Betrachtungen aus der Perspektive Luhmannscher Systemtheorie. *Nat. Und Landsch.* **2014**, *46*, 17–22.
57. Ekardt, F. Von Fallstricken und wirklichen Lösungen. Die Ökonomisierung von Biodiversität und Ökosystemen. *Politische Ökologie* **2015**, *141*, 136–139.
58. Heiland, S.; Kahl, R.; Sander, H.; Schliep, R. Ökosystemleistungen in der kommunalen Landschaftsplanung: Möglichkeiten der Integration. *Nat. Und Landsch.* **2016**, *48*, 313–320.
59. Hampicke, U. *Naturschutz-Ökonomie*; Ulmer: Stuttgart, Germany, 1991.
60. Meyerhoff, J. Transparente Entscheidungshilfe: Die Kosten-Nutzen-Analyse in der Naturschutz-Ökonomie. *Politische Ökologie* **1995**, *13*, 65.
61. Job, H.; Woltering, M.; Harrer, B. *Regionalökonomische Effekte des Tourismus in Deutschen Nationalparks*; Landwirtschaftsverlag: Münster, Germany, 2009.

62. Rommel, K. Ökonomie im Biosphärenreservat. Eine Kosten-Nutzen-Analyse kann auch im Umweltbereich sinnvoll sein. Ein Beispiel: Biosphärenreservat Schorfheide-Chorin. *Gart. Landsch.* **1997**, *107*, 26–28.
63. UN. Transforming Our World: The 2030 Agenda for Sustainable Development. Available online: <https://sustainabledevelopment.un.org/post2015/transformingourworld/publication> (accessed on 16 March 2020).
64. Leibenath, M.; Knippschild, R. Systemic evaluation of cross-border networks of actors: Experience with a German-Polish-Czech cooperation project. *J. Borderl. Stud.* **2005**, *30*, 73–90. [[CrossRef](#)]
65. Dempsey, J. *Enterprising Nature: Economics, Markets, and Finance in Global Biodiversity Politics*; Wiley Blackwell: Malden, MA, USA; Oxford, UK, 2016.
66. Himes, A.; Muraca, B. Relational values: The key to pluralistic valuation of ecosystem services. *Curr. Opin. Environ. Sustain.* **2018**, *35*, 1–7. [[CrossRef](#)]
67. Craig, M.P.A.; Stevenson, H.; Meadowcroft, J. Debating nature’s value: Epistemic strategy and struggle in the story of ‘ecosystem services’. *J. Environ. Policy Plann.* **2019**, *21*, 811–825. [[CrossRef](#)]
68. Chan, K.M.A.; Balvanera, P.; Benessaiah, K.; Chapman, M.; Díaz, S.; Gómez-Baggethun, E.; Gould, R.; Hannahs, N.; Jax, K.; Klain, S.; et al. Opinion: Why protect nature? Rethinking values and the environment. *Proc. Natl. Acad. Sci. USA* **2016**, *113*, 1462–1465. [[CrossRef](#)] [[PubMed](#)]
69. Spiegel Online. Landtag nimmt Volksbegehren “Rettet die Bienen” ins Gesetz auf: 1,75 Millionen Menschen haben ein Volksbegehren für mehr Naturschutz in Bayern unterstützt. Nun hat der Landtag mit großer Mehrheit beschlossen, dass die Forderungen Gesetz Werden. Available online: <https://www.spiegel.de/wissenschaft/natur/bayern-landtag-nimmt-volksbegehren-rettet-die-bienen-an-a-1277873.html> (accessed on 16 March 2020).



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