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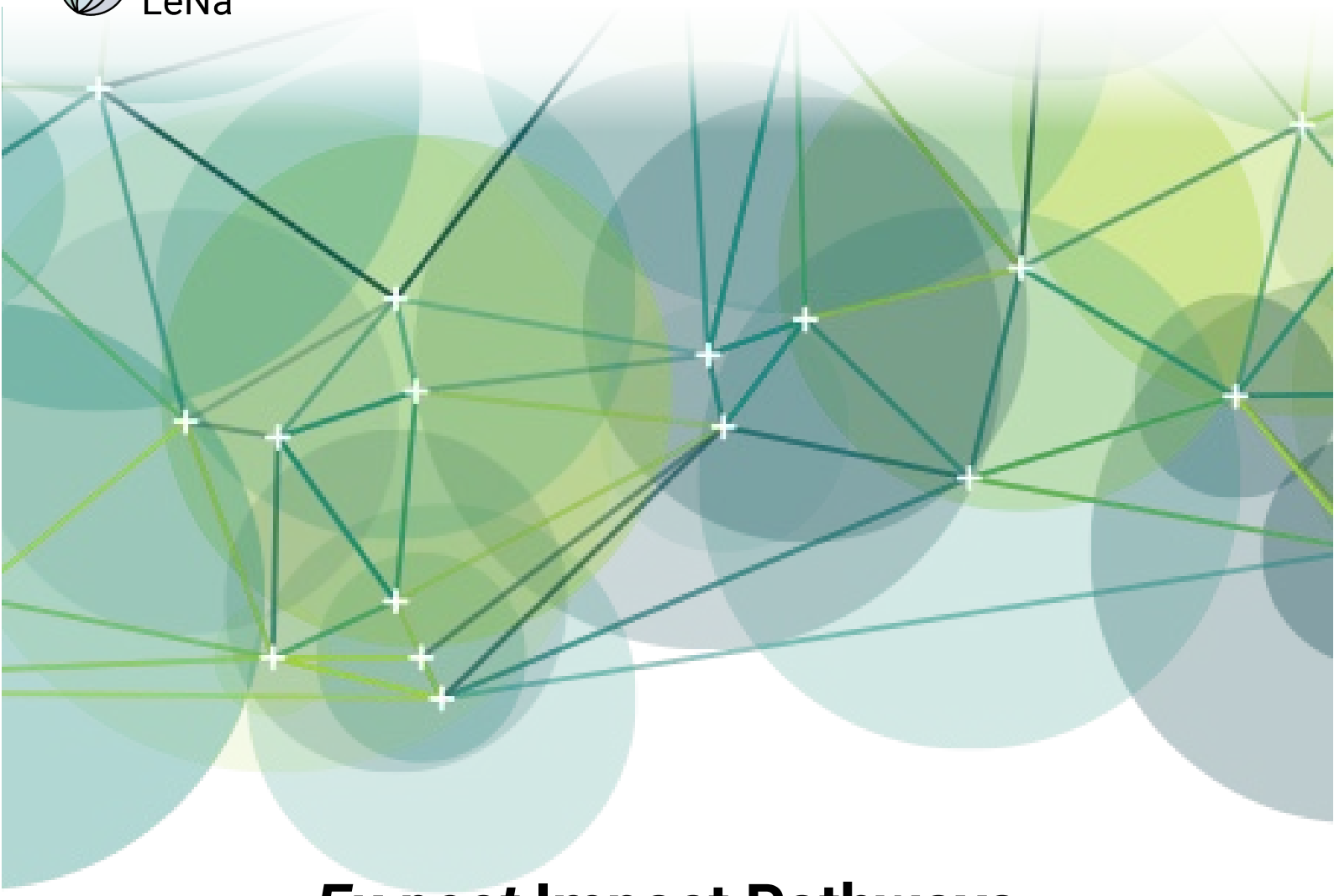

Ex post Impact Pathways

A guide to conducting workshops for impact appraisal

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LeNa Shape – Research with Societal Responsibility

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Preliminary remarks

This guide is meant to assist in the planning and conducting of a workshop for the structured assessment and appraisal of impacts and impact pathways for research projects near or subsequent to their completion. It describes the underlying steps and suggestions for independent planning and implementation of workshops. These workshops serve to enhance the understanding of impacts resulting from a research project, allowing for the demonstration and reporting of impacts e.g. to funders or a comparative appraisal of different initiatives, as well as to enhance impact literacy by individual researchers or at the institutional level. The guide draws on a series of workshops conducted in 2022 at the Leibniz Centre for Agricultural Landscape Research (ZALF) and the Leibniz Centre for Tropical Marine Research (ZMT) in the frame of the project LeNa Shape, funded by the German Federal Ministry of Education and Research (BMBF, grant numbers 01UV2110F-G). LeNa Shape addresses sustainability and the societal responsibility of research, and has among its goals to enable researchers in reflecting upon their research activity, including its societal impacts. For more information on the concept of research with societal responsibility and available tools to increase capacity for such research, see the material developed by LeNa Shape (2023, 2024).

The guide contains a description of the different parts of the workshop, a suggested schedule to assist in the time planning, and templates for the creation of whiteboards. The workshop can be conducted both on site and virtually. The use of pre-arranged virtual whiteboards for collaborative work is strongly recommended, particularly if workshops are held virtually. Familiarity with the concepts of societal impacts and impact planning is not required for participants, but workshop organizers and facilitators should have a sound understanding of the underlying concepts and approaches. As a broad literature and a wealth of resources exist for impact assessment, this guide does not provide an in-depth background of the methods used, but includes references for further reading.

The workshop described in this guide has been developed in the context of natural resource use and management. While the general concepts are widely applicable to different research fields, some of the examples and approaches used (in particular the impact criteria and indicator sets) will need to be adjusted according to context and research fields.

Introduction

This guide is addressing individuals interested in the systematic assessment of societal impact of their research project or their organization's research. It is written to assist in the organization and moderation of workshops, and thus should be used as preparatory tool by workshop organizers and facilitators. Following a brief introduction of the background and aims of the workshop, the different elements of the workshop are described along with their rationale, explaining the overall goal, preparation and content. Boldface items in the content description reflect the elements of the workshops included in the suggested schedule provided at the end of the manual. Two green boxes provide an overview of relevant theoretical background and details regarding workshop preparation. Additional suggestions for moderators are provided in yellow boxed texts. They are based on our experience with running workshops at our own institutions. Suggested reading and additional resources are listed at the end, and schedules and whiteboard examples are provided in the Annex.

Theoretical Background

- **Societal research impact** refers to the "the demonstrable contribution that research makes to the economy, society, environment, or culture, beyond the contribution to academic research" (ARC n.d.). These impacts can be positive, negative, intended and unintended.
- **Impact pathway & narrative**: Research Impact Assessment (RIA) approaches commonly utilize logical frameworks referring to inputs, activities, outputs, outcomes and impacts along an impact pathway. Contributions to impacts can be visualized in impact pathways or conveyed through an impact narrative.
- **Ex ante vs. ex post**: Research impact can be assessed after the conclusion of a research activity (*ex post*), anticipated beforehand (*ex ante*), and monitored during the activity. *Ex post* assessments primarily involve reviewing past or current research activities, their outputs, outcomes, and impacts to construct an impact narrative, account for research impact, and understand enablers or barriers to research impact. Conversely, *ex ante* assessments focus on setting goals and anticipating societal impact ("preview") to plan for impactful research by tracing necessary research activities, collaborations, transfer activities, etc., to achieve agreed-upon goals.
- **Contribution vs. attribution**: There are two approaches to linking research activities to impacts: one focuses on direct attribution, assuming research as a sufficient cause for narrow and specific impacts, while the other assesses contributions to wider societal impacts, considering research activities as necessary but not sufficient factors (Reed et al. 2021).
- **Qualitative impact assessment** involves analyzing descriptive data on the impact (potentials) of research activities and their underlying processes. This analysis is based on methods such as workshops, interviews, and case studies. Unlike quantitative approaches often applied for the accounting of impacts, qualitative assessment focuses on understanding the context and processes rather than solely relying on numerical metrics.

The aim of the impact pathway workshop described here is the structured appraisal of completed, or nearly completed, research (*ex post*). The workshop is used to assess research activities with regards to their societal impact by tracing research activities to associated outcomes and wider impacts. Impacts are considered on different levels:

- **context-specific goals** such stated objectives of research projects or programs (internally defined)
- **societally-defined targets,** for example the UN Sustainable Development Goals (SDGs)

In addition, interactions are examined, such as the joint contribution of different activities or outputs to impacts, or the contribution of particular activities or outputs to a number of different impacts. The workshop thus provides a means for telling an impact narrative, and allows for the joint assessment of previously isolated or unconnected activities, as well as the identification of previously unnoticed contributions to impacts. The workshop can be applied both to the assessment of specific research projects as well as to a broader assessment at an institutional level, for example of programmatic or research focus areas.

The consideration of societal impacts of research is increasingly gaining attention in recent years, particularly in the context of increasing demands for science to contribute to solving pressing sustainability challenges. The generation of societal impact is seen as a responsibility of research towards society. On the one hand, participatory forms of research that integrate not only different academic fields but also research and society, such as transdisciplinary research and citizen science, are becoming more common. At the same time, there is a drive for new, more integrative ways of assessing scientific excellence and quality, considering societal impact in addition (or even as integral) to academic merit. Research Impact Assessment (RIA) has developed as a distinct field in the past two decades, and additional indicators of scientific quality are identified e.g. in the DORA declaration or sought by initiatives such as CoARA.

While traditionally, academic performance is measured using metrics of scientific impact (such as number of publications, amount of funds acquired, or scientometric impact factors), (societal) RIA is an approach to reflect and demonstrate the impact of research beyond the academic world. Systematically anticipating and assessing these societal impacts, as well as the contributions to shared societal objectives and the underlying processes that generate impact, is relatively new, especially within the realm of natural resource management research, and presents significant potential for planning research with impact in mind (Pfeifer and Helming 2024).

As the quantitative attribution of specific societal impacts to a particular research activity is difficult due to the multiple interacting factors jointly contributing to impact (such as specific contexts), many of which are often unknown, the contribution of research to societal impact is regularly described qualitatively. This can be done for example through the use of impact narratives (understood here as

a compelling and plausible story describing particular impacts and their achievement, following the project or program's Theory of Change; see Douthwaite et al. 2020) or the tracing of impact pathways (Fig. 1). The qualitative approach to research impact is the one taken in this workshop.

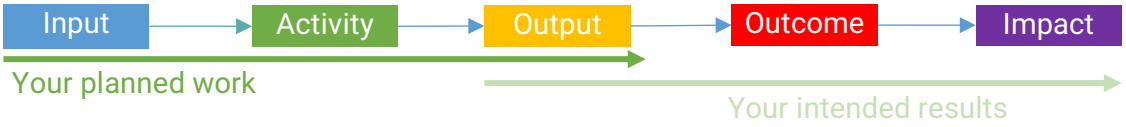

Figure 1 Impact Pathway scheme showing the sequence from research inputs (e.g. finances, material) to research activity and outputs (e.g. publications), which are within the time frame of a usual research project, to the wider outcomes (uptake and application of research output, usually by others) and eventual societal impact. Adapted from CSIRO (2020) and Fryirs et al. (2019).

The tracing of societal impacts can happen through the review of research that is already underway or concluded (in an *ex post* approach; see Barret et al. 2018), as done in the workshop presented here. It provides a means to tell an impact narrative and develop an account of research impact, for example in reporting about a project, or can serve for learning and analysis, e.g. by assessing enablers of and barriers to research impact.

Additionally, impact tracing can be applied in the planning, or preview, of research, focusing on the setting of goals and the anticipation of societal impact (i.e., an *ex ante* approach; see Blundo Canto et al. 2020). This is the focus of a second workshop guide (see Ferse and Pfeifer 2024).

In tracing and assessing the impact of sustainability-oriented research, two aspects are important**: 1) what societal impact should have been achieved?**, and **2) how was this impact achieved?**. While attribution studies require (quantitative) measurements to demonstrate achieved impacts, assessing research contributions involve examining impacts that have been or will be credibly influenced by research activities, along with credible processes and pathways this impact might have been achieved.

To assess or anticipate (**1) the societal impacts that research contributed to/will contribute to** entails a formulation of goals, an impact assessment based on impact pathways (via backtracking from impacts), and the definition of criteria and indicators for impact. To assess or anticipate **(2) how these impacts are achieved** requires an understanding of the processes leading to impacts, as well as (to the extent possible) the definition of criteria and indicators tracing the processes leading to impact.

While a number of useful indicator sets exist that can be used for tracing and demonstrating impact in terms of sustainability goals, tracing and demonstrating

the *processes* leading to impacts is more challenging. The achievement of goals ultimately depends on an interaction of various context-dependent elements, which often are outside the control of a project. Hence the focus on (likely) *contribution* to impacts, rather than *attribution* of impacts to particular research activities. Yet, the processes leading to these goals can be traced e.g. by participatory impact pathway assessment (PIPA; see Douthwaite et al. 2007, Douthwaite n.d.). Aspects of *how* research is conducted increase the likelihood of meeting certain societal goals, such as transdisciplinary research, co-design, and the establishment of trusted relationships to key actors (see e.g. Cvitanovic et al. 2016, Daedlow et al. 2016, Newig et al. 2019). Due to the diversity and context-dependency of such impact-supporting processes, defining generic indicators for them is challenging, but examples can be gleaned e.g. from indicators for social processes supporting environmental sustainability (Table 1, see Glaser et al. 2012).

Table 1: Examples of social processes supporting sustainability in coastal social-ecological systems, and examples of indicators to trace these processes. Adapted from Glaser et al. (2012).

Social processes	**Indicator examples**
Distributive and procedural justice	Number of infringements of tenure rights; enforcement of and compliance with resource extraction rules
Participation and decision-making	Number of meetings; levels of participation; character of social networks (density, evenness, distribution of powers)
Rule-making/institutional change	% of ecosystem users who feel their views are included in rule-making; ratio formulated/implemented laws & plans; change in institutional commitment to socio-ecological planning or participatory decision-making; increase in institutional integration or coordination across ecosystem boundaries
Conflict resolution	Presence and satisfaction with recourse mechanisms and procedures; degree of satisfaction with governance and management regime/style
Social learning	% of fisher families` youth education; presence and creation of leaders
Communication processes	Number of communication channels; frequency of use by different groups
Knowledge generation and social learning	% of fisher families' youths in education; number and perceived effectiveness of science-policy-practice links
Transparency and implementation of rights and rules	Knowledge and (perceived) reliability of laws

Social networking	Extent and density of network connections; between-ness and closeness indicators

The workshop comprises a number of steps that define and describe research activities and list outputs, discuss outcomes and impacts, identify interactions and trade-offs, and assemble an impact pathway. It traces the contributions of a research project/program to a set of previously specified impacts, by backtracking the impact pathway, and thus provides a systematic approach for identifying contributions to impacts that may previously have not been recognized or specifically intended. Potential criteria and indicators for different kinds of impacts are considered, and the nature and magnitude of impacts are reflected upon.

Format of the workshop

This workshop consists of a total of six hours, which can also be broken down into two shorter sessions (e.g. on subsequent days). The workshops can be conducted either on site or entirely virtually. In both cases, we found the use of virtual whiteboards very helpful (e.g., using Mural or Miro), particularly for documentation and archiving purposes, but the material can also be developed in paper format. Whiteboard templates are provided in the Annex.

Suggestion to moderators: When using digital tools, it is important that all participants have a good knowledge and adequate skills regarding their usage. Plan sufficient time and some exercises at the beginning of the workshop to familiarize participants with the used tools, and/or consider sharing a tutorial for their use prior to the workshop.

The workshop should be moderated by at least one dedicated person, although a team of two moderators works best as one can focus on administration and note taking, while the other leads the participants. The number of participants is flexible and can range from three to more than a dozen, but we found that (sub-)groups of 4-6 participants are an ideal size. The participants can include researchers of different seniority (e.g., doctoral candidates as well as department leaders), and should be comprised according to the specifics of the research to be assessed (e.g., representing different disciplines, work packages in a project, or projects within a research area). The workshop should start with a short presentation prepared by the moderators, drawing on the material in this guide, before going into facilitated group work on whiteboards, and end with a short wrap-up to address remaining questions and an outlook to the future use of the workshop material.

Suggestion to moderators: Short exit surveys of participants after the workshop are recommended if the workshop is to be repeated more than once, as they help to adjust the format, schedule and approach by identifying e.g. level of understanding of participants, clarification needs or potential technical challenges.

In the following, the concept of the workshop is described. A suggested schedule as well as templates for engagement material to be sent to participants beforehand and for whiteboards are provided in the Annex. A list of further reading and resources is given at the end of the guide.

Workshop Preparation

Utilize Virtual Workshop Tools: Leveraging virtual whiteboard platforms such as Mural or Miro enhances workshop collaboration and documentation. Design these whiteboards thoughtfully, allowing only necessary items to be editable by participants to maintain structure. Facilitators should share their screen while encouraging individual input to keep participants engaged and informed about the current task. Encourage direct input from participants, but provide support by adding items for them when necessary.

Moderation Techniques: Facilitators should select appropriate moderation techniques tailored to the workshop session. These encompass strategies for actively involving participants, navigating group dynamics, and cultivating constructive discussions, whether in-person or virtual. Additional resources on moderation techniques can be found here:

- In German:
  - Nachhaltigere Innovation durch Beteiligung: Eine Toolbox. https://www.partizipativ-innovativ.de/
  - Organisationshandbuch des Bundesverwaltungsamts. https://www.orghandbuch.de/Webs/OHB/DE/OrganisationshandbuchNEU/4_MethodenUndTechniken/Methoden_A_bis_Z/Workshop/Workshop_node.html
- In English:
  - IUCN SSC CPSG (2020) A Guide to Facilitating Virtual Workshops. http://www.cbsg.org/sites/cbsg.org/files/documents/CPSG%20Virtual%20Workshop%20Guide_Mar30_0.pdf
  - https://www.sessionlab.com/blog/virtual-facilitation/

Workshop Preparation

Participant Diversity: Ensuring diverse representation from various disciplines, sectors, and stakeholder groups is essential for the success of the workshop. Therefore, moderators should send appointment queries and select dates for the workshop that accommodate the availability of a wide range of participants. During the session, moderators should foster inclusive discussions and leverage the diverse expertise of participants. This can be accomplished by employing moderation techniques, including group work and facilitated discussions aimed at encouraging quieter participants to share their perspectives and ideas. In cases where language barriers exist, moderators may need to allocate additional time to facilitate translation between languages.

Presentation Preparation: Moderators should prepare concise presentations to facilitate the workshop session. The presentation should encompass a review of existing material, an overview of the session's objectives, the introduction of relevant concepts, definitions, and/or tools, and active guidance and engagement of participants throughout the workshop.

Wrap-up and Outlook: To effectively wrap up the workshop session and set the stage for the following activities the moderators should summarize key insights, address remaining questions, and provide a clear outlook on further course of action at the end of the workshop. Additionally, moderators may share an **exit survey** (via weblink or paper) to gather individual feedback on several aspects:

(1) What participants liked about the workshop and found interesting or useful.
(2) What participants are taking away from or learned during the workshop.
(3) Any ideas or open questions that remain for future workshops.
(4) Any aspects of the workshop that participants disliked or suggestions for improvement.

Workshop description

Goal:

The workshop is aimed at the participatory design and visualization of impact pathways & narratives of research at an organization, discussing outputs, outcomes and impacts, and also illustrating the interaction and integration of complementary research. It supports the estimation of impact of research on thematic, context-specific goals and on different societal goals. Indicators are used to estimate the intensity and magnitude of the impacts, taking into account the degree of contribution by the research considered. Interactions and trade-offs are identified, as well as joint contributions across different research fields or work packages within the organization.

Preparation:

(Only if on site): Prepare room, beamer, whiteboards, writing utensils, snacks and drinks

(Only if virtual): Set up a video conference link and share with participants

Ahead of the workshop, prepare a narrative and gap text (described below) to familiarize participants with the concepts and goals of the workshop. The text should provide some initial information on the workshop, describing the research project/program to be focused on, identifying specific explicitly stated goals of the project/program, and outlining its relevance to societal goals and sustainable development. It should then describe and explore specific research inputs, activities, outputs and outcomes of the research, allowing participants to fill in information on their own in the gaps. In addition, an impact pathway of the research project/program is provided in a schematic way for participants to add information on research activities, key outputs and outcomes. This text serves both to prepare participants and to collect information a priori for the preparation of material to be refined during the workshop. A template for the preparation of the narrative, gap text and impact pathway is provided in the Annex.

Prepare introductory presentation and set up (virtual) whiteboards by integrating available information on the project/program and information provided by participants filling in the preparatory material (above) into draft impact pathways. Prepare separate whiteboards for different draft impact pathways; one with context-specific impacts (goals of the project/program), and one with wider impacts (e.g., relevant SDGs). Review relevant SDGs, if applicable, together with associated targets and sub-targets, and prepare on overview of those (to be shared with participants beforehand, and/or presented before the second part of the workshop).

Potential modification: It is possible to work on several areas in parallel, developing individual impact pathways that are combined into a single visualization at the end of, and subsequent to, the workshop (e.g. for several research themes within a programmatic area, or several work packages within the same project). In that case,

you may either work on the different areas in succession (planning in additional time), or in break-out groups in parallel (planning in additional capacities or moderation), and consider breaking the workshop into two half days.

Suggestion to moderators: In preparation for the workshop, if you are not familiar with it, try to obtain a good overview of the background of the project or program addressed. In particular, familiarize yourself with the stated goals and objectives and work plan. Does a specific statement regarding expected societal outcomes and impacts exist already?

Content:

Part 1: Introduction, Contextual Impact, Draft Impact Pathway

The workshop should start with a ***welcoming & Introduction***, covering the schedule of the day, the moderators and participants, the format of the workshops (including technological tools used), the background and rationale of the workshop, and the underlying concepts. In introducing the prepared whiteboards, make sure to explain the different elements and how they are to be used, e.g. the meaning of colors. Including screenshots or pictures of the whiteboards in the presentation is helpful.

The presentation of underlying concepts should briefly cover the concept of (societal) research impact and its relevance for your project or institution, what an impact pathway (Fig. 2) and an impact narrative is, and the concepts of impact contribution versus attribution (see Introduction above). It should end with explaining the relevance of impact and impact indicators to your organization, and the rationale for conducting this workshop in the frame of the project/program.

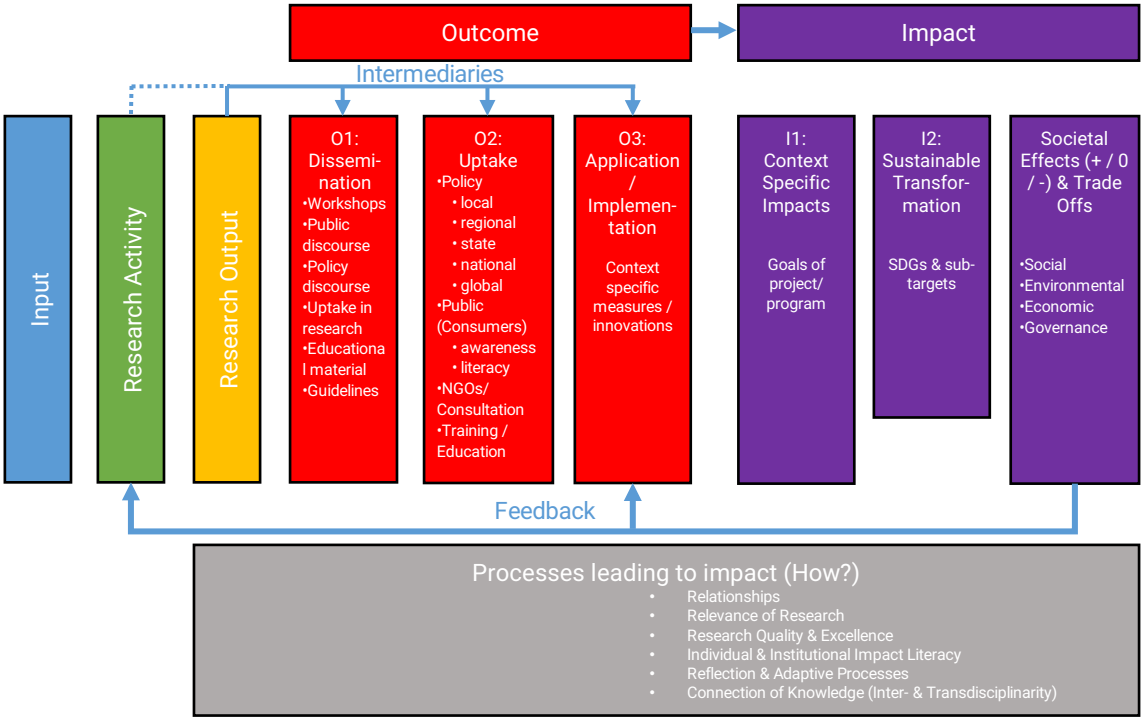

Figure 2 Schematic example of an impact pathway with the different areas addressed in the workshop. Note that individual items such as specific research activities, outputs or impacts are not yet included.

In ***presenting the previously collected information and explanation of group work***, you should first present the explicit goals of the research project/program you are considering (these constitute the *context-specific impacts*). The subsequent tasks will identify the contribution of research activity to these pre-defined impacts. Next, information collected from the participants ahead of the workshop is presented in the form of a draft, synthesis impact pathway (see template in Annex). This serves to illustrate the subsequent group work and clarify terminology and conceptual understanding. The group work is then explained by giving an overview of the individual steps (see below).

In the subsequent ***group work***, the participants work on jointly developing a ***draft impact pathway***. (Note: if covering different areas within the same project/program, you can either use parallel break-out groups, or repeat the group work for each area. For each area covered, separate information is gathered beforehand, and a separate draft impact pathway prepared). The group work consists of five consecutive tasks on the (virtual) whiteboard. The tasks are shortly described on the whiteboard. Each task is covered by a "post it" and should be uncovered and introduced by the moderator of the group. Participants are asked to write their initials on post-its they are adding, so that comments/elaborations can be traced later on if needed.

Task 1 - Inputs:

Inputs have already been entered on the draft impact pathway beforehand based on information gathered from participants. During the exercise, ask participants to briefly review the information, and add/elaborate if necessary.

Task 2 - Activities:

The participants are asked to collect research activities in their thematic field and add new ones where appropriate. Activities should be phrased as:

„Action“ (Development, Assessment, Analysis, Monitoring, Modeling) **OF „Something“ ON/FOR „Something“**

Once the activities are completed, participants are asked to make a chronological classification of the research activities. When did your organization start working on this research activity? If applicable: when has the work on this research activity been finished? Chronological order of activities along a timeline, or an understanding how activities fed into each other, helps in developing an impact narrative or a visual representation of an impact pathway.

Task 3 - Outputs:

The participants were asked (in the narrative and gap text) to think about some key outputs of the research activities in the workshop preparation, which should be provided on red stickers on the whiteboard (prepare beforehand). In the third task the participants are asked to add / agree on a maximum of two key outputs for each activity. Outputs can be new:

- Scientific Insight
- Method
- Concept
- Infrastructure
- Tool
- Technology

They should also indicate how this output has been shared with the public (e.g. peer-reviewed article; presentation; guidelines …). Place sticky notes with explanation next to each output where appropriate.

Task 4 - Outcomes:

The participants were asked to think about possible outcomes of their outputs in the workshop preparation, which should be prepared on yellow stickers added to the whiteboard (prepare beforehand). In task 4 they should now add outcomes to the visualized outputs, where applicable. In case an output has not been achieved yet they can add it as an „intended outcome” in the *after 20xx* section of the pathway. The end year of the pathway should be adjusted according to the end year of the project/program considered (if ongoing, this is the year of the workshop).

Outcomes are processes or products through which the output is implemented and therefore leads to change. They can address different levels (see Fig. 1):

- Dissemination: Material/actions that transfer research output into civil society, practice, politics or science (other and beyond research outputs themselves)
- Uptake: Reference of research outputs by external bodies, e.g. in policy, civil society or education
- Practical or Policy implementations or application

Participants should add a sticky note with one sentence describing the implementation of the output.

Task 5 – Impact Level 1: project/program goals

When preparing the whiteboard, specific project/program goals are listed as purple stickers beforehand. Participants are asked to link the outcomes to the listed goals. They should draw links where they know/believe that an outcome of a research activity contributed directly or indirectly to achieving a set goal. They should use solid lines where contributions are already verifiable, and dashed lines where contributions are intended.

There should only be one line coming out of each outcome – the line can however branch off to multiple goals. In case more than one goal is affected by the outcome: Is the outcome addressing synergies or trade-offs between these goals? Synergies should be marked with '+' and trade-offs with '-'.

The participants are asked to add a sticky note with one sentence describing the link between the outcome and goal (this can also be done after the workshop in case time is an issue).

After a ***break***, all workshop participants convene to discuss results of the previous group work.

If several themes or areas were worked on, the subsequent discussion is repeated for each of the themes and draft impact pathways. For the ***presentation and discussion of the impact narrative***, the moderator (or another designated presenter) first presents the whiteboard developed before, explaining the main findings in the form of a narrative and pointing out 1-2 highlights (those pathways that are particularly well or least developed). Other group members may add their own observations. All participants jointly reflect on the draft pathways:

- Do they agree with the activities listed?
- Do they agree with the outputs listed?
- Do they agree with the outcomes listed?
- Do they agree with the links between the outcomes and the goals (please also pay attention to the description)?
- They can change or add components where appropriate.

You may use the workshop to not only trace contributions of research to societal impacts, but also to gather some information on processes and structures facilitating the contribution to certain impacts. To do so, discuss with participants the links between outputs and outcomes, and between outcomes and goals. What happened along this way – what were the processes that led to impact? Who were intermediaries that helped to create outcome from outputs? Ask participants to add sticky notes with comments to the links. The insights generated can be used to support the *ex ante* planning of impact for future projects/programs (see Ferse and Pfeifer 2024).

If several themes or areas were worked on, participants can be asked to already reflect and comment on potential overlaps and linkages across the different themes and areas, for example in terms of outputs and outcomes contributing to the same goals.

In a second round, the participants can start thinking about clusters of activities within each theme/pathway. Which research outputs are new inputs for other research activities? They can discuss already existing links and intended links (where they see potential integrations). They should make notes in a dedicated note section of the whiteboard.

Suggestion to moderators: In our workshops, we worked on three themes in parallel break-out groups. As the subsequent discussion of all themes among the whole group was time consuming, we split the workshop into two half days. On the second day, we focused on the tasks addressing contributions to wider societal goals and discussed indicators. If the workshop is split into two days, the second day should start with a short recap of the previous day, reviewing the developed impact pathway, reflecting on trade-offs and synergies, and outlining the schedule and tasks for the day. If fewer themes are covered and fewer impact pathways developed, the entire workshop can be completed in a single day.

Unless the workshop is conducted in two parts on several days, a ***break*** should be taken before continuing with the next part.

Part 2: Societal Goals and Indicators

In the next tasks, the drafted impact pathways are developed further to consider contributions to societal sustainability goals, for example the UN Sustainable Development Goals.

Begin the part with an introduction of ***sustainability goals and indicators***, giving a presentation of relevant sustainability goals and indicators (for example, SAFA or CICES indicators, or the SDGs and their associated targets and sub-targets – see further reading and resources at the end). Build on material sent prior to workshop.

If focusing on the SDGs, participants can benefit from using the SDG Impact Assessment Tool (Eriksson et al. 2020; https://sdgimpactassessmenttool.org/en-gb/articles/instructions), particularly its step 4 for assessing impacts to determine whether they are positive or negative, or if there is insufficient information available (and what would be needed to assess this) (Fig. 3). Briefly introduce the tool to participants and allocate additional time for group work accordingly.

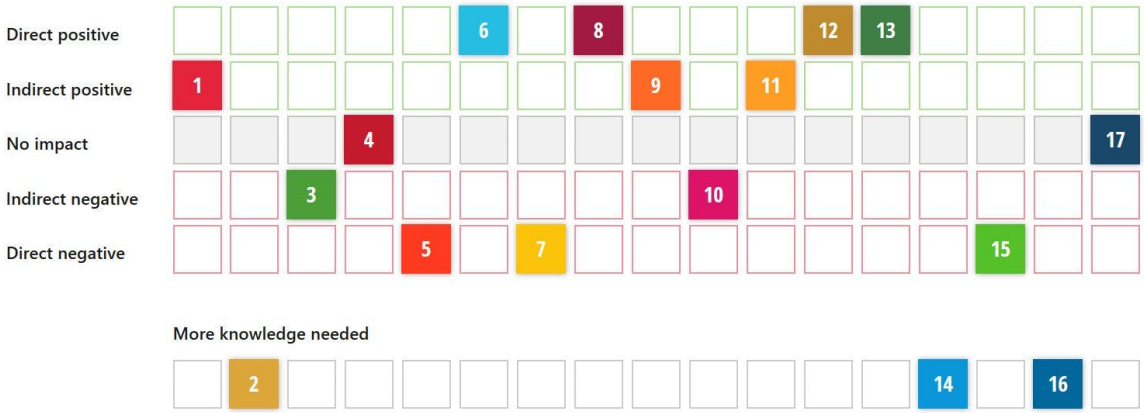

Figure 3 Example result for self-assessment of research impacts on different UN SDGs using the SDG Impact Assessment Tool developed by the Gothenburg Centre for Sustainable Development (source: https://sdgimpactassessmenttool.org/en-gb).

Following this, provide participants with an overview of the upcoming group activities. Continue by jointly working on tracing impacts on sustainability goals, or going into parallel break-out groups, if working on multiple work packages or themes.

In the ***group work on sustainability impact pathway(s)***, participants are asked to link the outcomes to relevant societal goals. The group will undergo three tasks: identifying links to societal goals (15 min), qualifying the nature of the link, and identifying synergies and trade-offs among the societal goals (10 min), and joint reflection on processes leading to impacts and potential indicators (15 min). Plan an additional 20 min if you intend to use the SDG Impact Assessment Tool to assess the nature of impacts on SDGs.

Task 1 - Links to societal goals:

The participants are asked to reassess the activities, outputs and outcomes identified during the earlier part of the workshop. Instead of linking them to context-specific goals as done previously, they are now asked to identify key societal goals, such as the SDGs, to which these elements will be linked. When preparing the whiteboard, identified sustainability goals (e.g., relevant SDGs) are listed as purple stickers (prepare beforehand). Participants can add/modify goals, as well as

activities, outputs and outcomes, as appropriate. They should draw links where they know/believe that an outcome of a research activity helped to improve/deteriorate a respective societal goal. Use of the SDG Impact Assessment Tool (see above) can assist participants in this. They should use solid lines where contributions are already verifiable and dashed lines where contributions are intended.

Suggestion to moderators: To enable a better flow of this exercise, prepare relevant societal goals and indicator sets beforehand, and share them with the participants. In case time is limited and the exercises cannot be completed during the workshop, participants can also be asked to continue identifying and sorting impacts afterwards, particularly if virtual whiteboards are used. This is most effective if participants are specifically assigned to work on individual impacts/criteria. However, be mindful that discussion of impacts among the participants is valuable and will often lead to different results than if participants identify and assess potential impacts individually.

Task 2 - Nature of the links, synergies and trade-offs:

Now, participants are asked to examine the identified contributions to societal goals reflect on the nature of the links, and to identify synergies and trade-offs among the relevant goals. There should only be one line coming out of each outcome – the line can however branch off to multiple goals. In case more than one goal is affected by the outcome: Is the outcome addressing synergies or trade-offs between these goals? Synergies should be marked with '+' and trade-offs with '-'.

The participants are asked to add a memo with one sentence describing the link between the outcome and impact (this can also be completed after the workshop in case time is an issue).

Task 3 - Indicators of impacts:

The SDGs have associated targets which contain quantifiable benchmarks that can serve as indicators. Usually, the processes leading to impacts are not underpinned by established indicators that could inform on them, either qualitatively or quantitatively. The participants are asked to jointly reflect on potential suitable indicators that could be used to qualitatively inform on contributions to the identified societal goals as well as the processes leading to these impacts. Who are intermediaries helping to create outcome from outputs, and impacts from outcomes?

If time permits:

The participants are asked to reflect on potential social, environmental and economic side-effects of achieving particular impacts, considering also the previously identified interactions.

Following a short ***break***, the participants gather in the large group to discuss the results of the group work.

In the ***presentation of updated pathways***, the moderators (or some other selected representative) from each group present the result of the group work and discuss it with all participants. Do all agree with the different elements? Is anything missing? Where do single work packages (for projects) or projects (for thematic areas/programs) sit in the Impact Pathways? If multiple pathways were developed in breakout groups, discuss with participants links between research activities in the different impact pathways, i.e. links across themes. How do research activities interact with each other - which research outputs are new inputs for other research activities? Participants can discuss already existing links as well as intended links (where they see potential integrations). Moderators take note by adding sticky notes, referring to activities (numbered from top to bottom) in the different impact pathways. In case more than one goal/different impact pathway is affected by an outcome: Is the outcome addressing synergies or trade-offs between these goals? Again, synergies should be marked with '+' and trade-offs with '-'.

Suggestion to moderators: If addressing multiple areas in your workshop (i.e. different work packages in a project, or different themes in a programmatic area) and have developed multiple impact pathways, you can aim to integrate them into an overarching scheme for the entire project/program, with different pathways according to themes or research clusters (see below: potential follow-up activity). In that case, you may want to aim for a joint discussion of linkages across impact pathways, and for the identification of clusters among the research activities.

In a second round, ***discuss the social, environmental and economic side-effects***. Participants are asked to reflect on what are the potential social, environmental and economic side-effects of achieving particular impacts, considering also the previously identified interactions.

End the workshop with a ***wrap-up and outlook***, giving the participants the chance to clarify any remaining questions they may have and informing them of what you will provide to them after the workshop.

Suggestion to moderators: Depending on your role in the institution and association with the project/program addressed in the workshops, you may want to remain in regular contact with (some of) the workshop participants, e.g. offering to finalize the draft impact pathway and provide it to the participants, share the workshop procedure/schedule and resources with them (e.g. in a dedicated cloud folder), and/or provide copies of the whiteboards. If you have used digital whiteboards, we recommend you to archive copies of the versions worked on by participants for future reference, and make an editable version available to the participants for their own future use in the project/program.

Potential follow-up activity: Development of a graphical combined impact pathway

When the goal of the workshop includes graphic visualization, subsequent activities may be required to combine and refine the components of the impact pathway. These activities may entail clustering components, gathering additional information through document analysis and/or surveys, and conducting feedback rounds with researchers.

Depending on the scale of the *ex post* assessment and/or complexity of the research subject, creating a clear yet comprehensive visualization can be challenging. To address this challenge, we developed the Impact Mapping Framework (see Pfeifer et al. 2024), which is presented in a circular format, streamlining information. It features the contributions of the assessed research towards societal goals, e.g. the SDGs, in the center (Fig. 4). Surrounding the center are contextual impacts, e.g. enhancements in ecosystem services and biodiversity. Intermediate outcomes that support the application and utilization of research knowledge are positioned between the impacts and research activities, which are depicted in the outermost circle. Research activities associated with particular contextual impacts are grouped closely together, enabling the identification of numerous impact pathways within the integrated impact map.

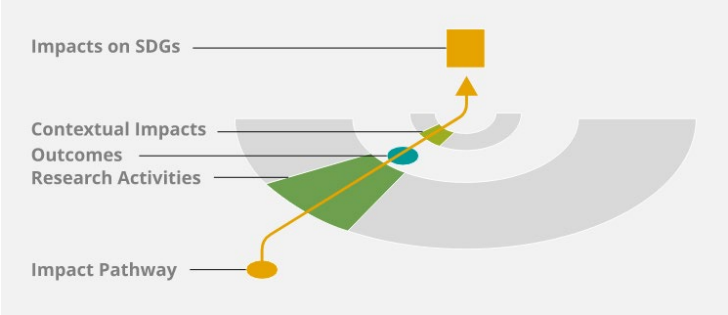

Figure 1 Impact Mapping Framework: Circular visualization.

The graphic visualization can be achieved using an online whiteboard, PowerPoint, or enhanced further with the assistance of graphic designers. One example of an enhanced implementation of the graphical representation of an *ex post* workshop is the *Impact Pathway Graphic Hub*[1] at ZALF. The interactive infographic on Soil Health (Fig. 5) illustrates how ZALF's soil health research aims to contribute to the SDGs by improving five soil functions. Clicking on the components in the graphic reveals additional information, such as impact pathways, for exploration. In the interactive infographic's most detailed layer, users can access descriptions of

[1] https://zalf.isometric.site/impact-pathways

research activities, associated projects and scientific publications, transfer products, generated outcomes, and its impact on soil functions and SDGs.

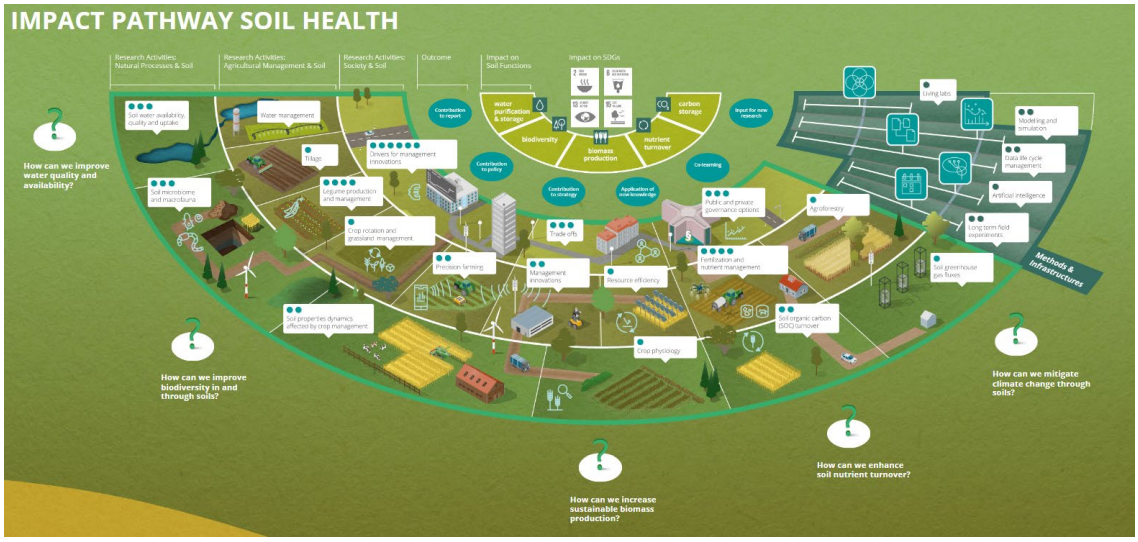

Figure 2 Impact Pathway Soil Health.

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Annex

Proposed time plan and schedule

Duration min. 4h 30min (more if multiple impact pathways are developed)

	Item	Duration	Content/Task
1.	Welcoming & Introduction	20min	Presentation of workshop rationale and context, societal impact, Research Impact Assessment, impact pathways concept, why impact/impact indicators at your institution; background of the research project/program to be assessed
2.	Presenting previously collected information, explanation of group work	15 min	- **Goals**: What are the stated goals of the research project/program - **Logical framework:** Presentation of a preliminary logframe developed by integrating information submitted by participants beforehand - **Explanation of group work**
3.	Group work: draft impact pathway	45 min	- **Input:** What inputs are underlying the research activity? - **Activity:** What research activity is taking place, and when? - **Output:** What are the concrete outputs generated by the listed activities? - **Outcome:** Which outcomes have resulted from the outputs? How? - **Impacts:** Which of the listed impacts can be linked to the outputs and outcomes? Are these links likely, or demonstrable? - **Synergies and trade-offs:** Identify where outcomes are addressing multiple goals – is the outcome leading to synergies or trade-offs among the goals?
	Break	10 min	
4.	Presentation and discussion of impact narrative	30 min per pathway	- Present whiteboard with main findings. - Add to and discuss the different components. - Discuss links between outcomes and goals. - Discuss potential clustering of and connections among activities.

	Break	10 min	
5.	Sustainability goals and indicators	20 min	- Presentation of relevant sustainability goals and indicators (build on material sent prior to workshop) - Explaining the group work
6.	Group work: Sustainability impact pathway	40 min	- **Impacts:** Which of the listed impacts (e.g. SDGs) can be linked to the outputs and outcomes? Are these links likely, or demonstrable? Are the impacts positive or negative? - **Synergies and trade-offs:** Identify where outcomes are addressing multiple goals – is the outcome leading to synergies or trade-offs among the goals?
	Break	10 min	
7.	Presentation of updated pathways, discussion of interactions between themes, trade-offs and synergies	30 min per pathway	- Present whiteboard with main findings. - Add to and discuss the different components. - Discuss links between outcomes and goals. - Discuss potential clustering of and connections among activities and pathways. - Discuss trade-offs and synergies among goals.
8.	Discussion of social, environmental and economic side-effects	25 min	- What are the potential social, environmental and economic side-effects of achieving particular impacts?
9.	Wrap-Up and Outlook	15 min	

LeNa

Template for preparatory material

Preparatory tasks for „Ex Post Impact Pathway Workshop"

Dear Participant,

Thank you for signing up for the „**Ex Post Impact Pathway Workshop [amend/modify to match name of research project or program]**". You are now part of a journey to discover the societal impact of our research at [name of organization/research project].

While we have very good metrics for assessing our scientific excellence, the societal impact of our research is less looked at and more difficult to assess. One possible assessment method is to develop so-called *impact pathways*, in which we link our research activities to intended *outcomes* and *impacts*. Such intended outcomes and impacts go beyond the scientific system and address societal needs and objectives. In the upcoming workshop, we intend to jointly develop a better understanding of how our research contributes to particular societal goals, with the eventual goal of more strategic planning of impactful research and a better demonstration of our impact.

In the first part of the workshop, we will jointly develop an impact pathway, considering the different dimensions of [name of research project/program; include examples of different work packages or research themes]. In the second part, we will focus on how research activities interact with each other and discuss indicators to estimate intensity and magnitude of impacts on jointly agreed societal goals (e.g., SDGs).

In order to be able to contribute as much of your experience as possible, we kindly ask you to undertake **a few preparatory tasks before the workshop**, and **return your notes to us until [specify time; a few days ahead of workshop]**:

- **Read Impact Narrative:** In the first part you find the draft of a so-called *Impact Narrative* – it is the story about how research in **[name of research project/program]** at [name of organization] leads to societal impact. Please read the narrative to get a first impression of the content and direction of the impact pathway.

  Since we are only at the start of the journey this is still a gap text, which will be filled with life and details continuously during our joint journey. Wherever the narrative triggers ideas or critique, please take notes and share them later in the group or send them to us directly.

- **Fill in schematic Impact Pathway:** In the second part of the document you find a schematic *Impact Pathway*, which follows the same structure as the narrative. Here we ask you to focus and take notes on research activities, outputs and established/intended outcomes **from [state year at beginning of timeframe considered]** onwards.

Please bring your notes to the workshop as a basis for the joint development of the impact pathway.

Thank you very much for your participation!

1. Impact Narrative: [Name of research project/program] at [organization] (Gap Text)

[Description of research project/program]

[Provide a short description of the research project or program considered, e.g. from the project proposal or programmatic description at the organization]

Within [name of research project/program], [name of organization] scientists aim at fulfilling the following goals:

Goal 1: [state an explicit goal of the research project/program]

[Provide a short description of a stated goal of the research project/program, e.g. from the project proposal or programmatic description at the organization; repeat for the different context-specific goals you would like to consider]

What is the relevance of [name of research project/program] for societal goals and sustainable development?

[Provide a short narrative text relating the research within the project/program considered to examples of societal goals, e.g. to different sustainability dimensions (social, ecological, economic, governance) as well as to the UN Sustainable Development Goals]

Input for [name of research project/program] Research at [name of organization]

[Provide a short narrative text describing the development and current extent of the relevant research at your organization, followed by a gap text section listing the different types of input that are the foundation of the research, e.g. amount of working groups or people, scientific partnerships, practitioners, third party and central funding, as well as physical infrastructure, laboratories, field sites, equipment etc. Only name the types of categories you would like participants to consider, leaving gaps for them to fill in amounts and numbers].

Example gap text section, to be adapted: *Since 20XX, at [name of organization], ___ working groups and a total of _____ people have been working on research to improve [aquatic resource use and conservation]. Their scientific expertise has been complemented by _____ scientific partnerships (e.g. _____) and practical experience by _____ practitioners (e.g. _____). Next to the people involved, the funding through third party (_____€) and central funds (_____€) as well as the physical infrastructures, such as laboratories (___), experimental sites (___ha) and equipment (___), made the research possible in the first place.*

Research Activities, Outputs and Outcomes

[Provide a short gap text describing the current research activities and their outputs and applications, as well as a description of the overall goals of the research project/program. Provide gaps for participants to fill in different outputs and outcomes].

Example gap text section, to be adapted: *Key outputs of these activities are _____, which have already been discussed in _____. _____ has been implemented by _____. Outputs of _____ were used for _____. Joint research activities in _____ have resulted in _____.*

Impact on [name stated goals of research project/program]

[Provide a short narrative text describing how the outcomes of the research considered contribute to the stated goals of the research project/program, with a gap at the end for participants to fill in examples of contributions].

Example text, to be adapted: *The outcomes of our research on [xxxx] contribute to [stated goals of research project/program] for example by improving underlying ecosystem services (e.g., biomass production, sediment retention and nutrient cycling) or practices (e.g., fishing methods, stock assessments and effective management). Concrete examples of such contributions are* _____.

Societal Impact

[Provide a short narrative text describing how the outcomes of the research considered affect different sustainability dimensions, with a gap at the end for participants to fill in examples of contributions].

Example text, to be adapted: *These improvements in [aquatic resource use and conservation] again have further social, economic, governance and environmental side effects, which constitute the societal impact of [aquatic resource] research at [name of organization]. Concrete examples of societal effects of [aquatic resource use and conservation] improvements by [name of organization] research are*
_____.

Contribution to Achieving SDGs [and/or similar high-level goals related to sustainability transformations]

[Provide a short narrative text describing how the outcomes of the research considered contribute to particular UN Sustainable Development Goals and/or similar high-level goals related to sustainability transformation, with a short gap text at the end allowing participants to provide own examples or specify further which sub-targets are addressed].

Example text, to be adapted: *Through the demonstrated pathway of impact the research of [name of organization] on [aquatic resource use and conservation] contributes to achieving the UN SDGs on food security (SDG 2), life below water (SDG 14), poverty reduction (SDG1), sustainable economic growth (SDG 8), and resource efficiency (SDG 12). It also responds to several of the Challenges formulated under the UN Decade of Ocean Science for Sustainable Development, namely protecting marine ecosystems and biodiversity (Challenge 2), sustainable food production (Challenge 3) and a sustainable and equitable ocean economy (Challenge 4), thereby contributing to two of seven desired Decade outcomes (A Healthy and Resilient Ocean and A Productive Ocean). [Aquatic resource] research at [name of organization] makes a particular contribution to sub-targets* _____ *in SDGs* _____.

2. Impact Pathway[2]: Impact of [name of organization]-research project/field [name of research project/program]

a. Please have a close look at the research activities listed here
   - *Are you missing anything? Which research activities are you conducting in order to improve aquatic resource use and conservation?*
   - *Do you have suggestions on different phrasing? (Phrasing should follow the logic **"activity" of smth. on/for smth.**)*
   - *Can you specify or combine some activities?*

b. Please think and take notes of **key** outputs of research activities. Naturally this specifically applies but is not restricted to research activities you work on or are very familiar with. Try to name a specific publication for each output.

c. Please think about and take notes on already established or intended implementation/dissemination of your noted scientific outputs (outcome)

(see figure on the following page)

[Fill examples of inputs and activities based on your familiarity with your organization, e.g. by listing under Input some laboratories relevant to the research considered, and under Activity some of the relevant research activities based on available project/program descriptions. The figure provided below contains several examples that should be adjusted or deleted according to your own specific case].

[2] Source: Adapted from CSIRO (2020)

Input	Activity	Output	Outcome	Impact
	Your planned work		Your intended results	
Resources mobilized to enable activities	*Scientific activities **(since 20XX)***	*Can be new:* • *Scientific Insight* • *Method/Concept* • *Infrastructure* • *Tool* • *Technology* *Published by researchers: in scientific articles, presentations, workshops, guides etc.*	*= use of output:* • *changes in working practices* • *changes in policy* • *everything that leads to „use" of output (commercial products; discussion of output in civil society, practice, politics or science)*	*Contribution of research activities on:* • *contextual goals* • *societal side effects* • *societal target systems (e.g. SDGs, UN Ocean Decade)*

 *People*  *Partnerships*  *Funding*  *Physical Resources* *Institutional infrastructures*	1.	Development	**of**	recommendations	**on/for**	improved policy instruments		Content of Workshop
	2.	Assessment Analysis Monitoring Modelling	**of**	living resource stocks	**on/for**			
	3.	Assessment Analysis Monitoring Modelling	**of**	fisheries practices	**on/for**			
	4.	Development	**of**	stock assessment tools	**on/for**			
	5.	Assessment Analysis Monitoring Modelling	**of**	fisheries institutions	**on/for**	development of co-management regimes		
	6.	Development	**of**	certification	**on/for**	sustainably harvested ornamental species		
	7.	Development	**of**	science – policy interface	**on/for**	fisheries data availability and exchange		
	8.	Development	**of**	citizen science program	**on/for**	seagrass monitoring		
	9.	Development	**of**	transformative knowledge	**on/for**	aquaculture sustainability		
	10.							
	11.							

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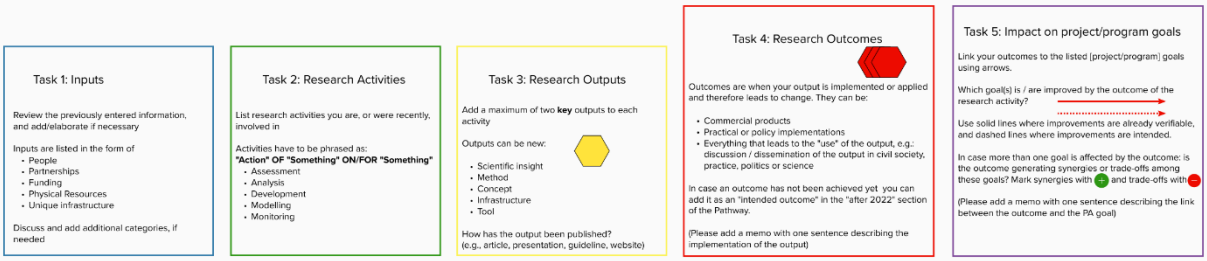
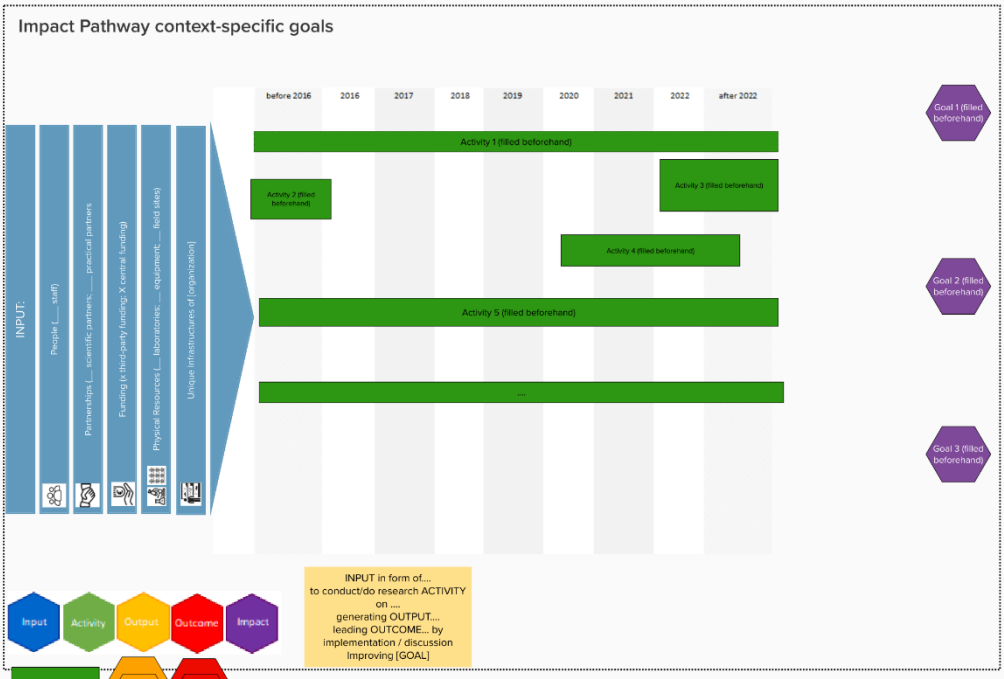
Examples of whiteboards for the workshop

Impact pathway for context-specific goals





Impact pathway for sustainability goals

Task 1: Impact on societal goals

Link your outcomes to the listed societal goals using arrows. Add or modify activities, outputs and outcomes as appropriate. Add or modify societal goals as appropriate.

Which goal(s) is / are improved by the outcome of the research activity?

Use solid lines where improvements are already verifiable, and dashed lines where improvements are intended.

Task 2: Synergies and trade-offs

In case more than one goal is affected by the outcome: is the outcome generating synergies or trade-offs among these goals? Mark synergies with ⊕ and trade-offs with ⊖

Reflect on the nature of the links - what are the processes linking individual outcomes to impacts on societal goals? Please add a memo with one sentence describing the link between the outcome and the impact.

Task 3: Indicators of impacts

Looking at the identified societal goals addressed by research in this theme, what are existing and/ or suitable indicators to track these goals?

What are suitable indicators to inform on the quality of the processes linking outcomes and impacts? Please add memos to the goals and links describing suitable indicators.