Inventory of behaviour science theories potentially influencing biodiversity decision-making
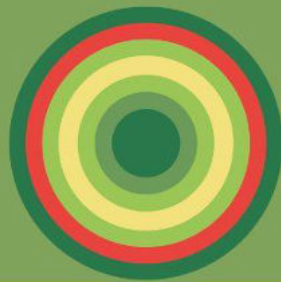
Deliverable number: D1.2

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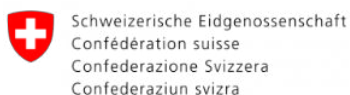* Corresponding author, email: hakon.aspoy@nina.no

April 2023

PLANET4B

BETTER DECISIONS FOR BIODIVERSITY AND PEOPLE

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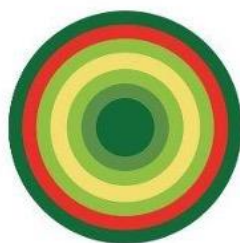
PLANET4B

BETTER DECISIONS FOR BIODIVERSITY AND PEOPLE

Key deliverable information

Project acronym	**PLANET4B**
Project title	understanding Plural values, intersectionality, Leverage points, Attitudes, Norms, behaviour and social lEarning in Transformation for Biodiversity decision making
Starting date	01st November 2022
Duration	36 months
Website	https://planet4b.eu/
Project coordination and scientific lead team	Ilkhom Soliev; Alex Franklin; Agnes Zolyomi; Torsten Wähler

Deliverable number	**D1.2**
Deliverable title	Inventory of behaviour science theories potentially influencing biodiversity decision-making
Task leader	Norwegian Institute for Nature Research (NINA)
Dissemination level	Public
Status	Final

Deliverable description

The report is the result of a systematic review of published literature on disciplinary approaches including behaviour and social sciences to provide an inventory of theories potentially applicable for influencing biodiversity decision-making. A complementary review of previous EU and global projects (grey literature) that have tested behavioural and decision-making interventions for biodiversity decision-making will also be included.

Version	Status	Date	Authors/Reviewers
0.1	Draft	16/04/2023	Authors: Håkon Aspøy (NINA); Yennie Katarina Bredin (NINA); Berit Junker-Köhler (NINA).
0.2	Draft	18/04/2023	Reviewers: Alex Franklin (CU); Ilkhom Soliev (MLU); Agnes Zolyomi
0.3	Draft	26/04/2023	Authors: Håkon Aspøy (NINA); Yennie Katarina Bredin (NINA); Berit Junker-Köhler (NINA); David Nicholas Barton (NINA)
0.4	Draft	27/04/2023	Reviewers: Alex Franklin (CU); Ilkhom Soliev (MLU); Agnes Zolyomi

Acknowledgements

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Executive summary

- As part of facilitating a shared starting point for engaging with behavioural and decision-making approaches to biodiversity, the aim of Task 1.2 was to develop a framework of disciplinary approaches to biodiversity relevant decision-making.
- To date, very limited information is available about what influences decision-making related to biodiversity. Therefore, there is an urgent need of information to better prioritise biodiversity in policy making and enable relevant stakeholders.
- The aim of Task 1.2 was to map expertise and experience of theories and relevant concepts within the consortium and make it available to all partners.
- We undertook two reviews of theoretical approaches to decision-making potentially relevant for biodiversity purposes in terms of relevant theoretical considerations and their application within global and European research projects.
- While the first review focuses on peer-reviewed research publications and relevant theories; the second review focuses on other relevant research projects.
- The reviews used the expert knowledge in the PLANET4B consortium with references to published book chapters, peer-reviewed literature and additional analysis of research projects.
- Together, the two reviews yielded 63 relevant theories, frameworks, models, and concepts, and 12 relevant research projects.
- Results were classified according to an intrapersonal-interpersonal-institutional gradient.
- Interpersonal and institutional perspectives were the most represented in both inventories.

1 Introduction

To transform policies to prioritize biodiversity loss, we primarily need to change the paradigms of systems that shape our behaviours and mindsets (Meadows, 1999) of key enabling actors and institutions across a wide range of sectors and at different scales. To change mindsets, we need to understand better what drives biodiversity related decisions and behaviour and how these are formed by deeper social-behavioural constraints such as values, norms and the intersectionality of social structures (Kaijser and Kronsell, 2014). We also need to understand how decision-making of individuals is shaped by institutional arrangements, broadly understood here as the informal and formal rules that guide human action (including policies and cultural and social norms). Based on the understanding of these complex systems we can develop and test adequate methods and pathways to trigger transformative governance to prioritize biodiversity.

In this report the project collects and classifies a range of frameworks[1], theories[2], models[3], and concepts[4] across a gradient of intrapersonal, interpersonal, and institutional levels of intervention. PLANET4B's wide range of interventions and choices of case studies are implicitly or explicitly built on a series of underlying discipline-specific theories of change, linking intervention design to biodiversity impact. Theoretical assumptions of behaviour and intersectionality along with leverage points (Meadows 1999) need to be diagnosed early in the project to scope analytical commonalities and complementarities useful to move forward with the project, such as in comparing a wide range of case study findings and developing input for policy making. The process of collecting, classifying and comparing theories is also expected to promote transdisciplinary learning and understanding among the project partners.

With this background, the objective of Task 1.2 was to provide an inventory of behavioural- and social science theories used by PLANET4B consortium partners in their work in the project. This can give insights about disciplinary assumptions about behaviour and decision-making that may influence biodiversity. A key element was to map these theories according to a gradient of intrapersonal, interpersonal, and institutional approaches as one input to common working processes and a framework for promoting transdisciplinary thinking among partners. The inventory was based on a review of published literature on disciplinary approaches that was provided by the consortium members. A complementary review of grey literature was conducted to identify projects that had tested behavioural and decision-making interventions for biodiversity decision-making. Example projects were also classified according to the intrapersonal-interpersonal-institutional gradient.

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[1] The development and use of a general **framework** helps to identify the elements and relationships among these elements that one needs to consider for institutional analysis. Frameworks organize diagnostic and prescriptive inquiry. They provide the most general list of variables that should be used to analyze all types of institutional arrangements. Frameworks provide a metatheoretical language that can be used to compare theories. They attempt to identify the universal elements that any theory relevant to the same kind of phenomena would need to include. Many differences in surface reality can result from the way these variables combine or interact with one another. Thus, the elements contained in a framework help analysts generate the questions that need to be addressed when they first conduct an analysis (see Ostrom, 2019).

[2] The development and use of **theories** enable the analyst to specify which elements of the framework are particularly relevant to certain kinds of questions and to make general working assumptions about these elements. Thus, theories focus on a framework and make specific assumptions that are necessary for an analyst to diagnose a phenomenon, explain its processes, and predict outcomes. Several theories are usually compatible with any framework. Economic theory, game theory, transaction cost theory, social choice theory, covenantal theory, and theories of public goods and common-pool resources are some examples (see Ostrom, 2019).

[3] The development and use of **models** make precise assumptions about a limited set of parameters and variables. Logic, mathematics, game theory, experimenta- tion and simulation, and other means are used to explore systematically the consequences of these assumptions in a limited set of outcomes. Multiple models are compatible with most theories. An effort to understand the strategic structure of the games that irrigators play in differently organized irrigation systems, for example, developed four families of models just to begin to explore the likely consequences of different institutional and physical combinations relevant to understanding how successful farmer organizations arranged for monitoring and sanctioning activities (see Ostrom, 2019).

[4] "**Concepts** are the way that we make sense of the social world. They are essentially labels that we give to aspects of the social world that seem to have common features that strike us as significant. ... the social sciences have a strong tradition of concepts, many of which have become part of the language of everyday life. Concepts such as bureaucracy, power, social control, status, charisma, labour process, cultural capital... alienation, and so on are very much part of the theoretical edifice that generations of social scientists have constructed. Concepts are a key ingredient of theories. Indeed, it is almost impossible to imagine a theory that did not have at least one concept embedded in it." (Bryman, 2012, p.8)

2 Methodological approach

2.1 Selecting theoretical inputs and information on relevant projects

The data material surveyed for this review consisted of published literature on behavioural- and social science theories potentially applicable for biodiversity related decision-making. Data collection was carried out in two separate processes. In the first process, peer-reviewed scientific articles, theoretically dealing with biodiversity related decision-making, were targeted. We focused this search on literature that was readily available about our target subject. Rather than doing a state-of-the-art systematic and comprehensive literature review with the aim of achieving externally valid generalizations, our aim was to map expertise and experience within the consortium and make it available to all partners. The approach taken here does in several ways correspond to what Paré et al. (2015) refer to as a narrative review (see also Davies, 2000). Our review also sought to determine certain trends or patterns within the body of literature that partners provided, in this case in the levels that theories and interventions could address for understanding or influencing biodiversity related decision-making (see Figure 1). Thereby, our approach also has elements resembling a descriptive review (King & He, 2005; Paré et al., 2015; Rumrill et al., 2010).

Mapping and reviewing the expert knowledge about behavioural- and social science theoretical inputs that could influence or inform us about biodiversity related decision-making was done by involving the PLANET4B consortium. An invitation to the various partners was issued, asking for input on theories that they were familiar with and that could be relevant for biodiversity related decision-making. Partners were also asked to provide example publications that showcased the applicability of these theories. This was done for two primary reasons: (I) to utilize the rich expert resources available within the project, represented by its partners, and (II) to facilitate understanding among partners and set up a shared knowledge base of theoretical approaches for understanding decision-making potentially relevant for biodiversity.

To complement the review of the consortium's expertise, a second review of research projects was conducted using *The Community Research and Development Information Service* (CORDIS)[5]. This is the European Commission's "primary source of results from the projects funded by the [European Union's] framework programmes for research and innovation".[6] Additional searches on Google were also carried out. Results were scanned and projects corresponding to the aim of Task 1.2 were recorded in a separate database.

Results were classified according to a gradient of intrapersonal, interpersonal, and institutional perspectives (see Figure 1 and Table 1). This gradient was developed for the proposal to enable mapping theoretical approaches at multiple levels. A multi-level approach to this subject is beneficial for two reasons. First, it can help increase a shared analytical understanding of the various conceptual levels on which project partners deal with behavioural change. Second, such an analytical understanding of the multiple levels on which behavioural change can occur is strategically important for

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[5] https://cordis.europa.eu/
[6] https://cordis.europa.eu/about/en

the output of PLANET4B and its uptake in policy (or other arenas of significance for biodiversity relevant decision-making).
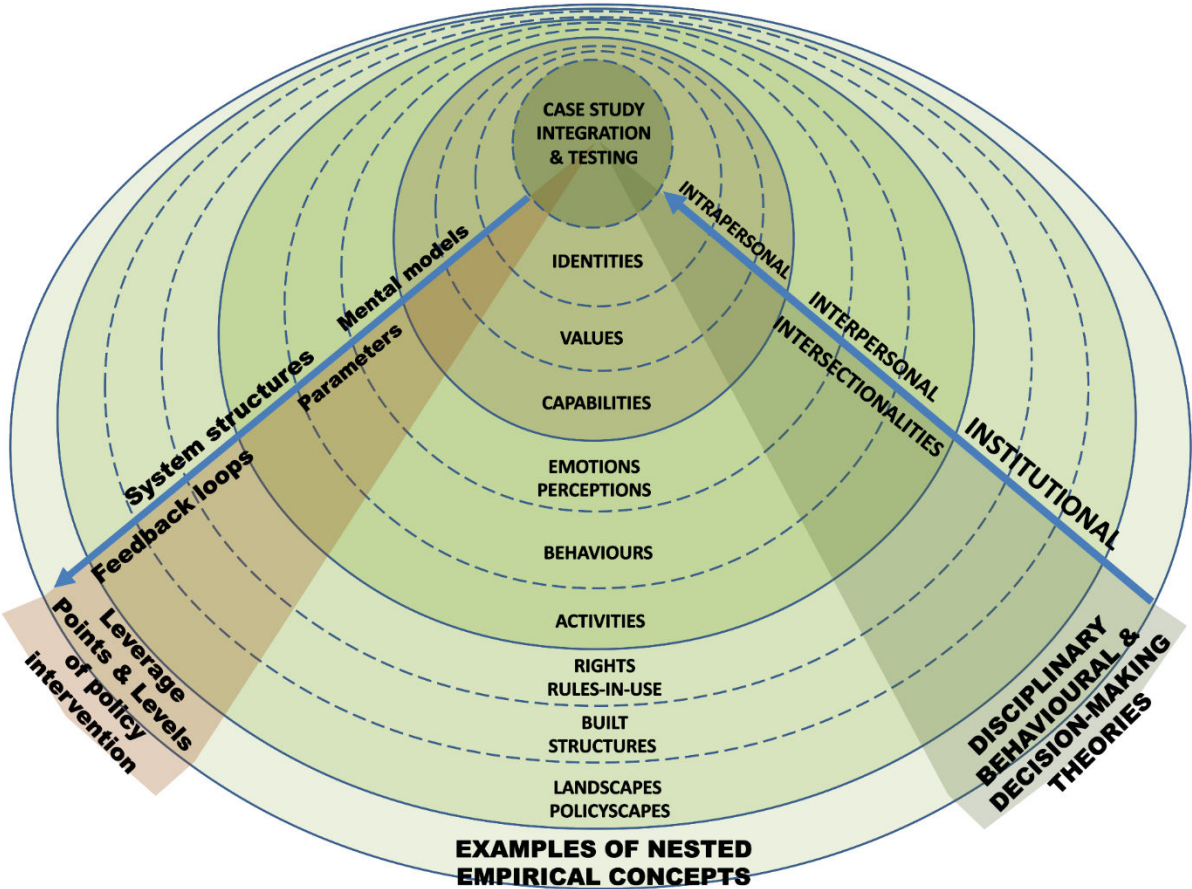

Figure 1. Classification of theories according to intrapersonal, interpersonal and institutional conceptual levels provides a common diagnostic framework for the project. Source: own elaboration.

Moving forward in WP1 and towards Task 1.5, we will develop a transdisciplinary diagnostic framework for case studies of biodiversity related decision-making. There, the classification of theories according to conceptual levels (Figure 1) will facilitate discussions with case studies about which theories of change underly their expectations about systems change, the biodiversity impact of interventions in their case, and their expectations about relevant policy recommendations. A common "leverage points" framework for PLANET4B may further help to identify assumptions about intervention design that are derived from theory or discipline specific assumptions (Figure 2).
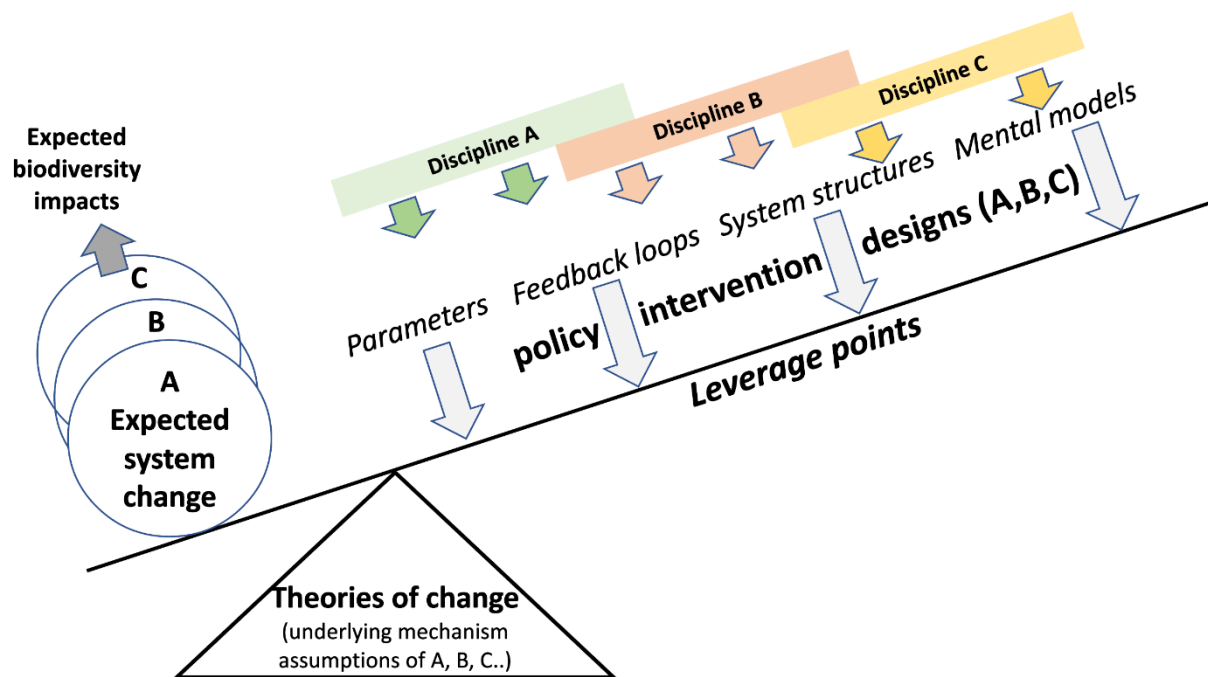
Expected biodiversity impacts

C

B

A

Expected system change

Discipline A

Discipline B

Discipline C

Parameters Feedback loops System structures Mental models

policy **intervention** **designs (A,B,C)**

Leverage points

Theories of change
(underlying mechanism assumptions of A, B, C..)

Figure 2. The classification of theories according to conceptual levels. Source: own elaboration.

2.2 Research question and review process

Review of PLANET4B expertise on theories

To review published literature on theoretical considerations from behavioural- and social sciences related to biodiversity decision-making, the following research question was formulated:

Which theoretical considerations from behavioural- and *social sciences, based on the expertise available within the consortium, are potentially applicable to behaviour and decision-making relevant for biodiversity?*

The PLANET4B consortium was consulted in an inquiry issued to all partners, asking them to contribute with theoretical inputs that they were familiar with, and which could be relevant for understanding biodiversity related behaviour and decision-making. An excel spreadsheet was set up as an initial and internal database for partners to fill out information including I) their names, so that for each theory, we would have the contact of an expert within the consortium; II) name of the theoretical input and; III) a peer-reviewed publication as an example of how each of the suggested theoretical inputs may be understood or applied. During a first round of reviews, the authors of this report then classed the theoretical inputs according to disciplinary affiliation. This was done to ensure detection of whether knowledge from some well-established disciplines were missing. In addition, the theoretical inputs were classed according to the levels of change that they were designed to understand or intervene at. Based on the content of the example publications, the theoretical inputs were thus placed according to the conceptual levels addressed, spanning a gradient from intrapersonal to, interpersonal, and institutional change (Table 1). After this initial round of reviews, a second round of invitations was sent for the source partners to review the classifications. Source

partners were asked to provide short descriptions of the theoretical inputs that they had contributed. During this round of revisions and through workshop discussions under Task 1.4, partners were also encouraged to add any additional theoretical inputs that were missing from to the list of frameworks, theories, models, and concepts that could be important for studying biodiversity relevant decision-making.

Grey literature review

To carry out the complementary review of projects (grey literature), the following research question was formulated:

How have disciplinary theories and practices been tested in projects through behavioural and decision-making interventions for biodiversity decision-making?

To identify the most appropriate database for finding projects, we consulted the NINA (Norwegian Institute for Nature Research) library, which has ample experience with systematic and grey literature searches. Subsequently CORDIS was chosen. Whereas CORDIS offers several options for generating research results, its 'Results in brief'-alternative was chosen. The reason for this was twofold. Firstly, it generates one result per project and, secondly, it effectively separates finalised projects from ongoing projects. Because the interest of Task 1.2 was on projects that can demonstrate impact, this report focuses on results in the former category. Results in the latter category are covered by the database of Task 5.3, which focuses on identifying ongoing projects and initiatives, for forging synergies with PLANET4B.

Keywords

Keywords were identified in collaboration with Task 5.3, which has a partly overlapping objective of mapping ongoing EU (European Union) projects of relevance for PLANET4B. Suggested keywords were listed in a document in SharePoint, an online platform that is integrated with Microsoft Office and which allows for collaboration and sharing of documents. The list of suggested keywords was thus shared with a core group of Task 1.2 participants for input and suggestions. In selecting keywords, the emphasis was given to include keywords that are of direct relevance to PLANET4B, such as biodiversity, and a wide variety of other subjects. The following keywords were used:

Primary keywords

"Biodiversity"

Alternative primary keywords

"Biological diversity"
"Species diversity"
"Genetic diversity"
"Community composition"

Secondary keywords

"Behavioural science" ("behavioral science")
"Intersectionality"
"Gender"
"Ethnicity"
"Leverage points"

"Attitudes"
"Creative methods"
"Transformative change"
"Theor*"
"Social theory"
"Behavioural theory" ("behavioral theory")
"Social science"
"Behavioural intervention" ("behavioral intervention")
"Behavioural change" ("behavioral change")
"Nudging"
"Degrowth"
"Institutional change"
"Psychology"
"Decision-making"
"Decision-making intervention"
"Arguments"
"Perception*"

Initial trial searches in CORDIS illustrated that one long search string including all keywords generated a vast and indiscriminate database (containing more than 7,000 projects), thus being poorly suited for identifying relevant results. Conducting separate searches for each primary keyword combined with each secondary keyword, on the other hand, yielded a comprehendible number of results and proved far more effective. For instance, searching for "'biodiversity' AND 'gender'" yielded 14 project results in English.

Together the searches that combined "biodiversity" with each of the secondary keywords yielded 174 separate project results. These were screened qualitatively in CORDIS before those with potential of falling within the scope of PLANET4B were recorded in a database. Together these amounted to 14 separate research projects.

Further, as in other parts of this task, internal resources were utilized. PLANET4B project partners were asked to contribute to our database by adding research projects (finished or ongoing) that might be of relevance to the task. This resulted in the inclusion of six additional projects, and thus a total of 20 projects in the database.

As the number of resulting projects was low, a second round of literature searches was initiated to limit the possibility of important projects being left out of the inventory. This was done by using the above listed alternative primary keywords, synonymous with, or similar to, "biodiversity", coupled with each of the secondary keywords. Altogether the 104 (4*26) searches yielded 23 additional projects which were compiled in a separate inventory for further scrutiny. After a screening process, three projects were selected as relevant for the scope of PLANET4B Task 1.2. Of these, one project was already recorded in the database, whereas the remaining two were new additions. Screening was carried out by two team members separately and yielded identical results. Consequently, the database amounted to 22 projects with potential of falling within the scope of PLANET4B. By critically considering the focus on change for biodiversity for each individual project, the database was further condensed to include 10 finalised projects with relevant outputs for biodiversity related decision-making.

As CORDIS only contains EU funded research projects, additional searches were carried out in Google to identify relevant projects outside of the EU. This resulted in the addition of two other projects (MEASURING IMPACT and NSF1658608) to the database, which then totalled 12 projects. To align the results with the published literature, the projects were classified according to level of change addressed along the intrapersonal-interpersonal-institutional gradient, also identifying their theoretical inputs (Table 2).

3 Results

3.1 Findings from the peer-reviewed literature and book chapter review – inventory of theoretical input

Within the PLANET4B consortium, 53 theoretical inputs from 12 behaviour- and social science disciplines were identified as potentially applicable to biodiversity related decision-making. These were supported by examples from both peer-reviewed articles and published book chapters. By classifying the theories according to the example literature and an intrapersonal-interpersonal-institutional gradient we found that theories covered the three levels, albeit with uneven distributions. Findings are highlighted in Table 1 (inventory of theoretical input) and Appendix 1 (short descriptions and references).

The following four observations can be made about the inventory of theoretical inputs and our attempt to classify these.

First, theoretical inputs addressing the intrapersonal level were the least represented.
In total, our results contain 18 different theoretical inputs that aim to understand biodiversity related decision-making at the intrapersonal level. These theoretical inputs were especially well represented in the disciplines of economics and psychology.

Second, theoretical inputs addressing the interpersonal level were the most represented in our data.
In total, 35 different entries were classified as interpersonal. In addition to being the most well-represented category of theories, interpersonal perspectives were evenly distributed among the listed disciplines in our dataset.

Third, theoretical inputs addressing the institutional level were the second most represented.
In total, 32 different theoretical entries were classified as institutional. Theoretical inputs addressing the institutional level were less represented by psychology than other disciplines. Disciplines with a substantial presence of institutional perspectives in our data include political science, science- and technology studies, and interdisciplinary approaches.

Fourth, theoretical inputs were represented by 12 disciplines from behaviour- and social sciences.
The most represented disciplines include psychology (n = 16), sociology (n = 11), economics (n = 10), and political science (n = 10). For psychology, input at the intrapersonal level was the most represented. For sociology and economics, input at

the interpersonal level was the most represented. For political science, input at the institutional was the most represented.

Table 1. Inventory of theoretical input based on PLANET4B expert knowledge from the behavioural- and social sciences that may influence biodiversity decision-making. Theoretical input is mapped to a gradient of intrapersonal, interpersonal, and institutional levels of intervention.

Discipline	Theoretical input	Intra-personal	Inter-personal	Institutional
Anthropology	Community Action Research		X	
	Cultural-evolutionary theory	X	X	X
	Ontological politics			X
Economics	Behavioural change wheel	X		
	Commons		X	
	Degrowth			X
	Farmer decision-making and behavioural factors ('System 2' thinking)		X	
	Game theory		X	
	Institutional analysis and development framework		X	X
	Institutional change theory		X	X
	Nudging	X	X	X
	Path dependency		X	
	Prospect Theory	X	X	
Human geography	Epistemologies of the South			X
	Integrating local and indigenous knowledge		X	X
	Theory of communicative action		X	X
Interdisciplinary approaches	Leverage points for transformation			X
	Telecoupling			X
	Transformative social innovation and grassroots innovation theory			X
Law	Intersectionality		X	X
Philosophy	Pragmatism/Pragmatist theory of inquiry		X	X
Political science	Nudging	X	X	X
	Commons		X	
	Decolonial theories			X
	Institutional change theory		X	X
	Path dependency			X
	Policy integration			X
	Political ecology			X
	Transformative research		X	X
	Transformative sustainability governance		X	X
	Worlding environmental governance			X
Psychology	ABC (Attitude-Behaviour-Choice) framework	X		
	Behaviour change wheel	X		

	BIT's upstream-downstream model with 'EAST' model (easy, attractive, social and timely)	X		
	COM-B (capability, opportunity, motivation: behaviour)	X		
	Human-nature interactions (ecopsychology)	X	X	
	Normative conduct (influencing)/social norms	X	X	
	Nudging	X	X	X
	Prospect theory	X	X	
	Psychological biases	X	X	X
	Psychological theories	X	X	
	Psychosocial frameworks	X		
	Salience	X		
	Theory of environmentally significant behaviour	X		
	Theory of planned behaviour	X		
	Value-action gap	X	X	X
	5E Model of Environmental Engagement (positive psychology)	X		
Science- and technology studies	Co-production of knowledge		X	X
	Ontological politics		X	X
	Post-normal science		X	X
	Responsible research and innovation		X	X
Social Ecology	Leverage points for transformation		X	X
Sociology	Community Action Research		X	
	Cultural-evolutionary theory	X	X	X
	Epistemologies of the South			X
	Feminist care ethics		X	X
	Nudging	X	X	X
	Social equity		X	
	Social practice frameworks	X	X	
	Social solidarities and collective identities		X	
	Socio-ecological resilience theory		X	
	Theory of communicative action		X	X
	Transformative context-based social investment			X
Sustainability science	Mode 2 knowledge production		X	X
	Leverage points for transformation		X	X
	Transdisciplinarity		X	X
	Transformative research		X	X

3.2 Findings from the grey literature review – project inventory

The multiple grey literature searches yielded 22 potentially relevant research projects. After further scrutiny, two of the projects were omitted from classification as they are still ongoing, making it difficult to determine reported impact of change at the

intrapersonal, interpersonal, or institutional levels. Another eight projects did not examine biodiversity-related behaviour and decision-making and were duly omitted from further analyses. Based on the results in brief the remaining 12 projects were classified according to their reported levels of impact along the intrapersonal-interpersonal-institutional gradient, and their theoretical input was identified. Results are highlighted in Table 2.

The following four observations can be made about the project inventory and our classification of reported results.

First, grey literature at the intrapersonal level was the least represented.
As for the review of published book chapters and peer-reviewed literature, the fewest projects reported on interventions at the intrapersonal level. From the grey literature review, only two projects, BIOMOT and BIOCORE, actively engaged with decision-making for biodiversity at this level. Further, the focus of these two projects were not limited to the intrapersonal level. Rather, both projects spanned all three levels of the gradient.

Second, grey literature at the interpersonal level was the second most represented.
In total, seven research projects were classified as dealing with biodiversity relevant decision-making at an interpersonal level. Two of these projects were exclusively attributed to this category. The remaining five overlapped with the other levels (two with the institutional level and three projects spanned all three levels).

Third, grey literature at the institutional level was the most represented in our data.
Nine research projects dealt with decision-making for biodiversity purposes at an institutional level. Four projects were categorized as exclusively institutional. Two of the projects related to both the institutional and the interpersonal levels, whereas three projects spanned all three levels.

Fourth, 11 theoretical inputs from six disciplines were identified in the 12 projects.
Ten of these were not among the theoretical inputs identified by PLANET4B partners (Table 1). Theoretical inputs identified from projects are presented in Table 2 and described in the Appendix 1.

Table 2. Inventory of research projects that have engaged with biodiversity-relevant behaviour or decision-making at the intrapersonal, interpersonal, or institutional levels of intervention. Theoretical input and discipline are specified in the table. For descriptions of the theoretical input, please see Appendix 1.

#	Acronym with project link	Name of project	Theo-retical input	Discipline	Intra-personal	Inter-personal	Instit-utional
1	ConFooBio	"Resolving conflicts between food security and biodiversity conservation under uncertainty"	Game theory	Economics		X	
2	BIOMOT	"MOTivational strength of ecosystem services and alternative ways to	Theory of committed	Interdisciplinary approaches	X	X	X

		express the value of BIOdiversity"	action for nature				
3	BIOSEC	"Biodiversity and Security: understanding environmental crime, illegal wildlife trade and threat finance"	Social justice theory	Political sciences; Philosophy			X
4	LITTLE TOOLS	"Enacting the Good Economy: Biocapitalization and the little tools of valuation"	Actor-network theory	Science- and technology studies			X
5	BESAFE	"Biodiversity and Ecosystem Services: Arguments for our future Environment"	Psychological biases (Framing)	Psychology			X
6	SOILSERVICE	"Conflicting demands of land use, soil biodiversity and the sustainable delivery of ecosystem goods and services in Europe"	Rational choice theory	Economics			X
7	SILCI	"Social Influence and Disruptive Low Carbon Innovations"	Social influence theory	Psychology		X	
8	POLICYMIX	"Assessing the role of economic instruments in policy mixes for biodiversity conservation and ecosystem services provision"	Institutional analysis and development framework	Economics		X	X
9	BIOCORE	"Risks of global warming: the case of coral reef ecosystems in developing countries"	Rational choice theory	Economics	X	X	X
10	OPERAS	"Operational Potential of Ecosystem Research Applications"	Socio-cultural valuation	Sustainability science		X	X
11	MEASURING IMPACT	"Measuring Impact. Stakeholder Engagement for Biodiversity Conservation Goals. Assessing the Status of the Evidence"	Stakeholder engagement / Stakeholder theory	Sustainability science		X	X
12	NSF1658608	"Psychosocial, Motivational, and Cooperative Effects of Communication, Enforcement, and Participatory Decision-	Humanistic rational choice theory	Economics		X	X

		Making in Resource Dilemmas"					

3.3 Limitations

In this task we have carried out two reviews of limited scope. Regarding the *review* of *published book chapters and peer-reviewed literature* we developed a methodology that allowed us to utilize the resources within the consortium in as systematic a way as possible. To this end, the project consortium functioned as our data population. Our findings are thus indicative of, and limited to, the knowledge and expertise of PLANET4B partners. An important reason to limit the inventory to review expert knowledge within the consortium was the nature of the project. Because PLANET4B is a transdisciplinary effort, its partners have different backgrounds and experiences. It was therefore a part of the planned research process to unpack the different experiences and make them accessible to everyone in the consortium at an early stage of the project. Whereas the topic driven approach taken here may not adhere to the same rigor as a systematic literature review in the classical sense, it allowed for effectively capturing and systemizing behavioural- and social science theories that are relevant for studying and engaging with biodiversity related decision-making. Because the PLANET4B consortium unites scholars and practitioners with very rich expertise combining knowledge and experiences from many relevant disciplines and practices across natural sciences, social sciences and the humanities, our review provides a valuable theoretical resource bank for PLANET4B and others to build on.

Inevitably, this approach has resulted in an inventory that is far from exhaustive. A notable potential limitation concerns the representation of disciplines. Several disciplines from behavioural and/or social sciences which have actual or potential relevance for studying biodiversity related decision-making are possibly lacking from this inventory. The same thing can be said about how disciplines are delineated in our inventories. Our results should not be regarded as building on definitive and official disciplinary definitions, but, again, rather as a product of the knowledge and experience in the PLANET4B consortium.

Under different circumstances, our current review could have been expanded to include peer-reviewed literature on theoretical approaches to biodiversity related decision-making beyond the expertise of the PLANET4B consortium. In going forward, the inventory will be kept as a living document to be further elaborated on, especially to assist the development of a transdisciplinary diagnostic framework (see also section 3.3 below).

With regards to the *grey literature review* we took a different approach. Here we did in fact use resources beyond the consortium. However, the literature searches for the review were mostly restricted to one database, again, due to the boundaries of the task, and input from PLANET4B partners. For purposes beyond the scope of PLANET4B and Task 1.2, additional databases could be surveyed to expand on the results of the present review.

3.4 Process towards developing transdisciplinary diagnostic framework(s) for biodiversity interventions

This report D1.2 is part of a process of understanding the theories applied by case studies to select and test interventions and how they form expectations about policy recommendations to come out of the empirical work (Figure 3). The first step is classifying theories proposed by partners according to their intrapersonal, interpersonal or institutional conceptual levels (Table 1), as well as their disciplinary "home ranges".
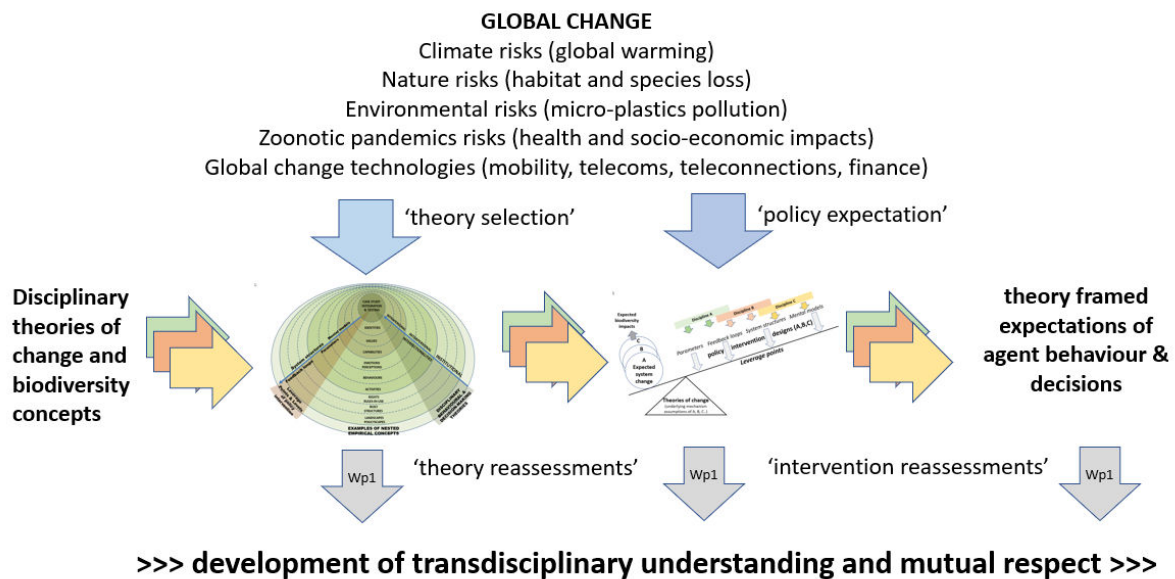
Figure 3. Identifying theories of change underlying case study policy interventions and recommendations as part of a transdisciplinary process. Source: own elaboration.

Following steps in WP1 (and with support of WP2) is to identify a common leverage points framework that can be used to identify the leverage points each theory assumes, and which can explain the choice of interventions and theoretical expectations about their impacts on biodiversity through system change (Figure 2). The intention of these diagnostic framework(s) is to develop transdisciplinary understanding and hence mutual respect across project partners for case studies and policy proposals that transcend widely ranging case study contexts and scales.

4 Conclusion and outlook

In this task we have shed light on efforts to engage theoretically with behaviour and decision-making relevant for biodiversity. We have completed two separate review processes, one based on experts' knowledge (who then provided published examples of theoretical applicability), and one based on project reports. By systemizing the knowledge and experience of the PLANET4B project consortium we have built an inventory of potentially useful theoretical considerations for studying biodiversity-related decision-making. We complemented this inventory with examples from applications of such theoretical considerations within the grey literature of previous EU, USAid (United States Agency for International Development), and NSF (United States National Science Foundation) projects. Through this process we sought to facilitate

understanding and knowledge exchange among project partners from the various disciplinary, formal, and empirical backgrounds represented within PLANET4B. As such, our inventory provides insights about the use of different theoretical considerations from the behavioural- and social sciences for understanding biodiversity-related decision-making.

Through our reviews, we have generated two databases that can be accessed for future inquiries of PLANET4B or other projects. Specifically, the inventories of theoretical inputs and projects will be used to facilitate knowledge transfer and understanding among PLANET4B partners through workshops in Task 1.4, it will feed into the development of the transdisciplinary diagnostic framework of biodiversity decision-making under Task 1.5 and contribute to the targeted review of methods under Task 2.1. The inventories will thus inform methodological applications within the case studies (WP3) and for policy-related purposes under WP4. Overall, these inventories contribute to fill the gap in the literature on most relevant theoretical foundations and research projects with direct relevance for biodiversity decision-making.

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Statement on data availability

The databases for the reviews of this report are available in Table 1, 2, and appendix 1.

Statement on ethics

- These reviews were carried out in compliance with the General Data Protection Regulation (GDPR) of the European Union (EU).
- The authors have no conflicts of interest to declare.

Annexes

List of Task 1.2 core group participants:
- Håkon Aspøy
- Yennie Katarina Bredin
- Berit Junker-Köhler
- David Nicholas Barton
- Vinicius Mendes

Attachments:

Appendix 1. Inventory of theoretical input including short descriptions and references.

#	Theoretical input	Short description	Literature
1	ABC (Attitude-Behaviour-Choice) framework	This framework considers that consumers' attitudes, values, and knowledge influence their behaviour. Providing information or changing attitudes thus can trigger behaviour change.	Van den Berg, H. et al., 2006. The impact of affective and cognitive focus on attitude formation. Journal of Experimental Social Psychology, 42, pp.373–379.
2	Actor-network theory	This theory considers that all elements are defined by relationships in the social and natural worlds in human and nonhuman interactions through shifting networks.	Muniesa, F., 2015. "Actor-Network Theory", in James D. Wright (Ed.), The International Encyclopedia of Social and Behavioral Sciences , 2nd Edition, Oxford, Elsevier: vol. 1, 80-84.
3	Appreciative Inquiry (AI)	By focusing on the strengths of an agent, the agent is moved towards achieving a goal. In the context of biodiversity, leading a conversation with the participants about sharing their success at promoting biodiversity, participants are likely to be motivated to act in favour of biodiversity-promotion/protection.	Cram, F. (2010). Appreciative inquiry. Mai Review, 3(1), 1-13. Whitney, D. D., Trosten-Bloom, A. (2010). The power of appreciative inquiry: A practical guide to positive change. Berrett-Koehler Publishers.
4	Behavioural change wheel	This framework focuses on a 'behaviour system' and its three conditions: capability, opportunity, and motivation (the 'COM-B system'). These are situated in a wheel form ('behaviour change wheel' (BCW)) around which nine intervention functions are positioned; around seven categories of policy instruments are placed that could enable those interventions to occur (Michie et al., 2011).	Michie, S., Van Stralen, M. M., & West, R. (2011). The behaviour change wheel: a new method for characterising and designing behaviour change interventions. Implementation science, 6(1), 1-12.

#	Theoretical input	Short description	Literature
5	BIT's upstream-downstream model with 'EAST' model (easy, attractive, social and timely)	This model focuses on changing the choice environment instead of altering behaviour — e.g. making sustainable choices more available or cheaper.	https://www.bi.team/wp-content/uploads/2023/01/How-to-build-a-Net-Zero-society_Jan-2023.pdf
6	COM-B (capability, opportunity, motivation: behaviour)	The COM-B model considers behaviour as part of a complex system. For a given behaviour, capability, opportunity and no other competing motivation for another behaviour should occur.	Willmott, T.J., Pang, B. & Rundle-Thiele, S. Capability, opportunity, and motivation: an across contexts empirical examination of the COM-B model. BMC Public Health 21, 1014 (2021).
7	Commons	In economics Commons (common pool resource) are referred to as goods managed by a collective / group of individuals and characterised by rivalry and non-excludable. The successful management of commons was researched by Elinor Ostrom who identified design principles such as set of rules defined by the users, monitoring, conflict resolution and sanctioning system besides the basics knowledge about what is the resource, who uses it and contributes to its maintenance. In political sciences commons are also defined as a social practice of self-organization (commoning) with a different logic to market mechanisms and public management. Representatives of this approach underline the importance of co-production, management and mindful use of these resources.	Ostrom, E. (1990). Governing the commons: The evolution of institutions for collective action. Cambridge university press. Bollier, D., & Helfrich, S. (Eds.). (2014). The wealth of the commons: A world beyond market and state. Levellers Press.
8	Community Action Research	Community action research is an alternative research method that uses the community as the unit of analysis. This approach forges research alliances with relevant stakeholders in the community to explore and develop solutions to local problems (Ozanne & Anderson, 2010).	Ozanne, J. L., & Anderson, L. (2010). Community action research. Journal of Public Policy & Marketing, 29(1), 123-137.
9	Co-production	According to Sheila Jasanoff "[...] coproduction is shorthand for the proposition that the ways in which we know and represent the world (both nature and society) are inseparable from the ways in which we choose to live in it" (Jasanoff 2004: 2). Jasanoff's concept of co-production highlights the co-evolutionary interactions between science, policy, and practice, and takes a critical analytical perspective on the interplay between science, policy, and practice. It assumes that our understanding of reality (the material) is shaped by what we know (the cognitive) and the context of knowledge production (the social), which cannot be divorced from how we choose to act in the world (the normative). In her analysis of environmental she debates points to tensions, which derive from a scientific "impersonal, apolitical and universal imaginary of climate change" conflicting with the subjective, situated and normative imaginations of human actors engaging with	Jasanoff, Sheila (ed) (2004): States of Knowledge: The Co-production of Science and Social Order. Routledge, New York. Jasanoff, S. (2010). A new climate for society. Theory, culture & society, 27(2-3), 233-253.

#	Theoretical input	Short description	Literature
		nature" (Jasanoff 2010: 233). Co-production builds on the co-evolution of knowledge and social processes, which gives importance to how knowledge is framed, disseminated, and legitimized within particular social contexts and how the processes and institutions of knowledge production shape social order and power. From a more practical perspective, the concept of knowledge co-production may be (and actually is) used with an instrumental intent to implement new forms of interactions/ collaborative processes between science, policy and practice. The aim is to close the "knowledge to action gap" by combining scientific knowledge with other forms of knowing and capturing different visions and perceptions of various actors.	
10	Cultural Evolutionary Theory	The cultural evolutionary theory aims at the extension of biology through culture – in particular, considering that "human cultural traits" such as behaviours, ideas and technologies "can exhibit complex patterns of transmission and evolution". "Cultural evolution is a fundamentally interdisciplinary field, bridging gaps between academic disciplines and facilitating connections between disparate approaches." (p. 7782)	Creanza, N., Kolodny, O., & Feldman, M.W. (2017). Cultural evolutionary theory: How culture evolves and why it matters. Proceedings of the National Academy of Sciences, 114, 7782 - 7789.
11	Decolonial theories	"Decolonial theorists establish a difference between colonialism and coloniality. Colonialism refers to political and historical moments that ended with the political independence of the last colonies in the 1960s, whereas coloniality refers to the diversity of practices that derive from the matrix of power created by colonialism and are still at work within contemporary, post-colonial societies. Decolonial theorists argue that coloniality is the result of a complex entanglement of different dimensions of assimetric power, knowledge, and ways of being." (Álvarez and Coolsaet, 2020, p.3)	Álvarez, L., & Coolsaet, B. (2020). Decolonizing environmental justice studies: a Latin American perspective. Capitalism nature socialism, 31(2), 50-69.
12	Degrowth	"Degrowth broadly means shrinking rather than growing economies, so we use less of the world's energy and resources and put well-being ahead of profit. The idea is that by pursuing degrowth policies, economies can help themselves, their citizens and the planet by becoming more sustainable." (WEF, 2023, n/p). Degrowth has inspired alternative measures to GDP (gross domestic product) such as Better Life Index (BLI), Inclusive Wealth Index (IWI), Happy Planet Index (HPI), and others. Degrowth means, in short, that we should prioritize sustainability and human well-being over economic growth (WEF, 2023).	WEF World Economic Forum (2023). What is degrowth? Available from: https://www.weforum.org/agenda/2022/06/what-is-degrowth-economics-climate-change/#:~:text=What%20is%20degrowth%3F,planet%20by%20becoming%20more%20sustainable. Access in April 25, 2023.
13	Deliberative democracy	Deliberation in political theory refers to decision-making as a result of reasonable discussion and debate among those who would be affected or are affected by the issue, which in this study is biodiversity and farming related practices.	Bächtiger, A., Dryzek, J. S., Mansbridge, J., & Warren, M. E. (2018). Deliberative Democracy - An Introduction. In The Oxford

#	Theoretical input	Short description	Literature
			Handbook of Deliberative Democracy (1st ed., pp. 1–31). OXFORD University Press.
14	Eco-psychology	Eco-psychology follows a whole-system approach and builds on three main principles: (a) there is a synergistic, holistic relationship between nature and humans, (b) the belief that we are separated from nature is an illusion which causes suffering both for humans and for the environment and (c) perceiving the relation between humans and nature is healing for both.	Buzzell, L. (2016). The many ecotherapies. Ecotherapy: Theory, research and practice, 70-82. Davis J. (2006): Ecopsychology Defined. Naropa University. URL: http://www.soulcraft.co/essays/ecopsychology.html
15	Epistemologies of the South	The epistemologies of the South propose "an engagement with the ways of knowing from the perspectives of those who have systematically suffered the injustices, dominations and oppressions caused by colonialism, capitalism, and patriarchy" (Santos, 2016, p.18).	Santos, B. (2016). Epistemologies of the South and the future. From the European South: a transdisciplinary journal of postcolonial humanities, (1), 17-29.
16	Feminist care theory	Ethics of care is a normative ethical theory which is founded upon a relational ontology with care understood as a practice. 'Good' care, as defined by Joan Tronto and colleagues (1990; 2013), is thus about caring 'with', recognising, taking responsibility for and responding to the care needs of others. It requires that we attend to how care is received by the recipient(s) and remain alert to any changes in care needs. As such good care also requires competence, an ongoing appreciation for the diversity of care needs and also very often the situated nature of good care. A widely cited (expansive) definition of care with close alignment to PLANET4B is: "a species activity that includes everything that we do to maintain, continue, and repair our 'world' so that we can live in it as well as possible. That world includes our bodies, ourselves, and our environment, all of which we seek to interweave in a complex, life-sustaining web" (Fisher and Tronto 1990:40). Tronto's idea of caring with thus challenges the mainstream neoliberal paradigm, which is based on an individualised conception of human life and responsibility.	Fisher, B., & Tronto, J. C. (1990). Towards a Feminist Theory of Caring. In E. K. Abel & M. Nelson (Eds.), Circles of Care. Work and Identity in Women's Lives. Albany: SUNY Press Tronto, J. C. (2013). Caring democracy: Markets, equality, and justice. New York: New York University Press www.care-ful-scholar.com
17	Game theory	"Game theory can be defined as the study of mathematical models of conflict and cooperation between intelligent rational decision-makers." (p. 1)	Myerson, R. (1991). Game Theory: Analysis of Conflict. Harvard University Press, Harvard.
18	Grassroots innovation for sustainability	Grassroots innovations are novel solutions to sustainability problems generated by people active in grassroots settings (civic, bottom-up, participatory democratic). It contributes to understanding and highlighting the political aspect of innovation in society.	Seyfang, G., Smith, A., (2007). Grassroots innovations for sustainable development: Towards a new research and policy agenda. Environmental Politics, Vol. 16, Issue 4
19	Humanistic rational choice theory	Rational choice theory is the cornerstone for scholarship about societal cooperation, and the primary inspiration for public policy governing societal	DeCaro, D. A. (2019). Humanistic rational choice: understanding the fundamental

#	Theoretical input	Short description	Literature
		commons. However, current behavioural theories cannot explain several important questions about cooperation or harness the brighter potential of human nature for societal benefit. Departing from narrow self-interest as the primary description of human behaviour, the current chapter reframes the problem of cooperation in terms of fundamental needs and social cognitions. Humans require self-determination, procedural justice, belonging, competence, security and trust to thrive. Governance systems that support these fundamental needs will be more productive and cooperative. Three elements of governance systems are examined using this perspective—shared decision-making, enforcement, and communication—helping to address several persistent questions about cooperation, and outlining the next generation of behavioural theory in the commons (DeCaro, 2019).	motivations that drive self-organization and cooperation in commons dilemmas. In Routledge handbook of the study of the commons (pp. 117-132). Routledge., ISO 690,
20	Human-nature interactions	Human-nature interactions (HNI), called by a recent review as personalized ecology, refers to a set of direct sensory interactions an individual person has with the natural environment. HNI depends on specific drivers (i.e. capabilities of the individual, opportunities she might have, as well as her motivations), and has specific consequences in terms of costs and benefits both for the individual and for nature. Between drivers and consequences feedback loops exist. The referred paper reviews 39 different theoretical concepts which all strongly relate to the concept of human-nature interactions.	E. Kelemen et al. How to assess the healing power of nature? – Impact evaluation process in a Hungarian school garden. Research and Practice. Palgrave, London, UK. pp. 70-82.
21	Institutional analysis and development framework	The IAD framework serves as a guideline to analyze and test hypotheses about the behaviour under diverse situations and multiple levels. The framework supports the analysis of how system rules, conditions, and attributes affect actors and their actions, as well as incentives and outcomes (Ostrom, 2011). The IAD typology of "rules-in-use" help in describing the structure of institutions for common property resource management. The typology has been extended to analyse conservation policy instruments as institutions, including payments for ecosystem services.	Ostrom, E. (2011). Background on the institutional analysis and development framework. Policy studies journal, 39(1), 7-27. Barton, D. N., Benavides, K., Chacon-Cascante, A., Le Coq, J. F., Quiros, M. M., Porras, I., ... & Ring, I. (2017). Payments for Ecosystem Services as a Policy Mix: Demonstrating the institutional analysis and development framework on conservation policy instruments. Environmental Policy and Governance, 27(5), 404-421.
22	Institutional change theory (or theories)	"Institutions are the rules of the game in a society" or the "humanly devised constraints that shape human interaction." These constraints can be based on formal rules (such as, laws and constitutions) and informal constraints (such as, conventions and norms). Institutional change theory aims to explain change in	Based on North (1990). Institutions, Institutional Change and Economic Performance. Cambridge: Cambridge University Press; and North (2005).

#	Theoretical input	Short description	Literature
		these institutional arrangements (rules, formal and informal) that govern human interactions (pp. 3-4).	Understanding the Process of Economic Change. Princeton: Princeton University Press.
23	Integrating local and Indigenous Knowledge with the scientific knowledge base	Tools to verify and validate evidence from parallel knowledge systems are necessary if knowledge from systems with different epistemological approaches are to be combined. It is important that these tools are transparent, do not alienate participants and facilitate confidence among those co-creating policy that the knowledge is both valid and agreed. This research area develops approaches to address this, focussing on biodiversity.	Smith, B. M., Chakrabarti, P., Chatterjee, A., Chatterjee, S., Dey, U. K., Dicks, L. V., ... & Basu, P. (2017). Collating and validating indigenous and local knowledge to apply multiple knowledge systems to an environmental challenge: A case-study of pollinators in India. Biological conservation, 211, 20-28.
24	Intersectionality	Intersectional theory suggests that people experience marginalisation and discrimination because society determines value based on a person's attributes, such as gender, religion, class, race, etc. The intersecting of these attributes leads people to experience differing levels, types and intensity of privilege or inequality.	https://denison.edu/academics/womens-gender-studies/feature/67969#:~:text=Intersectionality%20is%20a%20term%20used,gender%20equality%20to%20become%20inclusive.
25	Leverage Points	Leverage points is a framework from systems thinking (Meadows 1999, adapted by Abson et al., 2017) that can provide critical insight into which systems need changing, and where to intervene to change them. It is deliberately interdisciplinary, and can act as an organising framework for bridging disciplines and normative systems framings (Leventon, 2021). Deepest leverage points are those with greatest potential to transform systems and are framed as being around transcending paradigms and intent. For the sake of biodiversity, this is often framed as engaging with individual values and worldviews to prompt behaviour and decision-making change (e.g. Chan et al., 2020; Riechers et al., 2021), or to broader changes of governance paradigm to faciliate such change at individual levels (Leventon et al., 2021).	Meadows, D. (1999). Leverage Points. Places to Intervene in a System. The Sustainability Institute
26	Mode 2 knowledge production	The notion of "Mode 2" goes back to Helga Nowotny and colleagues. In this literature, the basic thesis is that scientific knowledge is no longer checked along academic standards by peers solely, but also by other social actors. Nowotny calls this "social robustness". You can think of it like this: new quality criteria of scientific knowledge are if this knowledge is accepted in society and also applied/used. These can be economic actors, policy, but also media, users, people affected, and citizens. The premise is that scientific knowledge has to be socially relevant in order to be socially robust. However, the Mode 2 proposal has also received a lot of criticism. First, this isn't as new as the authors make it out to be. Silvio Funtowicz and Jerome R. Ravetz,	Nowotny, H., Scott, P., & Gibbons, M. (2003). Introduction:'Mode 2'revisited: The new production of knowledge. Minerva, 41(3), 179-194. Nowotny, H., Scott, P., & Gibbons, M. (2001). Re-thinking science: Knowledge and the public in an age of uncertainty (p. 12). Cambridge: Polity.

#	Theoretical input	Short description	Literature
		for example, published the concept of "post-normal science" back in the 1990s. The other criticism of Mode 2 was that it would be too conformist, often addressing industry and economic actors and that it is not critical enough. However, Mode 2 has at least contributed to questions of academic knowledge production being widely and intensively discussed. As a result, there were several suggestions on how to make scientific knowledge more socially relevant so that it could better contribute to solving social problems. => see transdisciplinarity => Responsible Research & Innovation The aim of all these (somehow similar) approaches is not only to bring about changes in the R&I system, but an overall change in science governance, including policy as well as legal aspects, by reframing the process and societal function of knowledge production towards more extensive citizen rights and openness; this should foster democratic empowerment of society in general, and leading to a democratic transformation in the R&I system.	
27	Normative conduct (influencing)/social norms	Social norms (e.g. social proof, authority, liking, reciprocity, scarcity, commitment) affect human behaviour in a systematic manner.	Cialdini, R. B., Reno, R. R., & Kallgren, C. A. (1990). A focus theory of normative conduct: Recycling the concept of norms to reduce littering in public places. Journal of personality and social psychology, 58(6), 1015.
28	Nudging / Choice architecture	A nudge, (or choice architecture) is a trigger that alters behaviour in a foreseeable manner.	Thaler, R.H., Sunstein, C.R., 2008. Nudge: Improving decisions about health, wealth, and happiness. Yale University Press.
29	Ontological politics	Explores how different realities are enacted by different social practices (e.g. the use of various tools and instruments to measure environmental effects) which clash and generate ontological friction.	Mol, A. (1999). Ontological Politics. A Word and Some Questions. The Sociological Review Volume 47, Issue 1
30	Path dependency	This theory refers to processes where past events or decisions construct later events or decisions due to resistance to change.	Drechsler, M., & Wätzold, F. (2020). Biodiversity conservation in a dynamic world may lead to inefficiencies due to lock-in effects and path dependence. Ecological Economics, 173, 106652.
31	Policy integration	"Policy integration can manifest itself in different ways, but is always characterized by the cooperation of actors from different policy domains – or policy sectors. Policy domains are defined as relatively stable actor coalitions, including the institutions they installed in the pursuit of their shared interests. Policy integration most fundamentally consists of two approaches. The first is to create interdependencies between different policy sectors and to then coordinate these.	Tosun, J., & Lang, A. (2017). Policy integration: Mapping the different concepts. Policy studies, 38(6), 553-570.

#	Theoretical input	Short description	Literature
		The second approach to realize policy integration is by means of specific policy instruments, mostly of a procedural rather than substantive nature." (Tosun and Lang, 2017, p.554-555).	
32	Political ecology	"Refers to multiple and diverse critical approaches to studying the nexus between human societies and the natural environment. This tendency reflects efforts to accommodate the development of two epistemologically distinct forms of research in the field: a materialist one associated with Marxist political economy; and a poststructuralist one, focused on discourse analysis and the social construction of environmental issues." (Tetreault, 2017, p.2)	Tetreault, D. (2017). Three forms of political ecology. Ethics and the Environment, 22(2), 1-23.
33	Post-normal science	It is a problem-solving strategy appropriate when "facts [are] uncertain, values in dispute, stakes high and decisions urgent", conditions often present in policy-relevant research.	Funtowicz, S. O., & Ravetz, J. R. (1993). Science for the post-normal age. Futures, 25(7), 739-755.
34	Pragmatism/Pragmatic theory of inquiry	This approach acknowledges the instrumental nature of concepts as its starting point: concepts are used to solve a specific problem. Concepts are therefore forged within the inquiry to lead to a satisfactory solution to the problem. The solution must be satisfactory to the participants in the inquiry. As the composition of the community of inquirers changes, the definition of the criteria of success of the inquiry changes accordingly. If citizens are members of the community of inquirers, the conceptual framework in whose terms the problem is set and, then, addressed must embody their values, interests, and points of view.	Barrotta, P., Gronda, R. 2020. What is the meaning of biodiversity? A pragmatist approach to an intrinsically interdisciplinary concept.
35	Prospect Theory	Prospect theory describes that we tend to focus on avoiding loss and putting greater value on low probability outcomes than high probability outcomes.	Kahneman, D., & Tversky, A. (2013). Prospect theory: An analysis of decision under risk. In Handbook of the fundamentals of financial decision making: Part I (pp. 99-127).
36	Psychological biases: 1. Confirmation bias, 2. Endowment effect, 3. Familiarity, 4. Feelings,	1. Confirmation bias describes our tendency that we tend to notice, focus on, and give greater significance to evidence that aligns with our existing beliefs. 2. Endowment effect describes how we tend to value items that we own more highly than we would if they did not belong to them. 3. Familiarity bias describes the tendency to stay within our comfort zone and overvalue the choice that we already know. 4. Feelings of responsibility, guilt, anger, pride, etc. trigger various responses in terms of intention and behaviour for environmental actions.	1. Nickerson, R. S. (1998). Confirmation bias: A ubiquitous phenomenon in many guises. Review of General Psychology, 2, 175–220. https://doi.org/10.1037/1089-2680.2.2.175 2. Kahneman, D., Knetsch, J. L., & Thaler, R. H. (1990). Experimental tests of the endowment effect and the Coase theorem. Journal of Political Economy, 98, 1325–1348. https://doi.org/10.1086/261737.

#	Theoretical input	Short description	Literature
	5. Framing, 6. Status quo bias, 7. Zero risk	5. Framing describes how people decide on options based on whether the options are presented with positive or negative connotations. 6. Status quo bias describes our preference for the current state of affairs; resulting in resistance to change. 7. Zero-risk bias is a tendency to prefer the complete elimination of risk over alternatives with greater overall risk reduction.	3.1. Lundberg, P., Vainio, A., Macmillan, D. C., Smith, R. J., Veríssimo, D., & Arponen, A. (2019). The effect of knowledge, species aesthetic appeal, familiarity and conservation need on willingness to donate. Animal Conservation, 22, 432–443. https://doi.org/10.1111/acv.12477 3.2. Reder, L. M., & Ritter, F. E. (1992). What determines initial feeling of knowing? Familiarity with question terms, not with the answer. Journal of Experimental Psychology: Learning, Memory & Cognition, 18(3), 435–451. https://doi.org/10.1037/0278-7393.18.3.435. 4. Harth, N.S., Leach, C.W. and Kessler, T., (2013). Guilt, anger, and pride about in-group environmental behaviour: Different emotions predict distinct intentions. Journal of Environmental Psychology, 34, pp.18-26. 5.1. Tversky, A. and Kahneman, D., 1981. The framing of decisions and the psychology of choice. science, 211(4481), pp.453-458. 5.2. Kusmanoff, A. M., Hardy, M. J., Fidler, F., Maffey, G., Raymond, C., Reed, M. S., & Bekessy, S. A. (2016). Framing the private land conservation conversation: Strategic framing of the benefits of conservation participation could increase landholder engagement. Environmental Science & Policy, 61, 124–128. https://doi.org/10.1016/j.envsci.2016.03.016 5.3. Niemiec, R. M., Sekar, S., Gonzalez, M. & Mertens, A. The influence of message

#	Theoretical input	Short description	Literature
			framing on public beliefs and behaviors related to species reintroduction. Biol. Conserv. 248, 108522 (2020); Liu, J. et al. Framing sustainability in a telecoupled world. Ecol. Soc. 18, 26 (2013). 6. Samuelson, W., & Zeckhauser, R. (1988). Status quo bias in decision making. Journal of Risk and Uncertainty, 1, 7–59. https://doi.org/10.1007/BF00055564 7. Raue, M., & Schneider, E. (2019). Psychological perspectives on perceived safety: Zero-risk bias, feelings and learned carelessness. In M. Raue, B. Streicher, E. Lermer (Eds.), Perceived safety. Risk engineering. Springer. https://doi.org/10.1007/978-3-030-11456-5_5.
37	Psychological theories	Psychological theories aim to explain behaviour through psychological variables that enable or constrain certain (environmental) behaviour, such as perceptions, beliefs, attitudes, norms and emotions.	Based on van Valkengoed et al. (2022). To select effective interventions for pro-environmental behaviour change, we need to consider determinants of behaviour. Nature Human Behaviour 6: 1482–1492; and the cited references.
38	Psychosocial frameworks	These frameworks consider the emotional relevance of the discomforting reality and complex impacts of climate change, biodiversity loss, etc. and how it can result in rejection, anxiety and inaction at the individual level.	Büchs, M., Hinton, E. and Smith, G., 2015. 'It helped me sort of face the end of the world': The role of emotions for third sector climate change engagement initiatives. Environmental Values, 24(5), pp.621-640.
39	Rational choice theory	People make choices based on a logical and linear consideration of costs and benefits, which will define their action (only do things if benefits outweigh costs).	Toke, D. (2000). Rational Choice Theory and Environmental Policy. In: Green Politics and Neo-Liberalism. Palgrave Macmillan, London. https://doi.org/10.1057/9780230514157_3

#	Theoretical input	Short description	Literature
40	Responsible Research and Innovation (RRI)	The aim of "Responsible Research and Innovation" (RRI) is is the attempt to include a normative objective in the production of scientific knowledge, i.e. already in the research process. These objectives are often linked to the SDGs: if research activities want to strive for these goals, they have to be considered in the research process right from the start and also engage those actors who will be important for the implementation. RRI is characterised by an open, responsive and participative process of continuous reflection and co-production of knowledge. However, it also implies a certain extent of vagueness. On the one hand, it is used in and by two different contexts: the scientific literature and research, and the policy arena. On the other hand, its vital components (e.g. inclusion, reflexivity, ethics) leave room for various (often conflicting) interpretations. R&I processes too often fail to consider how they are imbued with politics, which makes them politically weak and vulnerable. RRI suggests making the political issues that are at stake explicit because it must not be denied that science and knowledge creation has a political dimension and implications; and that the political economy is shaping research. While RRI cannot be decoupled from its political context and will itself always embed a strongly political dimension, at the same time, it is sometimes blamed for being politically instrumentalised in supporting policies that are motived by goals of economic growth, jobs and strengthened economic governance. RRI builds on the criticism that the hidden politics of research are too often neglected, and the limitations and inherent political content of expert knowledge with regard to sustainability confront with the reluctance of researchers (in practice) to implement highly inclusive approaches that allocate (more) decision power to other/non-formal actors. Consequently, reflection on, and integration of the inherent political content and dimensions of R&I is a crucial step to developing new forms of governance in line with the normativity of RRI. As RRI is a highly normative concept that has strong ideological trajectories and is integrated in a complex science-policy-society interface, RRI can be seen as a deliberative process. Furthermore, as political empowerment is central to deliberative governance, deliberative processes in the context of RRI aim to be inclusive in terms of whom to involve and under which circumstances the involvement takes place.	Owen, R., Macnaghten, P., & Stilgoe, J. (2012). Responsible research and innovation: From science in society to science for society, with society. Science and public policy, 39(6), 751-760.

Stilgoe, J., Owen, R., & Macnaghten, P. (2013). Developing a framework for responsible innovation. Research policy, 42(9), 1568-1580. |
| 41 | Salience | In psychology, a stimulus is salient when it attracts the decision maker's (DM's) attention bottomup, that is, automatically and involuntarily. Automatic attention to salient stimuli has fundamental survival benefits, such as when one is noticing and avoiding a barking dog. However, because the salience of a stimulus may differ | Bordalo, P., Gennaioli, N., & Shleifer, A. (2022). Salience. Annual Review of Economics, 14, 521-544. |

#	Theoretical input	Short description	Literature
		from its current decision value, it can distract us from our goals and distort decisions. In standard economics, attention is either unlimited or, if costly, optimally deployed top down, given current goals and expectations. This approach is useful but does not recognize that goals often compete against bottom-up stimulus-driven attention. Sometimes goals lose, even in important decisions.	
42	Social equity	One important evidence gap is how behaviour change can best be accomplished among those groups that are the highest emitters, predominantly wealthier households. Most behaviour change research treats everyone the same however income is a crucial factor in behaviour.	Nielsen, K. S., van der Linden, S., & Stern, P. C. (2020). How behavioral interventions can reduce the climate impact of energy use. Joule, 4(8), 1613-1616.
43	Social influence theory	Behaviors are influenced by three processes: compliance, identification, and internalization.	Kelman, H. C. 1958. "Compliance, Identification, and Internalization: Three Processes of Attitude Change," Journal of Conflict Resolution (2:1), pp. 51-60.
44	Social justice theory	Social justice is a concept that originates in philosophical discourse but is widely used in both ordinary language and social science, often without being clearly defined. By synthesizing the common elements of various philosophical treatments (e.g. Elster, 1992; Feinberg, 1973; Frankena, 1962; Miller, 1999; Walzer, 1983), it is possible to offer a general definition of social justice as a state of affairs (either actual or ideal) in which (a) benefits and burdens in society are dispersed in accordance with some allocation principle (or set of principles); (b) procedures, norms, and rules that govern political and other forms of decision making preserve the basic rights, liberties, and entitlements of individuals and groups; and (c) human beings (and perhaps other species) are treated with dignity and respect not only by authorities but also by other relevant social actors, including fellow citizens (Jost and Kay 2010).	Jost, J. T., & Kay, A. C. (2010). Social justice: History, theory, and research., ISO 690,
45	Social practice frameworks	Relevant frameworks consider a complex system of habits, social norms, conditions of the physical environment along with socio-economic factors (institutions, individual opportunities and limitations) that affect what and how people do in everyday life.	Horne, C., Kennedy, E.H., (2017). The power of social norms for reducing and shifting electricity use. Energy Policy 107, 43–52. Roysen, R., & Mertens, F. (2019). New normalities in grassroots innovations: The reconfiguration and normalization of social practices in an ecovillage. Journal of Cleaner Production, 236, 117647. 7

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46	Social solidarities and collective identities	social solidarities and collective identities impact whether and how individuals mobilize to respond to socio-ecological challenges facing their communities (e.g. Messer et al. 2015; Bell 2016). The trust and respect that often flow from solidarity and collective identities can enable individuals to work together in response to shifting socio-ecological conditions (Pretty and Ward 2001; Adger 2003).	Leap, B.; Thompson, D. Social Solidarity, Collective Identity, Resilient Communities: Two Case Studies from the Rural U.S. and Uruguay. Soc. Sci. 2018, 7, 250. Leap, B., & Thompson, D. (2018). Social solidarity, collective identity, resilient communities: Two case studies from the rural US and Uruguay. Social Sciences, 7(12), 250.
47	Socio-cultural valuation	Socio-cultural valuation is defined in this chapter as an umbrella term for those methods that aim to analyse human preferences towards ES in non-monetary units. Under this umbrella, terms such as 'psycho-cultural valuation', 'social valuation', 'deliberative valuation', 'qualitative valuation' and 'subjective assessment' represent valuation approaches that aim to uncover individual and collective values and perceptions of ES without relying on market logic and monetary metrics (Santos-Martin et al. 2017).	Santos-Martín, F., Kelemen, E., García-Llorente, M., Jacobs, S., Oteros-Rozas, E., Barton, D. N., ... & Martín-López, B. (2017). 4.2. Socio-cultural valuation approaches. Mapping Ecosystem Services. Pensoft Publishers, Sofia, 102-112., ISO 690
48	Socio-ecological resilience theory	the ability to sustain a community by reorganizing the links between social and ecological things, beings, and processes that comprise it.	Leap, B.; Thompson, D. Social Solidarity, Collective Identity, Resilient Communities: Two Case Studies from the Rural U.S. and Uruguay. Soc. Sci. 2018, 7, 250. Leap, B., & Thompson, D. (2018). Social solidarity, collective identity, resilient communities: Two case studies from the rural US and Uruguay. Social Sciences, 7(12), 250.
49	Stakeholder engagement	The environmental management and environmental policy literature has developed a distinctively practice-oriented approach to stakeholder engagement. While the other streams of literature have devoted considerable effort to the theoretical development of stakeholder engagement, environmental management and environmental policy research has focused on explaining the processes through which various stakeholders can be included and acknowledged in decision-making and policy-making processes, especially related to environmental and sustainability issues (Kujala et al. 2022).	Kujala, J., Sachs, S., Leinonen, H., Heikkinen, A., & Laude, D. (2022). Stakeholder engagement: Past, present, and future. Business & Society, 61(5), 1136-1196., ISO 690
50	Stakeholder theory	Stakeholder theory is originally a theory of strategic management (Freeman, 1984), and the strategic dimension in stakeholder engagement focuses on	Kujala, J., Sachs, S., Leinonen, H., Heikkinen, A., & Laude, D. (2022).

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		stakeholders' willingness to participate in business value creation (Kujala et al. 2022).	Stakeholder engagement: Past, present, and future. Business & Society, 61(5), 1136-1196., ISO 690
51	Telecoupling	The telecoupling concept was developed by integrating concepts such as "teleconnections (e.g. interactions between distant climatic systems) and globalization (interactions between distant human systems)." Through telecoupling analysis, sustainability issues can be understood better, since different types of interactions can be analyzed based on the integration of multiple coupled human and natural systems. In this manner, "telecoupling encompasses both socioeconomic and environmental interactions among coupled human and natural systems over distances." (Liu et al, 2013, p.1).	Liu, J., Hull, V., Batistella, M., DeFries, R., Dietz, T., Fu, F., ... & Zhu, C. (2013). Framing sustainability in a telecoupled world. Ecology and Society, 18(2).
52	Theory of committed action for nature	This theory seeks to explain and predict committed action for nature (or: biodiversity). Hence action directly, not motivation for action. This has several reasons. First, action is much easier to measure; actions can be seen, motivations cannot. Second, action is much more relevant than motivations; actions change the world, motivations do not. And finally, focusing research on motivations would invoke many poorly defined concepts and open up the dreaded attitude-behaviour gap, which is the often striking difference between what people think to be good and what they actually do. Next to note in the explanandum is that we focus on committed action. 'Committed' here means that the actor devotes much more energy, thought and persistence to the action than would be necessary for reasons of job, income, tradition or reputation. The lives of committed actors are 'lives for nature' to a full or more subdued but still significant degree. This focus is justified for reasons of research practicalities but also because we may assume that to some extent, knowing what drives the heroes will help understand what drives the more common person as well to some degree. Moreover, heroes provide the exemplary stories for others to re-tell and re-live; next to their direct impacts, heroes change the world also through that route (De Groot et al. 2015).	De Groot, W. T., Bonaiuto, M., Dedeurwaerdere, T., & Knippenberg, L. (2015). A theory of committed action for nature. Nijmegen: The BIOMOT project, ISIS, Faculty of Science, Radboud University Nijmegen., ISO 690
53	Theory of Communicative Action	The theory constructs a two-level concept of society that integrates the lifeworld and systems paradigms. The lifeworld is the taken for granted universe of our everyday existence, the system`s world of action refers to the fields of economy/market and policy/administration/government. Involving the needs of the lifeworldly actors in biodiversity protection and restoration will help to prevent a colonization of the lifeworld by the systems world.	Habermas, J. (1981). The theory of communicative action, volume one: Reason and the rationalization of society. Trans. by McCarthy, TA Boston, Mass.: Beacon Press.
54	Theory of environmentally	Environmentally significant behavior can be defined by its (1) impact - direct, when behavior directly causes environmental change (e.g. clearing forest) or indirect, when behavior that affect international development policies, commodity prices,	Stern, P. C. (2000). New environmental theories: toward a coherent theory of

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	significant behavior	national environmental policies, tax policies - that shape the context in which choices are made that directly cause environmental change; (2) intent, when behavior is with the intention to change (normally, to benefit) the environment. It is necessary to adopt an impact-oriented definition to identify and target behaviors that can make a large difference to the environment. This focus is critical for making research useful. It is necessary to adopt an intent-oriented definition that focuses on people's beliefs, motives, and so forth in order to understand and change the target behaviors.	environmentally significant behavior. Journal of social issues, 56(3), 407-424.
55	Theory of planned behaviour	This theory considers that behaviours are affected by intentions determined by three aspects: attitudes, subjective norms, and perceived behavioural control.	Ajzen, I. (1991). The Theory of Planned Behavior. Organizational Behavior and Human Decision Processes,50, 179–211. Ajzen, I. (2005). Attitudes, Personality, and Behavior (2nd ed.). New York: Open University Press. Home, R., Balmer, O., Jahrl, I., Stolze, M., & Pfiffner, L. (2014). Motivations for implementation of ecological compensation areas on Swiss lowland farms. Journal of Rural Studies, 34, 26-36.
56	Transdisciplinarity	Transdisciplinary research bridges the traditional boundaries between disciplines and between academia and practice. It is increasingly common, motivated by the intellectual demands of dealing with complex interrelated issues at the food, water, energy, and environment nexus. There are also demands from funders and society at large for relevant research which will have an impact on society. Transdisciplinary teams can generate new knowledge to address complex problems while integrating multiple disciplines and stakeholders.	Harris, F., & Lyon, F. (2014). Transdisciplinary environmental research: a review of approaches to knowledge co-production. Nexus network think piece series, paper, 2, 28.
57	Transformative context-based social investment	Proposes a kind of interpretation of the "social investment welfare state" (a political view and practice, widely discussed in social policy analysis, of welfare and social policies as an investment on the future aimed at individuals' well-being). Specifically, the hypothesis holds that by promoting context-based policies and not just targeting individuals or categories, social investment could play an important and transformative role toward greater economic, social, and environmental sustainability of local systems.	Villa, M. (2016). The transformative role of the social investment welfare state towards sustainability: criticisms and potentialities in fragile areas:. The transformative role of the social investment welfare state towards sustainability: criticisms and potentialities in fragile areas:., 29-49.
58	Transformative research	Entails a shift in research priorities towards currently marginalized approaches in social sciences, humanities and participatory research, to generate a much-needed understanding of obstacles to action and just and equitable strategies for overcoming them with due consideration of issues of justice and equity	Turnhout, E., & Lahsen, M. (2022). Transforming environmental research to avoid tragedy. Climate and Development, 14(9), 834-838.

#	Theoretical input	Short description	Literature
59	Transformative social innovation	This theoretical perspective conceptualises social innovation as changing social relations (changes in framing, knowing, doing, and orgaising). It is transformative in the sense of altering or replacing dominant institutions in specific socio-material contexts.	Villa M. (2016), The transformative role of the social investment welfare state towards sustainability. Criticisms and potentialities in fragile areas, Sociologia e Politiche Sociali N. 3/2016. DOI: 10.3280/SP2016-003003
60	Transformative sustainability governance	"Sustainability transformations are fundamental changes in structural, functional, relational, and cognitive aspects of socio-technical-ecological systems that lead to new patterns of interactions and outcomes. For some, transformation arises endogenously from incremental, carefully planned interventions made by (often policy) actors, whilst for others, transformation is an emergent property of large-scale political-economic forces and social mobilization. In other cases, transformation is not human generated, but triggered by exogenous biophysical forces such as climate change." (Scoones et al., 2020, pp.65-66)	Scoones, I. et al. (2020). Transformations to sustainability: combining structural, systemic and enabling approaches. Current Opinion in Environmental Sustainability, 42, 65-75.
61	Value-action gap	The value-action gap is the difference between what people say they value and what people actually do.	Robb J, Haggar J, Lamboll R, and Castellanos E (2019). Exploring the Value–Action Gap through Shared Values, Capabilities and Deforestation Behaviours in Guatemala. Environmental Conservation 46: 226–233
62	Worlding environmental governance	"Many socioenvironmental struggles around the globe involve trying to protect the disappearance of other "worlds." Along with biological diversity, human languages, traditions, understandings, and the intimate relationships between peoples and their lands are under attack through various forms of colonization, capital expansion, or simply the globalization of lifeways. "Worlding" encompasses processes of making the world intelligible and determining the "we" in relation to "others" as well as the extent to which such processes of sense making constitute the worlds we live in. As such, worlding environmental governance has to do with the essential practices for understanding the struggle of maintaining many worlds on a single Earth." (Inoue, 2018, p.25-27)	Inoue, C. Y. A. (2018). Worlding the study of global environmental politics in the Anthropocene: Indigenous voices from the Amazon. Global Environmental Politics, 18(4), 25-42.
63	5E Model of Environmental Engagement (positive psychology)	This model of positive psychology describes how goal orientation (promoting goal-oriented hope: setting a goal; believing that one canachieve the goal; viewing the potential paths; and trusting other members of society to follow the same desired goal (social trust) can aid behaviour change	Macharis, C. and Kerret, D., 2019. The 5E model of environmental engagement: bringing sustainability change to higher education through positive psychology. Sustainability, 11(1), p.241.