Systemic Stakeholder Analysis

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Background on the methodology and its application within the Bio-Mo-D project

by

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and

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08-2024

DOI: 10.13140/RG.2.2.36065.52324

Citation:
Neumann, K.; Sievi, M. (2024): Systemic Stakeholder Analysis – Background on the methodology and its application within the Bio-Mo-D project. Consideo, Lübeck

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Summary

A multitude of stakeholders, encompassing various sectors, are involved in the modernization of ecosystem-related reporting in Germany at both corporate and national levels. The Bio-Mo-D project aims to identify pathways towards these objectives and recognize key stakeholders and their roles. Employing an *explorative* stakeholder model aids in comprehending the factors facilitating and hindering each objective, as well as the interconnections between them and the roles played by numerous stakeholders. A refined *descriptive* model further illustrates generic dynamics, facilitating the identification of major stakeholders along impact chains. This enhanced understanding of processes, triggers, and dynamics enables the Bio-Mo-D project to identify e.g. potential *advocacy coalitions*, underscoring the significance of pilot applications in catalyzing the dynamics of reinforcing feedback loops in the *mainstreaming process* and the need for feasible *science-policy-interfaces*.

Keywords

Systemic, Stakeholder, Biodiversity, Qualitative Modeling, Cause and Effect Modeling

Research question

The Bio-Mo-D project[3] seeks to modernize and expand economic accounting and reporting in Germany for both, the national and corporate levels, by integrating indicators for the state of nature (national accounting) and the impact of economic activities (corporate reporting) on nature respectively. It focuses on ecosystem services, biodiversity, and the ecosystem accounting. The aim is to provide business, political and social leaders with information to make ecologically sustainable decisions – and thus to ensure that sufficient value is placed on nature and biodiversity.

One focus of the project is to map the stakeholder landscape in order to get a better understanding of who the stakeholders are, their role as a lever towards modernization, as a hinderance, as a user of the data, or as a profiter from ecosystem services.

The challenge is to not just name stakeholders or simply categorize them, but also to explore the weight of their role, to identify the potential for synergies and alliances, and at the same time keep track of the external developments during the project.

Methodological background

A systemic stakeholder analysis is based on a cause-and-effect model (Sterman 2000) that explores the interplay of all the aspects behind the overall objective, in this case the modernization of the economic accounting and reporting regarding ecosystem services, whether they are hard factors such as methodology, data, usage of information, regulation, or soft factors like motivation, political agenda, mainstreaming, or competitiveness.

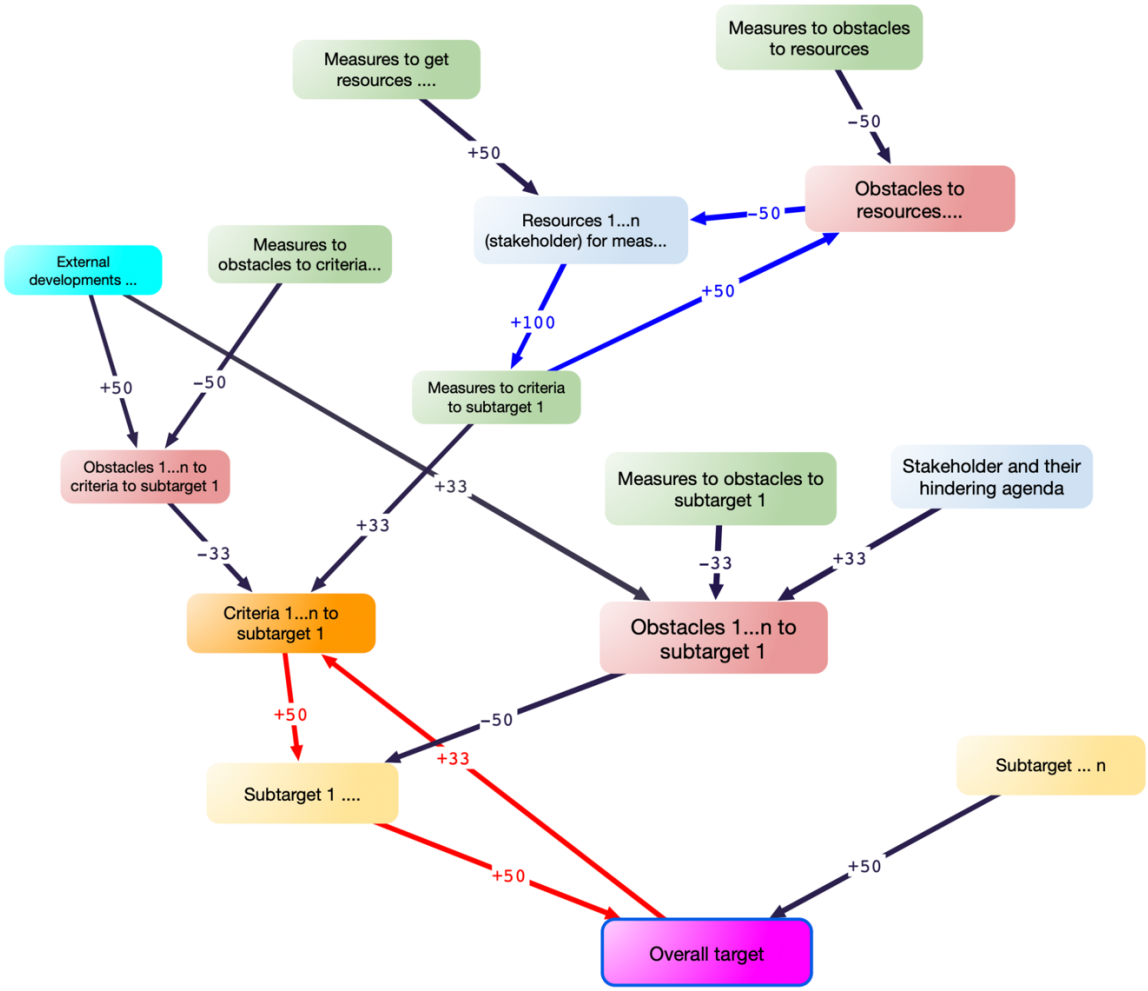
It is not to be confused with a systemic stakeholder modeling (Neumann et al. 2018), which implies the collaborative modeling together with the stakeholders. Nevertheless, the Bio-Mo-D project was holding a series of workshops with stakeholders who gave valuable input to the model.

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[3] The project is funded by the Research Initiative for the Conservation of Biodiversity (FEdA) of the Federal Ministry of Education and Research (BMBF). The project duration spans from 2021 to 2024. For more information, see website https://bio-mo-d.ioer.info

It should also not be confused with a systematic stakeholder analysis, which usually involves creating a list of stakeholders and categorizing them according to their importance. Nevertheless, at the beginning of the project, both approaches were pursued in parallel. The categories included aspects like “potential for activation”, “potential impact”, or “connectivity”. This approach was abandoned once the number of relevant stakeholders grew massively, from the originally envisaged about 50 to the now more than 200 stakeholders that are in total triggering more than 1,300 impacts depicted by connections between the factors. Unfortunately, defining their weight regarding the different criteria became too time consuming for the project.

Fig. 1 The general structure of an explorative stakeholder model



Weighted cause and effect relations between factors with a reinforcing feedback loop (red) and a balancing feedback loop (blue) highlighted. The colors of the factors indicate their category to later compare measures, obstacles, resources, targets, stakeholders, etc.
Source: own representation, Bio-Mo-D Project.

The cause-and-effect model is a qualitative model (Neumann 2012) that first establishes connections between so called factors using arrows, indicating the impact: whether one factor is increasing the other (+) or decreasing (-) it. As figure 1 shows for example measures can lead to more (+) of a criterion or to less (-) of a problem. In a second step, the impacts can be weighted by relative comparison, determining whether one factor has a stronger or weaker impact compared to the other factor’s effect onto the same factor.

Since the background of the topic is defined by soft (see soft systems thinking (Checkland 1999) and hard factors equally, the basis for the assumptions within the model can't all be validated data. Rather it is a qualitative approach known from *grounded theory* or *qualitative social research* (Maxwell 2012). If no data or other facts, such as regulations, are available, the assumptions are based on expert's estimates. If not a larger number of experts is available, sometimes it is the estimate of just a few experts. Assumptions are valid until more experts disagree or validated data proves otherwise.

The quality of a model is thus defined by both, the consideration of crucial factors and the correct interconnections. It is important to note that in the sense of abductive logic, the conclusions from these kinds of models are valid until there are flaws found in the model (Hasty; Daws, 2010). In other words, one cannot doubt the model's conclusion unless false or missing connections or factors are identified.

For rather complex challenges, this often means that people have a fixed mindset and doubt the whole model without taking the effort to investigate potential flaws of the model. Also, not using a model to explore a complex challenge means that conscious or even subconscious assumptions remain vague and non-transparent, hence the saying 'any model is better than no model', as a model can be communicated and improved.

A model can be analyzed by just reading and interpreting the interconnections or by computer-based analysis of dynamics from feedback loops and the sum of impacts along multiple impact chains. Some software tools also allow for weighting of connections and even distinguish between short-, medium-, and long-term weights.

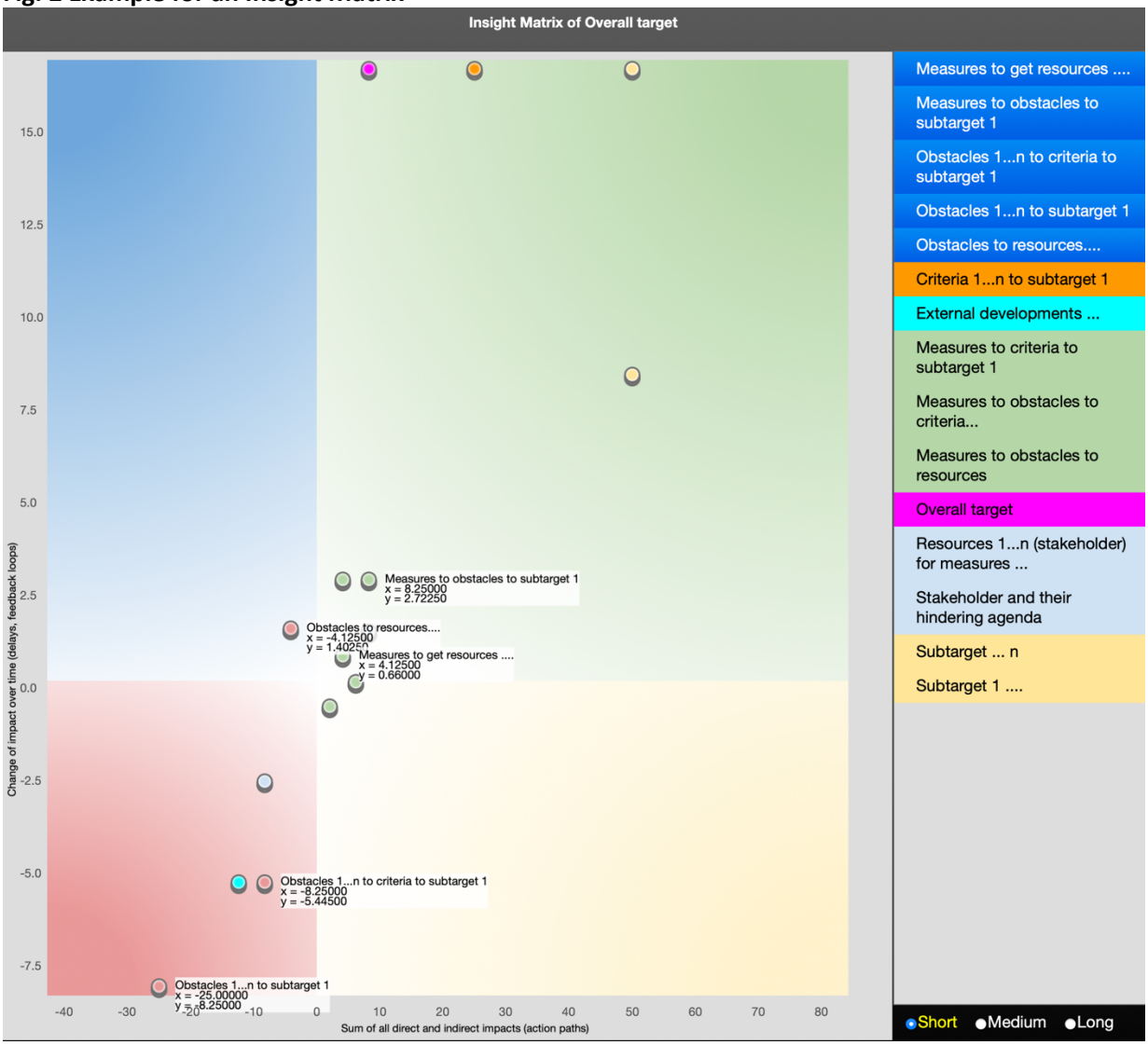
If the connections are weighted, the analysis can calculate the weighted impacts the different factors have onto a selected factor, such as the objective of the project. For this, there are basically three approaches: the sensitivity model (Vester 2007), the so called fuzzy cognitive maps (FCM) (Kosko 1985), or the approach from Consideo and their software iMODELER (Neumann 2022). While the sensitivity model only works under ideal conditions[4], the FCM and iMODELER can be applied for all cause-and-effect models. Both start the calculation of a factor's impact with an impulse value of 1, which is multiplied by the weights along the different impact chains towards a selected target factor.

The iMODELER enhances the FCM approach, by considering and incorporating the effects of feedback loops. It thus combines the weighted impact from impact chains with the potential effects from feedback loops, indicating how an influence might change from short term to medium term and long term. The result is an insight matrix (figure 2) showing the x-axis for the impact and the y-axis for the change of the impact over time. Alternatively, a tornado chart (figure 3) lists the values of the x-axis for an easier comparison of the different factors.

The feedback loops, as we should later see, play a crucial role in the modernization of economic reporting. There are (figure 1) balancing feedback loops that potentially reverse an impact, and there are reinforcing feedback loops, that increase an effect whether it is a vicious or a virtuous cycle.

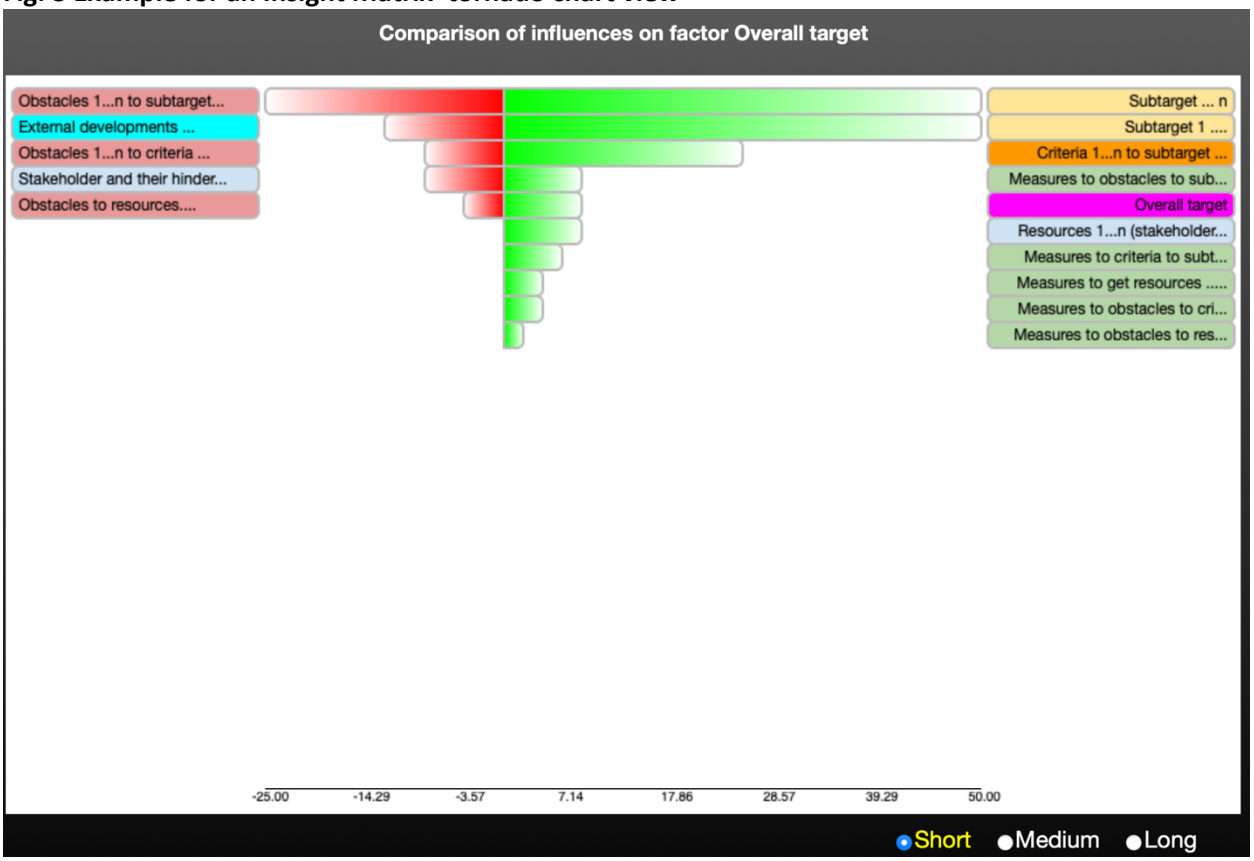
[4] Vester (2007) names 18 bio-cybernetical criteria

Fig. 2 Example for an Insight Matrix



The position on the horizontal axis indicates the positive or negative impact of a factor onto a chosen factor – in this case on the overall target. The vertical position indicates the change of impact from short- to medium- to long-term.
Source: own representation, Bio-Mo-D Project.

Fig. 3 Example for an Insight Matrix' tornado chart view



The tornado-chart shows the x-values from the Insight Matrix for a selected time step.
Source: own representation, Bio-Mo-D Project.

A model can be explorative or descriptive, with the latter being the visualization of a system already known, while the former seeks to reveal what the system is (Neumann 2012). Of course, sometimes these two are combined in a model.

There are two ways to structure an explorative model. Either it is started by some form of collection of the potentially important factors that are afterwards connected, or it is started from a target factor systematically asking by what it is directly influenced and connecting that with either a (-) or a (+) arrow. This process is continued for all factors by asking what influences them until concrete actions to reach a target are identified. One way of facilitating these questions is the so called Know-Why-Method (Neumann, 2012), which explicitly asks for factors, that are needed, and for factors, that are hindering, in the present and in the future. There is a meta-systemic approach behind it that is not further explained in this paper.

The Bio-Mo-D stakeholder model is based on the explorative collection of influencing factors onto the target factors to then connect the different stakeholders to the factors they influence. Only in some cases the project identified stakeholders who could not be connected to the existing factors and thus required additional factors to explain their role. Figure 1 shows the general structure of the stakeholder model.

In the project's model there are lots of factors representing criteria. Also, there are several factors representing obstacles or measures to more than one other factor. And there are stakeholders connected with more than one measure or obstacle from both subtargets. These manifold interconnections lead to synergies, trade-offs, and feedback loops.

The explorative model on stakeholders for the Bio-Mo-D project, therefore, does not just show the importance of the different stakeholders, it also reveals general levers for action that should consequently be influenced by stakeholders as well.

The explorative model became quite comprehensive. Hence, for a better understanding of the challenge, the synergies, and the role of different types of stakeholders, we have afterwards derived a smaller, descriptive model from the large explorative model. That will be described further down below.

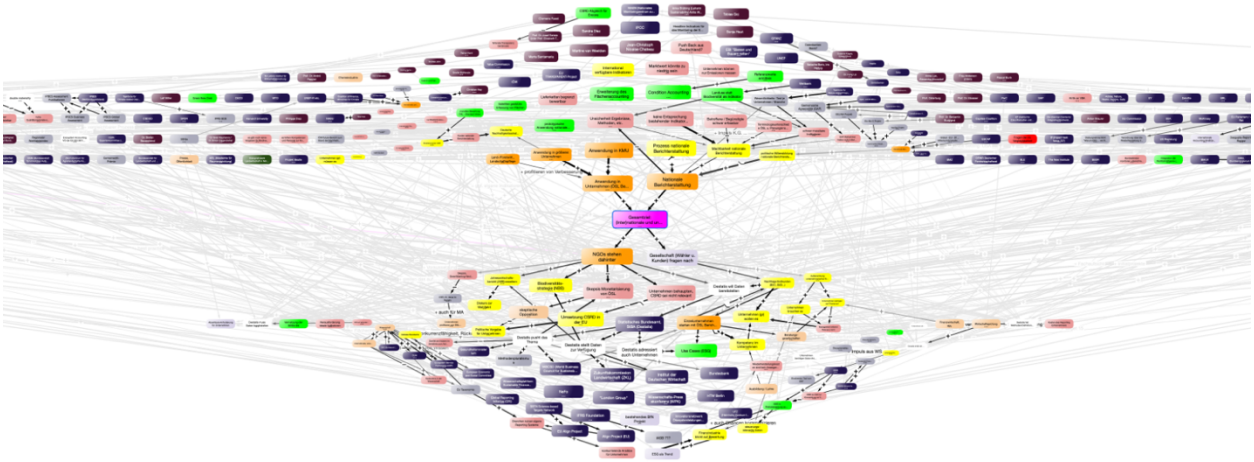
Structure of the explorative model

The research consortium from The Leibniz Institute of Ecological Urban and Regional Development (IOER), Helmoltz Centre for Environmental Research (UFZ), Institute for Futures Studies and Technology Assessment (IZT), the Value Balancing Alliance (VBA) with BASF, and Consideo developed the model from internal as well as from workshops with stakeholders[5] (Grunewald et al. 2022; Grunewald 2023), from parallel projects and publications, and from targeted interviews. Sources and discussions are documented right within the model with the factors and the connections.

The consortium decided to use the explorative model only as an internal tool, so it became possible to name certain opposing stakeholders without the impression of any allegedly political bias.

The model started from a factor collecting both targets, the reporting of the state of ecosystem services and the impact onto them on a company's and the national level.

Fig. 4 The shape of the overall model in a not readable view showing just a part of the model



The model from perspective of the overall target (pink) to modernize both corporate and national reporting/accounting using a fisheye-effect. The model uses more than 10 categories, e.g. stakeholders (dark blue), targets (yellow), obstacles (red), projects (grey), concrete measures (light green).
Source: own representation, Bio-Mo-D Project.

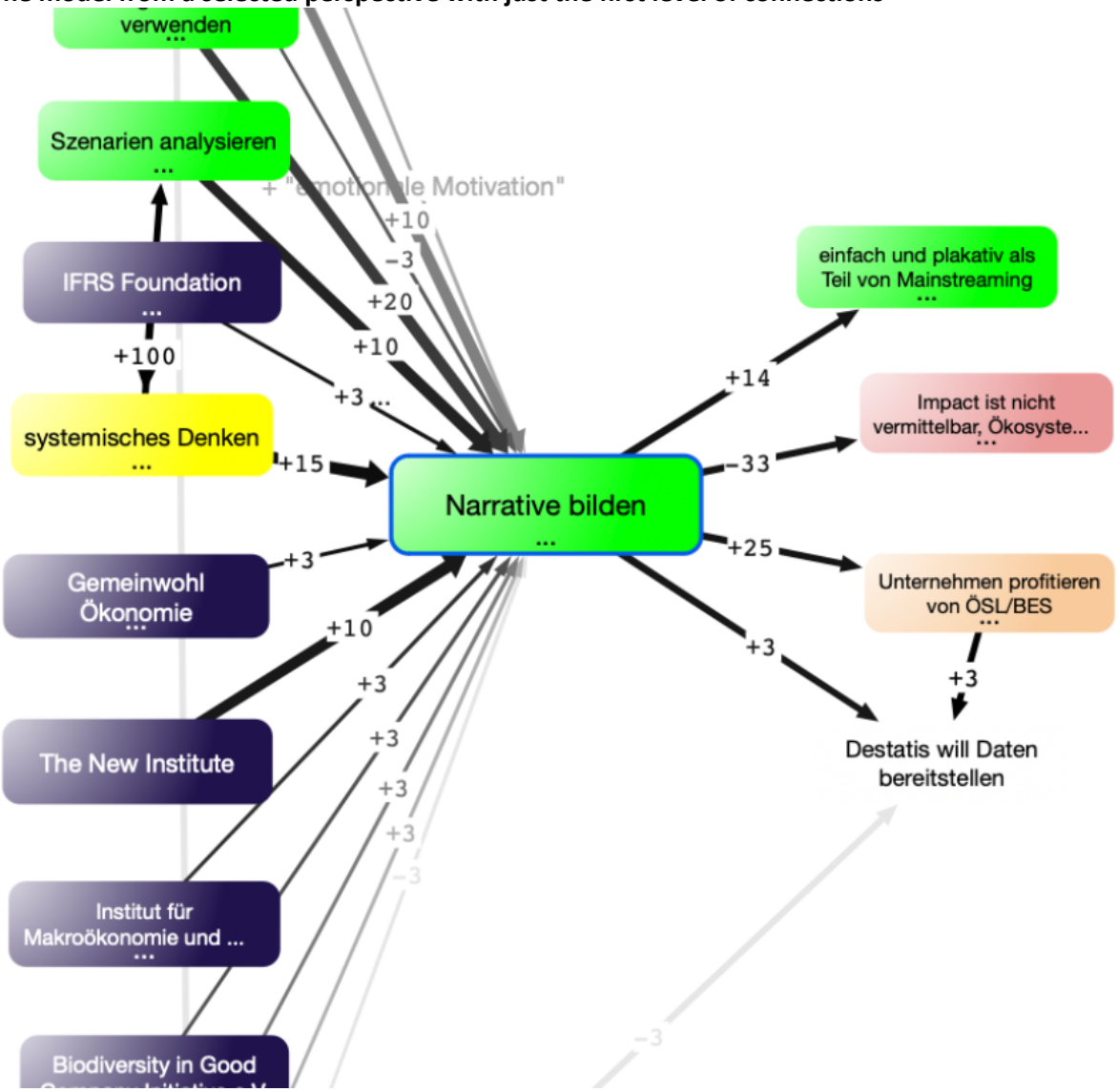
The model currently contains a total of 597 factors, 1,372 connections, more precisely with factors for 232 institutional stakeholders, 127 concrete persons, and 61 projects or tools. Since there are interconnections between the activities that lead to the reporting and the use of the data, as there are dynamics that describe for example a process of mainstreaming of the topic, the model has become quite

[5] Experts from the natural, social, and political sciences, representatives from businesses, federal ministries, federal agencies, and conservation organizations (Grunewald 2024-1).

complex featuring more the seven million feedback loops. Figure 4 shows the shape of the model with the combined target (pink factor) in the center and the many interactions between the factors that lead to a reporting and those that make use of the reporting. The lighter color of the connections in the background is a feature of the software to just indicate the many more connections that become readable only through changing to different perspectives.

To work with the model the consortium used the iMODELER's feature to focus certain perspectives and reduce the number of connections. Figure 5 randomly shows the model from the perspective of the factor "Narrative bilden" with just the first level of impacts and effects.

Fig 5 The model from a selected perspective with just the first level of connections



The model from the perspective of the factor "Narrative bilden" (developing narratives) showing just the first level of connections. The weights of the connections are either set by the software after the user selects "weak", "very weak", "medium", "strong" or "very strong" from a list, or manually adjusted.
Source: own representation, Bio-Mo-D Project.

Weighting of impacts

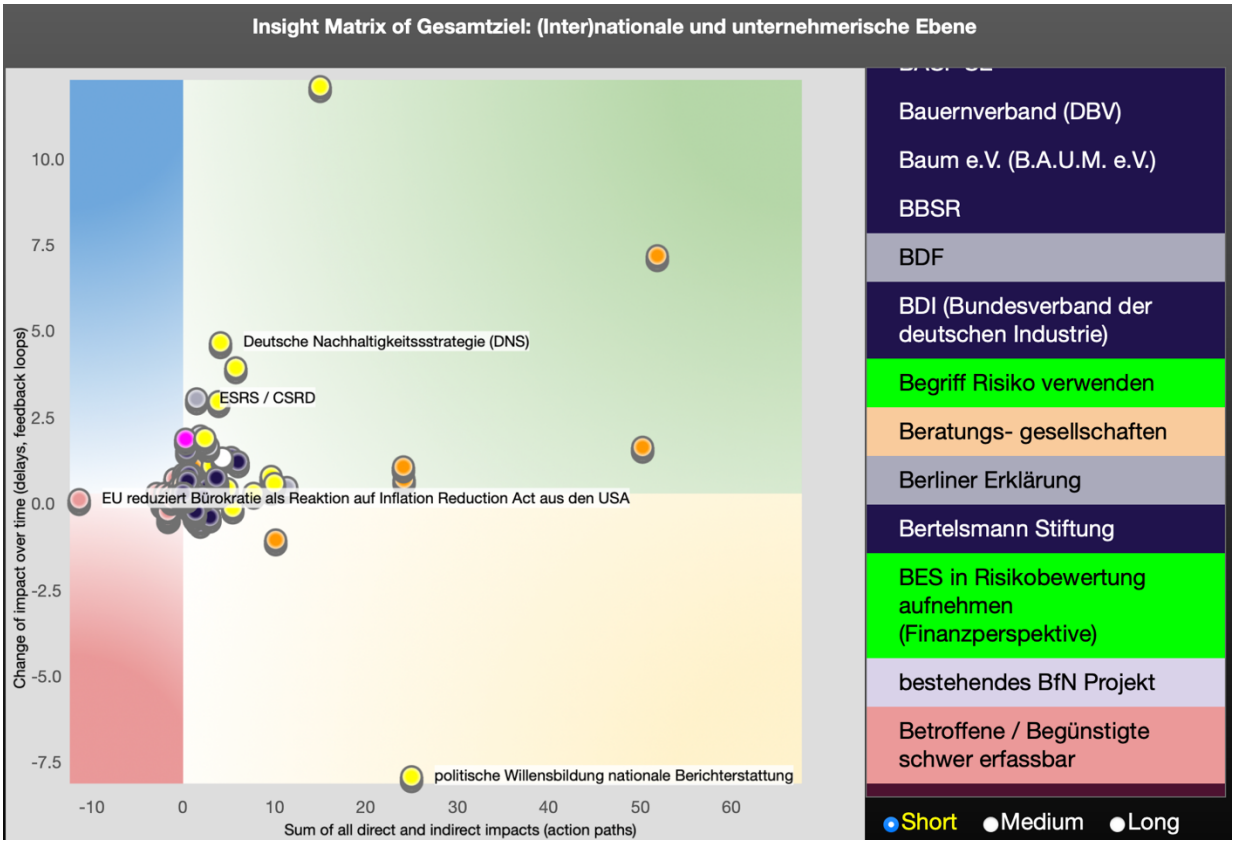
As mentioned before the quality of the model depends on the consideration of the crucial factors and on the correctness of the interconnections. The quality of the weighting of the connections therefore also improves with the availability of data and otherwise with the quality of the input from experts and studies.

One after the other, for each factor the relative strength of the impact of the influencing factors is compared. Either there is data that allows to distribute percentage values or a fuzzy ranking of what has the most and what the least impact is carried out. If applicable there is further differentiation between the short-, medium-, and long-term weight. Figure 3 shows the weight of the connections onto the factor "Narrative bilden" (creating narratives).

The consortium had to make a sacrifice to this approach as the number of stakeholders and the dynamics of the developments in the field were binding the resources so there was only time for a *pareto optimal* weighting. Therefore, for many factors only strong, and weak influences were defined leaving the rest without further differentiation as medium impacts. Consequently, the analyses only show what is important and what seems to be less important, but they don't show a ranking of the influences although the matrix and the tornado chart would suggest that.

Analyses of the model

Fig 6 An example of an insight matrix from the Bio-Mo-D project

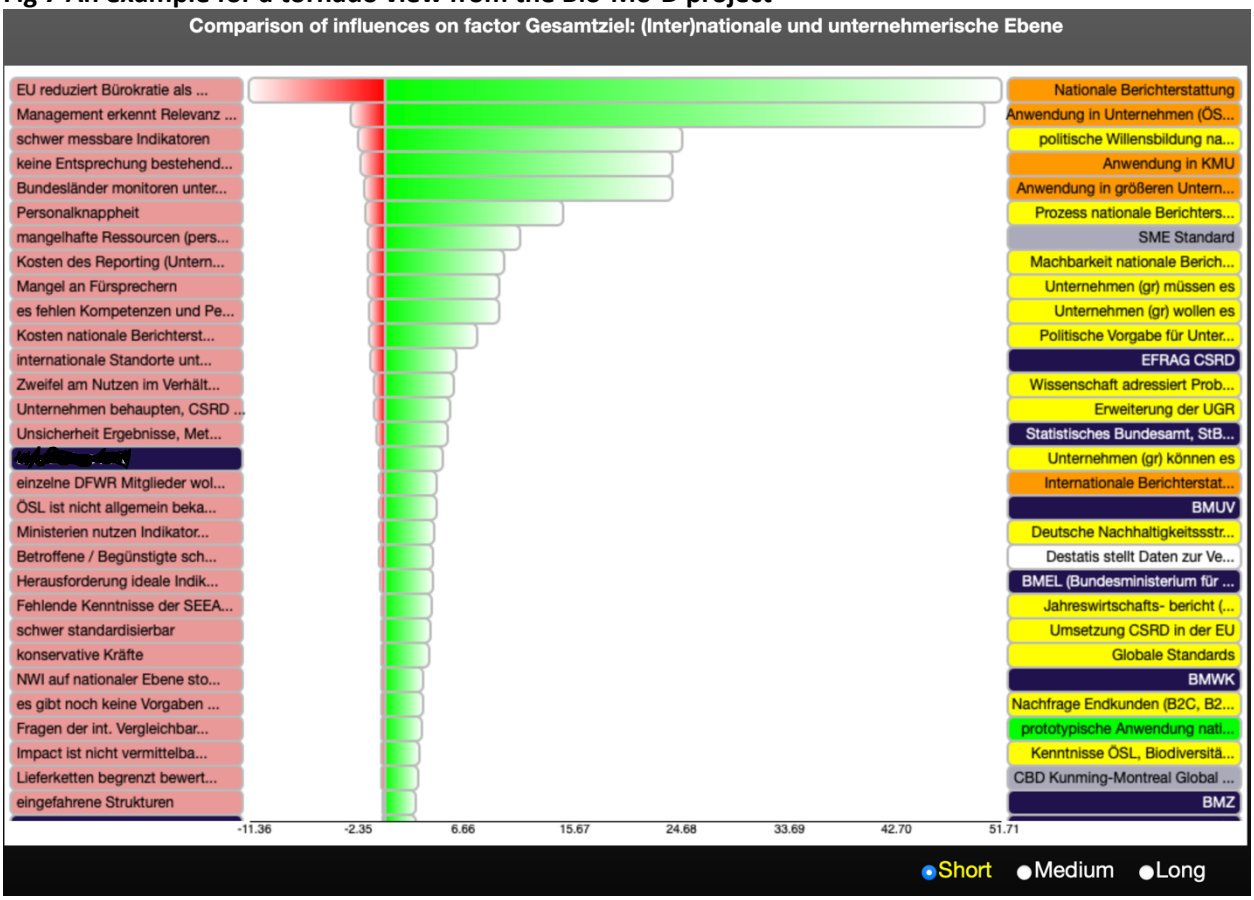


Source: own representation, Bio-Mo-D Project.

There are multiple ways to analyze the model to identify effective measures and crucial stakeholders. The first step usually is to look at the insight matrix (figure 6) of the overall goal of both the national accounting and the corporate reporting.

As noted, in this project because of the pareto optimal weighting the result cannot be the exact order of impacts, but only the differentiation whether a factor has a stronger or a weaker impact and whether this is changing over time. Figure 7 shows a list of factors with apparently a ranking of the factors with a negative effect on the target on the left side and a positive effect on the right side.

Fig 7 An example for a tornado view from the Bio-Mo-D project



The Tornado-View shows the x-values of the Insight Matrix for the selected time stamp (short-, medium-, or long-term) with the x-values being the sum of the weighted impact chains of the different factors towards the target.
Source: own representation, Bio-Mo-D Project.

That way some possible flaws can be detected if some factors appear to be on the wrong side. It can be checked from both the matrix and the tornado chart what cause chains and what feedback loops explain a factor's effect. If the connections are correct there is obviously no flaw.

The analysis of the overall target shows the importance of a factor to reach both targets. For the Bio-Mo-D project it was important to see the relevance for each target, the national accounting and the corporate reporting. Also, the analyses should reveal synergies and potentials for *advocacy coalition* (Sabatier, Weible 2007) forming. To achieve that, the matrices of the single targets were put next to each other to identify factors of common relevance.

The analyses were carried out from different points of view. Measures and targets and obstacles were compared as were stakeholders filtered after their criteria as national or international scientific organizations, national or international political players, media, company players, NGOs, or potential beneficiaries of a reporting or accounting.

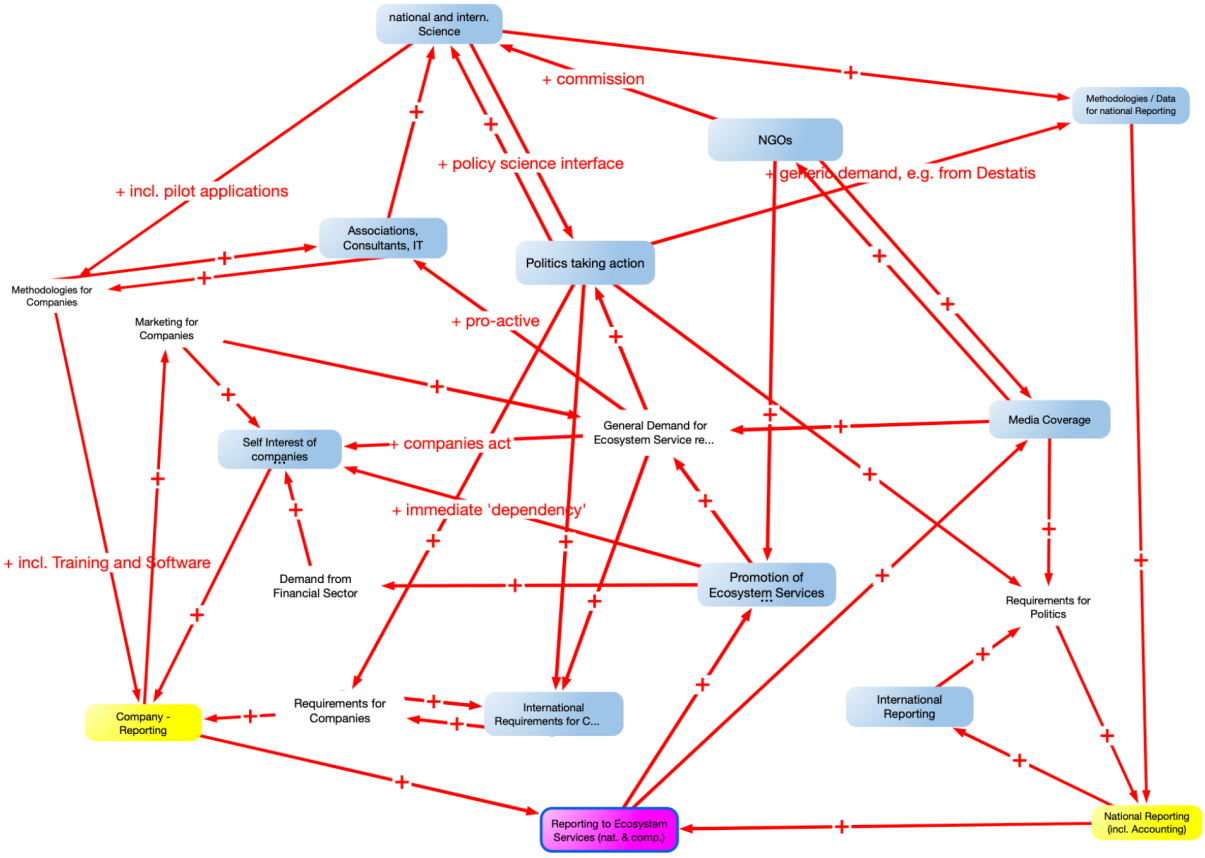
The factors that were equally relevant whether as a synergy or a trade-off then were further analyzed through their cause chains and feedback loops.

Since the explorative models grew quite comprehensive containing a huge number of feedback loops and cause chains, we derived a smaller descriptive model that helps to look at the basic mechanisms and dynamics behind the targets.

Deriving a descriptive model

The generic model features 72 reinforcing feedback loops that show the potential dynamics towards exponential progress. Figure 8 shows the processes that lead to both targets and the basic interconnections between both targets. Of course, international developments (the corporate sustainability reporting directive (CSRD) as a mandatory reporting standard for large companies, the UN's system of environmental economic accounting ecosystem accounts (UN-SEEA-EA) for the national accounting, targets of the Kunming-Montreal Global Biodiversity Framework) influence both targets as would any legal requirements. Both targets need methodology and data. The biggest synergy is the mainstreaming that leads to self-interest for both companies and politics. Many companies are also triggered by immediate dependency from ecosystem services or at least from growing demand from the financial industry. For both targets, pilot applications could trigger the reinforcing feedback loops as virtuous cycles.

Fig 8 The descriptive generic model highlighting 98 reinforcing feedback loops (red)



A descriptive model derived from the explorative model aggregating the stakeholders such as NGOs, Media Coverage, Politics, Science, Companies, etc.

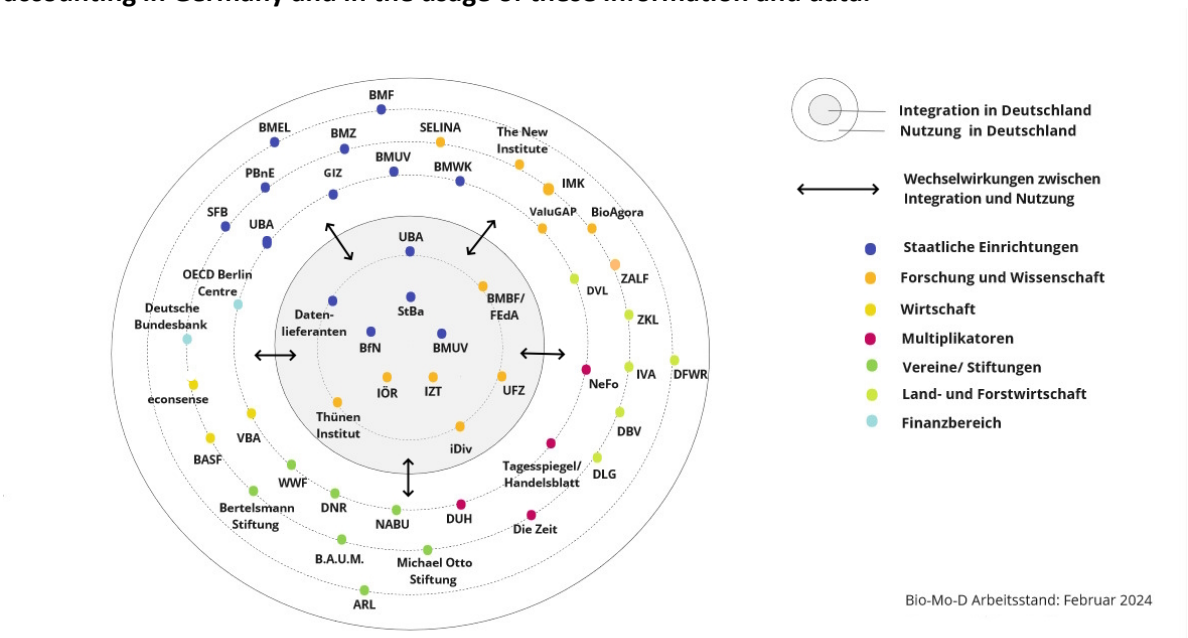
Source: own representation, Bio-Mo-D Project.

The blue factors from the generic model stand for categories of stakeholder like science, national politics, companies, media, NGOs, or beneficiaries of a promotion of ecosystem services in the explorative model. It is thus feasible to analyze the importance of the different stakeholders from each category to then see the major drivers along the processes and for the feedback loops. This analysis is used to suggest so called *advocacy coalitions* (Sabatier/Weible 2007; Weible et al. 2010; Weible/Ingold 2018) between them. *Advocacy Coalition* refers to a form of alliance of actors or groups with similar political goals and interests. These coalitions are characterized by shared similar fundamental convictions and worldviews, as well as a collective intent to influence or change existing policies in the same direction.

Utilization of the results within the Bio-Mo-D Project

The models and their analyses serve the Bio-Mo-D project in many ways, starting with a way to collect the large numbers of stakeholders and properly describe their role. Figure 9 provides a current insight into the research work based on a section of stakeholder modeling. It helps to identify stakeholders for interviews, focus groups or targeted networking events, and to form questions around the processes towards the targets. And it serves as basis for the identification of potential *advocacy coalitions* as well as for the reflection of important *science-policy-interfaces*, both described with further publications from the Bio-Mo-D project (Grunewald et al. 2024-2). For context, the science-policy-interface is defined 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” (van den Hove, 2007, p. 807).

Fig 9 Identification of stakeholders in the integration of ecosystem information into national accounting in Germany and in the usage of these information and data.



The stakeholder analysis can be differentiated into two phases: phase of compiling ecosystem information and phase of societal usage of this information. In the integration phase, actors from science and research as well as actors from governmental institutions play a significant role. The usage phase involves actors from science and research, business, media, NGOs, finance, etc.
Source: own representation, Bio-Mo-D Project.

Discussion

The systemic approach compared to a mere systematic approach offers various benefits by generating new insights. If the roles of stakeholders remained trivial with no new insights the mere listing of stakeholders in a table with categories might have been the easier way especially if the model grows to a size where the researchers lack the resources for a proper weighting of all the connections. However, the pareto optimal solution of weighting only the strong and weak impacts is feasible, if there is no need for a detailed ranking of overall influences from the stakeholders.

In the Bio-Mo-D project, the systemic stakeholder analyses on the one hand showed the importance of the dynamics of mainstreaming and the prototype applications for both targets as a trigger to the synergetic mainstreaming. Part of a mainstreaming would be the development of proper science-policy-interfaces.

During the project some major and ongoing developments dominated the role of stakeholders like the mandatory reporting standard for larger companies, the corporate sustainability reporting directive (CSRD) for companies fostered by the European Financial Reporting Advisory Group (EFRAG) (EFRAG 2022; Wildner et al. 2022) and the Kunming-Montreal Global Biodiversity Framework (CBD 2022; Förster et al. 2023), and for the national reporting the UN's system of environmental economic accounting ecosystem accounts (UN-SEEA-EA) (United Nations et al. 2021; Zieschank/Grunewald 2023). Decisive developments like these and the introduction of such obligations and agreements require an adoption of the weighting of influences of existing factors and sometimes new, additional factors, so that the model is continuously updated and supplemented with new data.

Both a challenge and a major benefit is the integration of the researchers from the consortium to motivate them to not just provide input to the model in facilitated sessions but to work with the model all by themselves. The tool offers the feature of a collaborative link and a changelog for teamwork on the same model. After all, some researchers still find the systemic approach unconventional compared to linear systematic approaches. They tend to prefer a small number of aggregated arguments to back the importance of a stakeholder instead of the logical conclusion from a systems analysis from a model that features a very large number of interconnected and thus transparent arguments.

Declarations

Ethical Approval

Not applicable.

Funding

The project is funded by the Research Initiative for the Conservation of Biodiversity (FEdA) of the Federal Ministry of Education and Research (BMBF). The project duration spans from 2021 to 2024. For more information, see website https://bio-mo-d.ioer.info.

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