

# Towards useful forms of co-production in metocean services for the European Arctic

A PPP-SERA Special Services Workshop

Report



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# CONTENT

<b>1. Introduction and background</b>	<b>4</b>
1.1 The Polar Prediction Project	4
1.2 The Societal and Economic Research and Applications task team	5
1.3 The Special Services Workshop	6
<b>2. Workshop structure and participants</b>	<b>7</b>
2.1 Workshop structure	7
2.2 Participants	7
2.3 Survey results	7
<b>3. Key themes and topics</b>	<b>10</b>
3.1 Setting the stage: keynote presentations	10
Presentation 1: Stakeholder engagement in the Polar Prediction Project (PPP)	10
Presentation 2: The relevance of co-production in European polar research	10
Presentation 3: Lessons on co-producing climate services	11
Presentation 4: SALIENSEAS - Experiences and lessons from a co-production project	11
Presentation 5: APPLICATE - Knowledge co-production in the Arctic and beyond	11
3.2 Breakout sessions	12
Breakout session 1: Benefits and challenges of co-production across the value chain	12
Breakout session 2: Enabling factors for co-production	14
3.4 Discussion	16
<b>4. Conclusion</b>	<b>19</b>
<b>REFERENCES</b>	<b>21</b>
<b>ANNEXES</b>	<b>22</b>
i. Workshop programme	22
ii. Participant survey results	23
ii. Jamboards	25
Jamboards Breakout Session 1	25
Jamboards Breakout Session 2	29



# 1. Introduction and background

Environmental conditions in the Arctic Ocean are becoming more dynamic due to climate change, while the range of human activities in the European Arctic Ocean is projected to increase. Weather and ice conditions are becoming more extreme and variable, at the same time that specialized environmental forecasting services are increasingly being made available by a growing range of public and commercial providers, to facilitate human safety, community well-being, as well as sustainable operations. The tailoring of these services is increasingly based on the premise of co-production, to suit diverse user needs across the Polar Regions, and research is funded under the condition that co-production with a range of stakeholders and end-users will need to take place. However, there is a limited understanding, both practically and conceptually, of what such co-production initiatives entail in the European Arctic Ocean context, and how co-production processes can be carried out in ways that benefit both user and research communities.

This report presents the results of an online workshop organised in January 2021 by the Socio-Economic Research and Applications group of the Polar Prediction Project (PPP-SERA). This, so called, Special Services Workshop gathers researchers involved in current projects aimed at co-producing environmental information services for maritime actors and sectors in Arctic waters. The objectives of this workshop are to generate awareness about, to identify opportunities and challenges of, and to draw lessons from co-production processes across these research projects. The workshop will lead to shared insights and lessons on transdisciplinary network building, engagement of and engaging with users, and on project management. In this report, we share the insights from the workshop, with a focus on challenges of inter- and transdisciplinary collaboration, integrating projects in Arctic user communities, and on bridging gaps between research, service production and user applications.

## 1.1 The Polar Prediction Project

The Polar Prediction Project (PPP) is one of the key programmes of the World Meteorological Organisation's (WMO) World Weather Research Programme (WWRP). PPP has been conceived to support coordinated international research efforts to improve environmental prediction services, such as on weather and sea ice, for the polar regions, with anticipated benefits for weather forecasting for the lower latitudes. The Year of Polar Prediction (YOPP) is one of the flagship activities of the PPP, with a core phase from mid-2017 to mid-2019. The mission of PPP is to enable a significant improvement in environmental prediction capabilities for the polar regions and beyond, by coordinating a period of intensive observing, modelling, verification, user engagement and education activities. In this mission statement the theme of user engagement is emphasised.

The primary goal of the PPP is to advance scientific knowledge such that society, both within and outside of Polar Regions, may benefit through making available more accurate WWIC forecasts and improved service provision. Although realising that this goal relies on achieving an improved understanding, characterisation and modelling of atmospheric, oceanic and land-surface processes in Polar Regions, the PPP acknowledges the need and challenge to translate scientific success into

societal value, and hence responds to concerns about human or environmental safety in relation to human activities and operations in the polar regions. In this context, and for the purpose of this report, societal value is defined as enhancing opportunities while reducing human risk.

## 1.2 The Societal and Economic Research and Applications task team

To understand and stimulate user engagement in PPP, as well as societal value from scientific efforts requires social and interdisciplinary research to better understand WWIC-related decision-making and communication processes. It also necessitates improved methods to evaluate the impact of better WWIC services, and to measure the socio-economic value of these services across a wide spectrum of potential users and across a range of spatial, cultural, social, political, economic and geographic contexts. Towards these ends, the PPP established a special research group of social and interdisciplinary scientists and service practitioners in 2015. This initiative led to the official establishment of the Polar Prediction Project's Societal and Economic Research and Applications (PPP-SERA) task team.

The task team held an inaugural meeting in Ottawa, Canada in 2015, with annual follow-up meetings in Christchurch, New Zealand, in 2016 (Thoman et al., 2017), in Fairbanks, Alaska, in 2017, in Wageningen, The Netherlands, in 2018, and in Punta Arenas, Chile, in 2019. The main interest of the PPP-SERA is in understanding human behaviours and decision-making processes to identify the need for and utilisation of WWIC forecasting services. The tasks of the PPP-SERA include defining, developing and promoting a collaborative research program to complement physical-science activities undertaken as part of the PPP (such as modelling and forecasting), much of which will be undertaken around its Year of Polar Prediction (YOPP), a concentrated period of intensive observation and modelling activities that occurred between 2017 and 2019 and was followed by an extended consolidation phase, extending into 2022, during which the results of the more intensive observation phase are being linked and also better connected to service providers and users. More specifically PPP-SERA aims to:

- Build a community of social and interdisciplinary scientists and service providers interested in WWIC information service provision in and for the Polar Regions;
- Stimulate dialogue between environmental forecasters, researchers and end-users across a range of relevant activities;
- Understand the role and relevance of WWIC services in decision-making of diverse end-user groups operating in the Polar Regions;
- Engage and learn from users and providers on how best to tailor and co-produce WWIC services; and
- Assess the societal effects and implications of contributions made by PPP.

PPP-SERA has stimulated and initiated a range of dedicated research projects, which the group termed Special Services Projects and which aim at understanding the information needs of stakeholders in the Polar Regions, and to facilitate the enhancement of societal value through applications of improved environmental information services. In addition, PPP-SERA has stimulated conversations between social scientists, WWIC forecasters and end-user groups through

moderated PPP-SERA Open Sessions that were held at the group's annual meetings. The Special Services Workshops build on this experience and aim to facilitate targeted exchange and learning, through a series of regionally-focused workshops that will be undertaken during the YOPP Consolidation Phase.

### 1.3 The Special Services Workshop

This report presents the results of a Special Services Projects workshop held in and focused on the European Arctic, titled: "Co-production in the European Arctic weather, water, ice and climate services". The workshop was held as an online meeting on Monday 25 January 2021. The key purpose of the workshop was to reach out to researchers and research projects in Europe that focus on the development of weather, water, ice and climate (WWIC) information services for communities and economic sectors in the European Arctic region, based on a strong stakeholder engagement component, and to identify and discuss joint challenges and lessons. A detailed description of the workshop content and participants is provided in the following chapters.

## 2. Workshop structure and participants

### 2.1 Workshop structure

During the 4-hour workshop, researchers and representatives gathered who have been or are currently involved in relevant European projects aimed at co-producing weather, water, ice and climate (WWIC) information services for communities and economic sectors in the European Arctic. Main topics of discussion were the state of the art of co-production approaches in European Arctic research, the need to understand and map different approaches taken across a range of European projects, and the challenges and potential lessons for the future. The workshop included both keynote presentations and interactive sessions in the form of breakouts and discussions.

The workshop was held on the Zoom platform, and was prepared and hosted by Machiel Lamers of Wageningen University and Research, and by Jelmer Jeuring of The Norwegian Meteorological Institute.

### 2.2 Participants

A total of 34 people registered for the workshop, and almost 30 people joined the online meeting. In the first part of the workshop the results of a survey were presented (see also 2.3) that was part of the registration process. The objective of the survey was to get an insight into the background of participants, their experience with co-production processes, and their expectations about the workshop. The main geographical scope of the workshop was the European Arctic, and participants from many different European countries joined. In addition, some participants from North America joined as well. The majority of participants qualified themselves as researcher or (research) consultant, working in fields ranging from meteorology and climate science to various social sciences. Participants' career stages varied from Master student to management levels. Slides with a more detailed overview of participant characteristics are included as Annex.

### 2.3 Survey results

Next to getting an overview of participants' background, the registration survey included several statements for which respondents were asked to give their level of agreement. Four statements were provided about definitions of and capacity for applying co-production in Arctic WWIC research. Level of agreement was measured on a 1-10 scale (1 strongly disagree; 10 strongly agree).

The first statement pertained to definitions of co-production. It stated that "there is a need to more clearly define the concept of co-production in the field of Arctic weather, water, ice and climate services" (Figure 1). Almost 75 percent rated this statement 8 or higher, indicating that many participants prefer more clarity around the meaning and purpose of co-production. Participants were also asked to share their agreement with the statement "it is clear to me when co-production is a suitable approach in a research project" (Figure 2). While almost 30 percent of participants agreed (strongly) with the statement (8 or higher), over half of the participants were

more ambivalent and rated their agreement between 4 and 7. Together, these two statements show that participants may still be not entirely sure what co-production can do for both researchers and stakeholders, and what conceptual, methodological and practical aspects should be considered in co-producing Arctic WWIC research.

The third statement was “applying co-production in my research brings, overall, more benefits than challenges” (Figure 3). Most respondents were in some level of agreement with this statement, and over 40 percent rated the statement 8 or higher. This indicates that, despite a certain level of uncertainty about the conceptual basis of co-production, incorporating co-production principles in research is mostly seen to create positive outcomes.

- *Lesson 1: Co-production in Arctic WWIC research and service development may benefit from further conceptualization and translation into practical applications.*

The last two statements pertained to individual and organizational capacity to apply co-production in Arctic WWIC research. The statements were “I feel that I have sufficient skills to implement the co-production methods that are needed in my research” (Figure 4), and “I feel that I have sufficient institutional support to implement the co-production methods that are needed in my research” (Figure 5). Participants appeared to have a rather varied perception when it comes to currently having the necessary individual competences. Almost 25 percent (strongly) disagreed (1-3 rating), indicating that one out of four do not see themselves capable of applying co-production methods. At the same time was one out of three in (strong) agreement (8-10 rating), which points to a big part of participants seeing themselves as having sufficient skills to work with co-production in their research. A nuanced picture emerged as well about the level of institutional support. One out of four participants (strongly) agrees (8-10 rating) to having sufficient institutional support, while 60 percent is more ambivalent (4-7 rating). This may point to an overall need for strengthening institutional support, in order to fully capitalize on the potential of co-production in Arctic WWIC research.

- *Lesson 2: There is room for investing more in the individual and organizational research capacity to support successful implementation of co-production in Arctic WWIC research and service development.*

Overall, these topics were forming a fruitful basis for discussions during the workshop, which facilitated both the organizers and participants to dig deeper into the challenges and benefits around co-production.



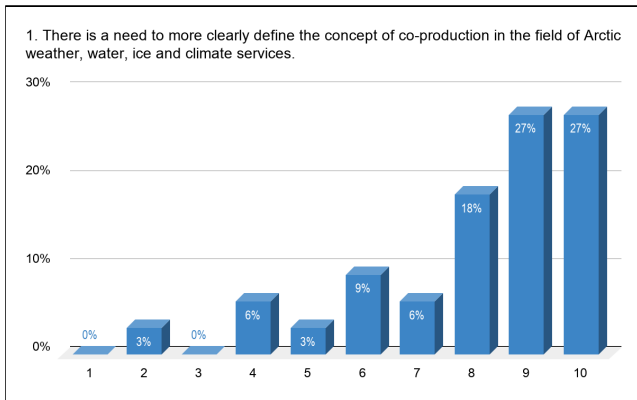


Figure 1. Need for defining co-production

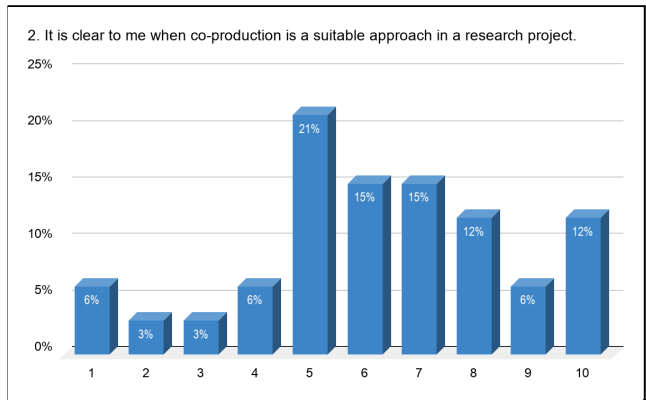


Figure 2. Co-production suitability

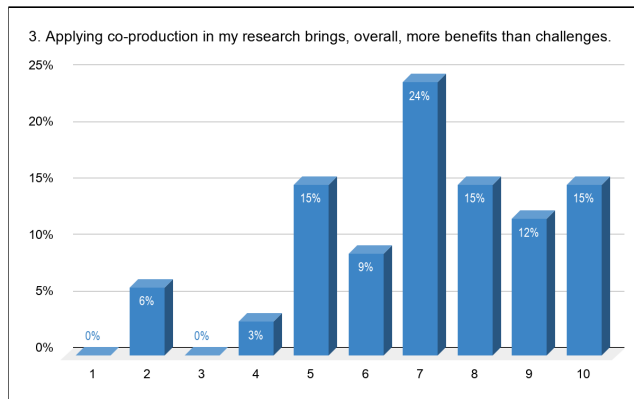


Figure 3. Benefits of co-production

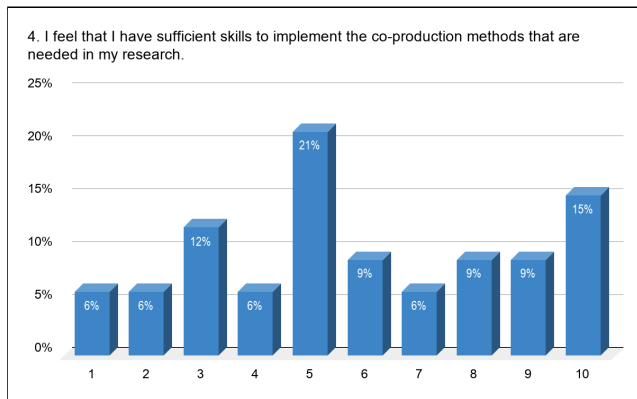


Figure 4. Skills to apply co-production

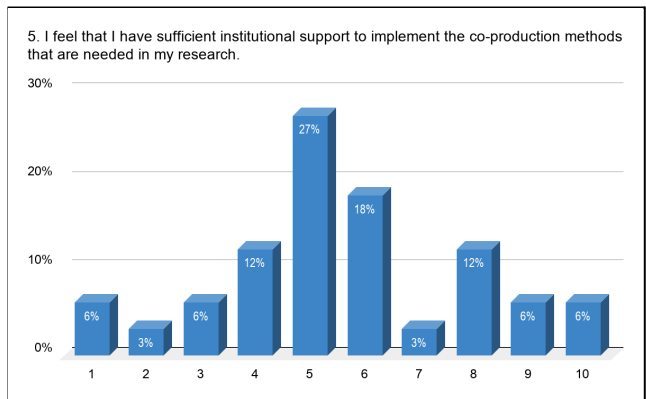


Figure 5. Institutional support for co-production

### 3. Key themes and topics

This chapter discusses the output generated in the various presentations and breakout sessions of the workshop. At the end of the chapter we will describe the key discussion points raised by the participants during the plenaries and breakout sessions, both orally and through the chat function.

#### 3.1 Setting the stage: keynote presentations

At the workshop we gave the floor to a range of experts that each in their own way set the stage for an informed discussion on the role of co-production in metocean services for the European Arctic.

##### Presentation 1: Stakeholder engagement in the Polar Prediction Project (PPP)

Dr. Kirstin Werner is the director of the International Coordination Office (ICO) of the Polar Prediction Project (PPP), based at the Alfred Wegener Institute (AWI) in Bremerhaven, Germany. Dr. Werner outlined key activities organised as part of the Year Of Polar Prediction (YOPP), emphasising the user engagement and communication activities. These include various panel discussions, the [Polar Prediction Matters \(PPM\)](#) dialogue platform between users and providers of polar forecast services, the [IcePod podcast](#), the [‘Polar Predict News’](#) newsletter and active social media presence through [Twitter](#) and [Instagram](#). Particularly through Polar Prediction Matters, an attempt is made to actively reach out to various user groups to understand forecast users and their needs, and to generate dialogues between forecast users and providers.

##### Presentation 2: The relevance of co-production in European polar research

Dr. Annette Scheepstra is a researcher at the Arctic Centre of the University of Groningen in the Netherlands, who has been part of the stakeholder engagement components of both EU-PolarNet programmes I and II. The purpose of EU PolarNet is to develop an integrated European Polar research programme that addresses key societal challenges and research needs, based on a co-design process. Dr. Scheepstra has also been involved in the drafting of a White Paper on the Status of Stakeholder Engagement in European Polar Research, which emphasised various roles and levels of engagement, from equal partners, advisors and experts to visitors. Based on their work a number of recommendations for stakeholder engagement have been formulated, including trust building, early and ongoing engagement, time and resources requirements, and representativeness and diversity. Also, European funding on Polar research will emphasise co-creation of knowledge in collaborative projects of natural and social sciences, such as interdisciplinary and transdisciplinary research projects, as well as acknowledgement of needs of indigenous rights holders. There are currently several attempts to collect relevant experiences and lessons through surveys with the aim of harnessing lessons and insights for the future.

### Presentation 3: Lessons on co-producing climate services

Dr. Marta Bruno Soares of the University of Leeds discussed lessons for co-production from the wider field of climate service development projects worldwide. She presented a variety of reasons to stimulate co-production, including non-linearity experienced between the production and use of climate science, the idea that co-produced knowledge increases credibility, legitimacy and saliency, and thereby enhances the usability of climate services. However, there are still many questions regarding when and how to apply which method or tool. She presented a range of ingredients for effective co-production, based on experiences in various projects, including: co-defined specific goals, regular involvement of relevant actors, co-identification of entry-points for development, effective feedback loops, flexibility and adaptability, sufficient human and financial resources, inclusiveness of actors and sufficient time. She also presented some common pitfalls, including communication challenges between various actors; insufficient resources, competences and capacities; challenges in managing expectations; and issues in ethics and values.

### Presentation 4: SALIENSEAS - Experiences and lessons from a co-production project

Dr. Berill Blair is a postdoctoral researcher at the Environmental Policy of Wageningen University. She presented recent insights from the SALIENSEAS project, an international project funded through the JPI-ERA4CS Climate. SALIENSEAS aimed to understand mobility patterns and user needs of shipping sectors in European Arctic seas, to develop and employ participatory tools for co-production, and to develop a range of demonstration services. Part of the project focused on the development and iterative testing of seasonal to sub-seasonal (S2S) sea-ice forecasts with cruise ship captains and ice pilots by means of a serious game. In terms of key lessons, SALIENSEAS has demonstrated that co-production is a resource intensive process for service users and providers alike, timing and type of appropriate co-production depends on the stakes held by users, the level of scientific uncertainty, the demand for the product, and the institutional capacity. Social sciences can contribute by brokering knowledge across multiple domains, including considerations of policy frameworks, institutions, societal needs, and where to invest skill, to increase societal value from innovation.

### Presentation 5: APPLICATE - Knowledge co-production in the Arctic and beyond

Dr. Marta Terrado and dr. Dragana Bojovic of the Barcelona Supercomputing Center, presented experiences from the H2020 APPLICATE project. APPLICATE aims to develop enhanced predictive capacity for weather and climate in the Arctic and beyond and determine the influence of Arctic climate change on Northern Hemisphere mid latitudes, for the benefit of policy makers, businesses and society. A key tool has been the establishment of a user group as a way to generate engagement with the different stakeholder target groups. The project also included co-development of a series of case studies. The project resulted in the following insights about successful co-production: Involve users as project partners or alternatively compensate them for their time, prioritize interactions at project conferences and assemblies, keep the scope flexible but with sufficient scientific support, develop case studies for storytelling and engagement.

### 3.2 Breakout sessions

Two breakout sessions of 20 minutes each were held, where participants were divided into small groups. The participants received a link to an online Jamboard (see Figure 6). In groups of 4-6 persons, the potential benefits and challenges around implementation of co-production, as well as the enabling personal, organizational and external factors of co-production in research and development were discussed.

#### Breakout session 1: Benefits and challenges of co-production across the value chain

In the first 20-minute breakout session, participants were invited to reflect on benefits and challenges of co-production at various stages of the value chain from data production to end-user decisions. Value chains are an increasingly used concept to describe and understand different stages of product development, collaboration and communication, and the interactions that (need to) take place within and between those stages between researchers, stakeholders and other relevant actors (Dawson et al., 2017, GDFRR, 2019), in order to go ‘the last mile’ and ensure climate services’ potential to add societal value.

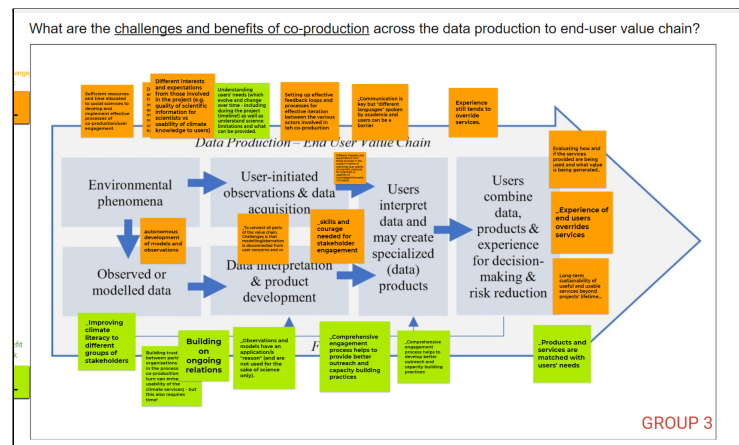


Figure 6: example of the Jamboard interface (breakout session 1)

Table 1 includes the key themes of challenges and benefits that emerged during the breakout session. See the Annex section for the full list of input. Some themes pertain to specific stages in the value chain (e.g. upstream, outcomes) while other themes affect various stages of the value chain, and pertain to co-production more generally (e.g. forms and processes of co-production).

#### Challenges

Identification of starting points for co-production, including suitable stakeholders and key questions to address is seen as a challenge for initiating co-production processes.

Second, it was seen as a challenge to connect the different stages of the value chain from end-to-end. Specifically, to translate any identified user needs into concrete ‘upstream’ activities, for example in terms of implications for modelling and observations.

At the output side of the value chain, salience of outcomes resulting from co-production appears an important challenge. Diverging perceptions of how relevant a certain outcome is may

emerge from different interests, value perceptions or agendas across actors involved in the co-production process.

Various challenging aspects were mentioned related to the form co-production processes should take, and what the roles of different actors are in this process. This includes communication across disciplines, setting up platforms for feedback and iteration, and project team formation.

A final challenge pertains to various types of resources. This includes financial resources, but also the ability to dedicate sufficient time and money, and ensuring presence of skills and expertise for engaging with stakeholders.

### *Benefits*

Participants saw various benefits of co-production to mark starting points for collaboration. These include the opportunity for co-scoping the process towards user needs while being able to adapt to new insights during the collaboration. Co-production also allows for building on existing relations between users and producers.

Co-production can help strengthen connections between the collaboration process and the product or service that is to be developed. For example, to balance the attention in a project between basic scientific research tasks and practical applications, steer the development process through iterative dialogues, or provide new ways of looking at data.

Two other themes were closely related to the above, and relate to benefits of co-production in the form of either product outcomes or process outcomes. Product-related benefits imply an improved match and relevance of products for user needs, making them more tailored to the context in which a product or service will be used.

Co-production can also benefit the collaboration process itself, through outcomes beyond the delivery of a new product or service. For example, co-production can strengthen (institutional) trust and form a basis for new partnerships or trigger innovation. Additionally, involving users and stakeholders in a co-production process, can result in higher literacy about weather and climate processes. Such literacy can support stakeholders in adapting to climate change and improve their knowledge about weather and climate services more generally.

*Table 1. Key challenges and benefits of co-production*

<p><b>Challenges</b></p> <ul style="list-style-type: none"> <li>➤ <i>Identification of starting points</i></li> <li>➤ <i>Incorporating upstream input from users</i></li> <li>➤ <i>Diverging perceptions of outcome salience</i></li> <li>➤ <i>Form and process of co-production</i></li> <li>➤ <i>Availability of resources</i></li> </ul>
<p><b>Benefits</b></p> <ul style="list-style-type: none"> <li>➤ <i>Starting points for collaboration</i></li> <li>➤ <i>Connecting process and product</i></li> <li>➤ <i>Product outcomes</i></li> <li>➤ <i>Process outcomes</i></li> </ul>

- *Lesson 3: Co-production can be beneficial at, and is potentially an essential ingredient of, various stages in Arctic WWIC research and service development value chains.*

- Lesson 4: Successful co-production is contingent on overcoming a multiplicity of challenges including a). Reaching a shared understanding about end-to-end connections between R&D ingredients, actors and outcomes; b). Making user-centered choices about forms of co-production and role divisions, and; c). Ensuring access to sufficient types of resources.
- Lesson 5: Arctic WWIC research and service development can further benefit from co-production approaches, especially when building on existing collaborations and trust between providers and users.
- Lesson 6: When key resources are present, co-production can create a self-reinforcing dynamic through its potential to nurture and strengthen its own necessary pre-conditions, including mutual trust, and societal salience of outcomes that goes beyond the scope of service development.

## Breakout session 2: Enabling factors for co-production

In the second breakout session, participants were invited to engage for 20 minutes in a discussion about various factors that may contribute to a positive environment for implementing a co-production approach. The Jamboard that was used in this session discerned between three levels of enabling factors; personal skills, organizational capacity and external factors. In addition, wildcards were introduced to allow participants to include any enabling factors that do not fit under the three levels, but that are closely related to, or connecting the individual, organizational and external factors (see Figure 7 for an example of a filled out Jamboard). Table 2 includes the key factors themes that were brought up by participants (see Annex for the full list of responses).

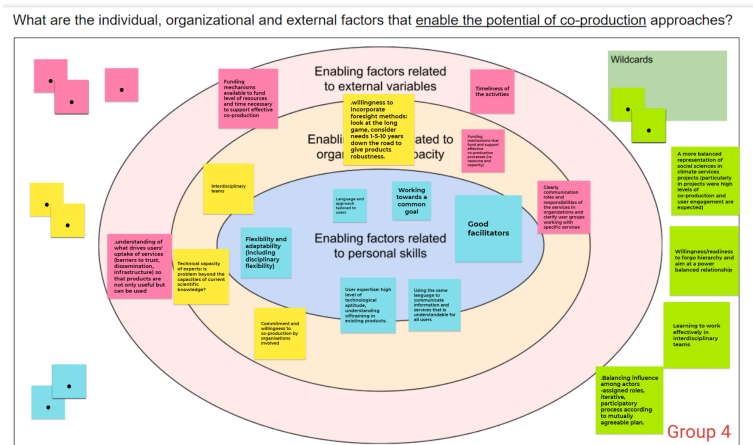


Figure 7: example of the Jamboard interface (breakout session 2)

### Personal factors

Three types of enabling factors on the personal level were mentioned. These include a variety of communication and collaboration skills, such as being able to listen and showing empathy. In addition, methodological skills for interacting with users, as well as possessing expertise across relevant disciplines and contexts were seen to be important for successful co-production.

A second factor pertains to the way researchers are knowledgeable about and interested in specific user contexts in which needs for WWIC information emerge. This means, for example, that

speaking local language and translating technological terminology into understandable communication formats to match the expertise of different users are key enabling skills.

A third enabling factor on the personal level relates to interdisciplinary attitudes. For example, being genuinely curious about user needs, being able to think out of the box and being trained in or used to interdisciplinary thinking are favourable factors mentioned in the breakout session.

### *Organizational factors*

On an organizational level, enabling factors that are related to strategic ways of collaboration between researchers and users include investing in building mutual trust and prioritization of key focus areas where co-production can add value.

Second, it was noted that if potential issues around funding are accounted for, co-production can be facilitated. For example, by specifically targeting funding resources to co-production principles (e.g. capacity building), and gearing bureaucratic processes towards the pace of co-production.

A third organizational factor pertains to methodological capacity. This means that organizations should have the tools and instruments to facilitate workshops and training, and to have in-house expertise that covers various aspects of the value chain, including technical capacity.

Fourth and finally, various aspects of organizational culture were mentioned. For example, an egalitarian working culture, an open source mentality, interdisciplinary teams and innovative mindsets were mentioned as important factors that facilitate co-production on the organizational level.

### *External factors*

External factors that affect successful co-production include aspects that related to perceived benefits and relevance of the process. For example, the level of perceived justification among users to engage in a research project based on the costs versus benefits, and the level of trust between users and researchers.

Similarly, the extent to which co-production stakeholders have sufficient resources, especially having the time to participate was mentioned. Related to this is the way co-production activities are aligned with the user activities and everyday obligations. Importantly, varying levels of resources between different stakeholders may result in uneven power and some stakeholders to be overlooked as potential users to engage in the research process.

External factors that enable co-production were also identified on the policy level. For example in terms of funding mechanisms that allow for long-term engagement, and the availability of open data about climatology. Awareness and perceptions of urgency for the need to provide climate services among policy makers and industrial sectors was also seen as an important facilitating factor.

### *Wild cards*

Finally, two factors were mentioned as wild cards. First, the general need for developing interdisciplinary capacity at all levels was mentioned. This means to learn how to work in

interdisciplinary teams and, specifically in the context of climate services, to strongly integrate social scientific methods and theories in the research and development of climate services.

The second wild card pertained to equity between researchers, and between researchers and stakeholders. This includes the facilitation of participatory collaborations, power-balanced relationships, and continuous feedback among co-production participants.

Table 2. Factors enabling successful co-production.

<p><b>Personal factors</b></p> <ul style="list-style-type: none"> <li>➤ Communication and collaboration skills</li> <li>➤ User-oriented</li> <li>➤ Interdisciplinary skills</li> </ul>
<p><b>Organizational factors</b></p> <ul style="list-style-type: none"> <li>➤ User-oriented</li> <li>➤ Funding</li> <li>➤ Methodological and technical capacity</li> <li>➤ Organizational culture</li> </ul>
<p><b>External factors</b></p> <ul style="list-style-type: none"> <li>➤ Outcome justification</li> <li>➤ User resources</li> <li>➤ Science-policy connections</li> </ul>
<p><b>Wild cards</b></p> <ul style="list-style-type: none"> <li>➤ Interdisciplinarity and social science integration</li> <li>➤ Equity</li> </ul>

- *Lesson 7: Enabling factors for successful co-production in Arctic WWIC research and service development are interdependent and connect the individual and institutional levels.*
- *Lesson 8: Communication skills and a curious, interdisciplinary mindset, with genuine interest in a service context are important personal competencies that enable interdisciplinary and eventually transdisciplinary collaboration that facilitates co-production.*
- *Lesson 9: Research institutes and related organizations involved in Arctic WWIC research and service development need to account for co-production in their strategies, which includes investing in stakeholder relationships, and in researcher capacity building.*
- *Lesson 10: Arctic WWIC research and service development needs to be sensible to the wider societal dynamics which shape the user and stakeholder context. This includes the legal and ethical assumptions and consequences related to co-production in particular contexts, and the varying access among stakeholders to resources needed to participate in an equal co-production process.*

### 3.4 Discussion

The workshop generated in-depth discussions between the participants around many of the topics brought up during the presentations and breakout sessions. These discussions took place both during the plenary presentations and during a dedicated discussion session at the end of the workshop. In this section we will briefly describe the key discussion items.



First, a commonly shared conviction of participants at the workshop is that co-production methods are beneficial in creating various ‘bridges’ between different stakeholders or communities involved in or affected by WICC services production. These include actors with different academic disciplines, in science or operations, producers or users, with different cultures or languages, or with different interests. It was emphasised that in research and development of WICC services in the Arctic context, the term ‘user’ can pertain to a wide range of stakeholders. For example, a user to be involved ranges from an Inuit fisherman, an expedition cruise operator, or a service provider working in an operational forecasting centre. In other words, the value chain as used and discussed at the workshop is broad in terms of actors. An important challenge here also pertains to the involvement and integration of social and natural sciences. For example, interdisciplinary collaborations between natural and social sciences can be challenged due to the different academic epistemologies and languages. Co-production approaches can help to bridge these barriers by providing time to address various differences and developing a shared conceptual framing.

Second, and related, the diversity of potential stakeholders also means that not every user or participant is able or willing to take part in similar ways. There are major differences in the ability of indigenous communities, cruise tourism operators, or large extractive industries to participate effectively. Some may have dedicated staff to maintain contacts with knowledge institutions, while for others it would be an additional workload. Some key user groups are also challenging to involve because of the simple fact that they would be on-route during large parts of the year. This particularly pertains to maritime operators, such as captains and navigators. In addition, not every national or local context is the same when it comes to co-production. For example, it was mentioned that communities and stakeholder groups in Russia would be far behind when compared to North-America, when it comes to the willingness, competences to effectively and meaningfully take part in co-production. It is important to point out that even within these different groups and organisations you would find people with different roles and tasks, which require widely different types of services and with different levels of commitment and abilities.

Third, during the discussion it was emphasised that researchers should distinguish between stakeholders and rights holders in these collaborative research and development processes. The first category can be considered as a category of participants that would be important to include, while the second category can be considered as participants with the right, and therefore essential to include, based on certain legal regulations (e.g. land ownership).

Fourth, depending on existing contacts or the level of engagement needed, co-production in WICC services development can be organised as a project feature, at the programme level (required by funders) or in a more institutionally embedded way, i.e. as an ongoing process in conducting research and development in the Arctic region. In other words, scale matters in co-production. A key challenge for co-production as a project feature is how to integrate research or services development projects in a user community. Building trustful relations with practice takes time. Therefore, longer term relations and contacts are valuable, as it gives the possibility to build on existing levels of trust. At the same time it is important to remain open for new stakeholders to enter the process.

Fifth, in order to make sure that co-production is a genuine iterative process, with participation and co-decision making in key moments in a process, it is important that sufficient funding (or address possible power inequalities that lack of funding can cause) should be allocated that would allow stake-/right-holders to become partners in research and development. This typically has serious cost implications. The participants of the workshop emphasised that there are many administrative and institutional hurdles to make this possible. One example of such a hurdle would be the lack of instruments or approaches to reflect on co-production requirements in evaluations of project proposals.

Sixth, discussions at the workshop also emphasised that co-production of WICC services is not bound to any particular scientific discipline. All too often it is still seen as a 'social science hobby', or something that the social scientist would take care of in a project that is dominated by natural science research. However, co-production and stakeholder engagement is a necessary competence that needs to be nurtured through investing in researcher skills across all disciplines. Co-production should be integrated transversally at all project levels: all partners should be conscious of the approach and work keeping it in mind, even if not everyone is directly involved in participatory processes. Additionally, it was mentioned that involving artists and science communicators adds value to co-production processes. Thus, successful co-production includes transdisciplinary involvement by making use of competences that lie beyond scientific disciplines and strongly embed the co-production in societal processes.

- *Lesson 11: Co-production of Arctic WWIC services is not the exclusive domain of social sciences, but requires input from all sciences: its transdisciplinary potential to build bridges across users and producers is distributed across the service production chain.*
- *Lesson 12: The value of co-production of Arctic WWIC services is contingent on flexible, long-term funding and institutional support, to allow engagement and partnerships between researchers, stakeholders and rightholders.*
- *Lesson 13: Co-production processes and their impact are sensitive to context and culture and should aim for transdisciplinarity, for example by involving locally embedded science communicators and artists.*

## 4. Conclusion

This report presents the results of a workshop held in and focused on the European Arctic, titled: “Co-production in the European Arctic weather, water, ice and climate services”. The workshop was held under the umbrella of PPP-SERA and is a key Special Services activity in the YOPP consolidation phase. The workshop took place as an online meeting on Monday 25 January 2021. With the purpose to reach out to researchers and research projects in Europe that focus on the development of WWIC information services for communities and economic sectors in the European Arctic region, the workshop participants discussed various aspects around co-production and stakeholder engagement, and identified joint challenges and lessons. Based on the workshop proceedings as reported in detail in the previous chapters, we identified a range of key lessons that can help realizing successful implementation of co-production in WWIC research and development projects in the European Arctic and beyond. These lessons are positioned throughout the report, and are summed up again here as a conclusion of this report:

- *Lesson 1: Co-production in Arctic WWIC research and service development may benefit from further conceptualization and translation into practical applications.*
- *Lesson 2: There is room for investing more in the individual and organizational research capacity to support successful implementation of co-production in Arctic WWIC research and service development.*
- *Lesson 3: Co-production can be beneficial at, and is potentially an essential ingredient of, various stages in Arctic WWIC research and service development value chains.*
- *Lesson 4: Successful co-production is contingent on overcoming a multiplicity of challenges including a). Reaching a shared understanding about end-to-end connections between R&D ingredients, actors and outcomes; b). Making user-centered choices about forms of co-production and role divisions, and; c). Ensuring access to sufficient types of resources.*
- *Lesson 5: Arctic WWIC research and service development can further benefit from co-production approaches, especially when building on existing collaborations and trust between providers and users.*
- *Lesson 6: When key resources are present, co-production can create a self-reinforcing dynamic through its potential to nurture and strengthen its own necessary pre-conditions, including mutual trust, and societal salience of outcomes that goes beyond the scope of service development.*
- *Lesson 7: Enabling factors for successful co-production in Arctic WWIC research and service development are interdependent and connect the individual and institutional levels.*
- *Lesson 8: Communication skills and a curious, interdisciplinary mindset, with genuine interest in a service context are important personal competencies that enable interdisciplinary and eventually transdisciplinary collaboration that facilitates co-production.*
- *Lesson 9: Research institutes and related organizations involved in Arctic WWIC research and service development need to account for co-production in their strategies, which includes investing in stakeholder relationships, and in researcher capacity building.*

- *Lesson 10: Arctic WWIC research and service development needs to be sensitive to the wider societal dynamics which shape the user and stakeholder context. This includes the legal and ethical assumptions and consequences related to co-production in particular contexts, and the varying access among stakeholders to resources needed to participate in an equal co-production process.*
- *Lesson 11: Co-production of Arctic WWIC services is not the exclusive domain of social sciences, but requires input from all sciences: its transdisciplinary potential to build bridges across users and producers is distributed across the service production chain.*
- *Lesson 12: The value of co-production of Arctic WWIC services is contingent on flexible, long-term funding and institutional support, to allow engagement and partnerships between researchers, stakeholders and rights holders.*
- *Lesson 13: Co-production processes and their impact are sensitive to context and culture and should aim for transdisciplinarity, for example by involving locally embedded science communicators and artists.*

## REFERENCES

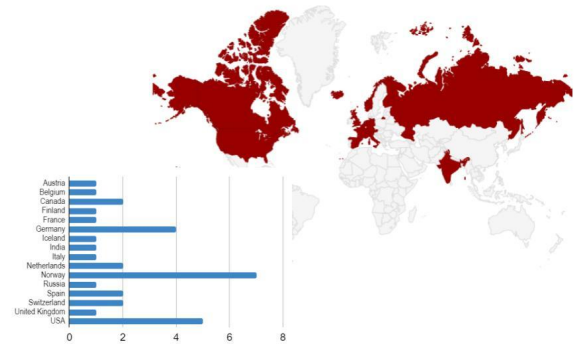
- Dawson, J., Hoke, W., Lamers, M., Liggett, D., Ljubicic, G., Mills, B., ... & Thoman, R. (2017). Navigating weather, water, ice and climate information for safe polar mobilities. *WMO WWRP/PPP Publications Series, (WWRP/P)*.
- GFDRR. (2019). *The Power of Partnership: Public Private Engagement in Hydromet Services*. World Bank.

# ANNEXES

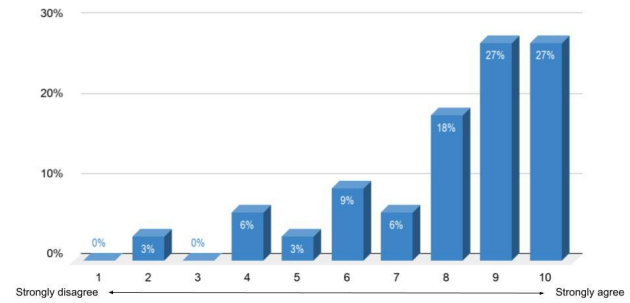
## i. Workshop programme

12.45 Join and sound checks  
13.00 Welcome PPP SERA (M. Lamers)  
13.05 Overview PPP YOPP (K. Werner)  
13.15 Introductions through survey results presentation (J. Jeuring)  
13.25 Presentation 1: Successful co-production of weather & climate services (M. Bruno Soares)  
13.45 Presentation 2: European Polar Research (A. Scheepstra)  
14.05 Break 10 minutes  
14.15 Introduction to breakout groups and using jamboards  
14.25 Breakout session 1  
14.45 Plenary presentations Group 1 + 2 + 3  
14.55 Presentation 3: lessons from research projects (B. Blair)  
15.10 Break 10 minutes  
15.20 Presentation 4: lessons from research projects (M. Terrado, D. Bojovic)  
15.35 Introduction to breakout session 2  
15.40 Breakout session 2  
16.00 Plenary presentations Group 4 + 5 + 6  
16.10 Break 10 minutes  
16.20 Plenary discussion  
16.50 Final thoughts and next steps  
17.00 End

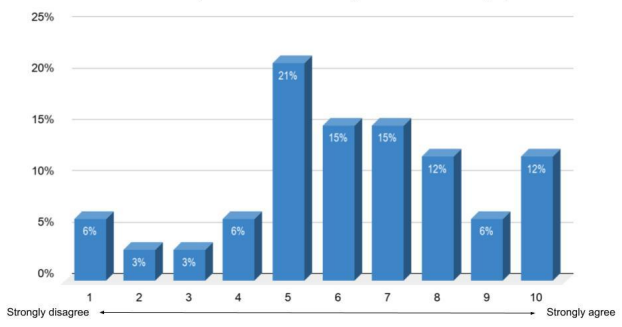
## ii. Participant survey results



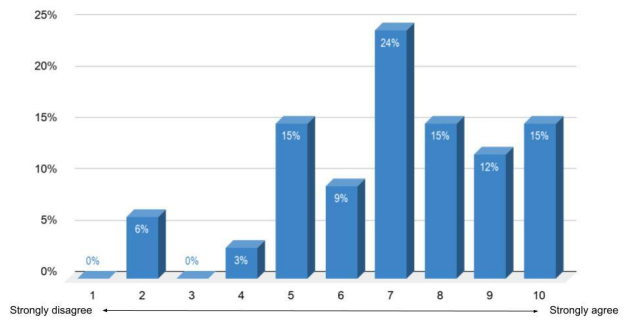
1. There is a need to more clearly define the concept of co-production in the field of Arctic weather, water, ice and climate services.



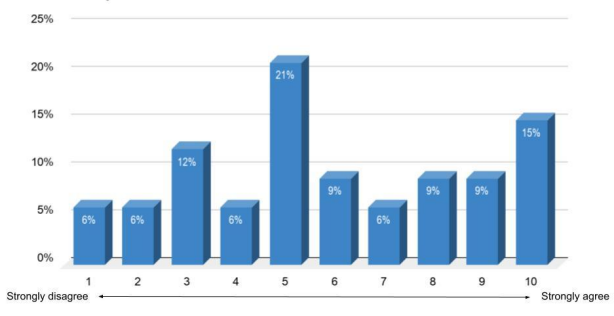
2. It is clear to me when co-production is a suitable approach in a research project.



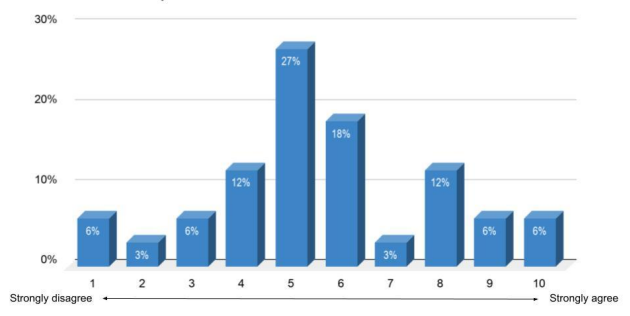
3. Applying co-production in my research brings, overall, more benefits than challenges.



4. I feel that I have sufficient skills to implement the co-production methods that are needed in my research.



5. I feel that I have sufficient institutional support to implement the co-production methods that are needed in my research.



What do you hope to take away from participating in the workshop?

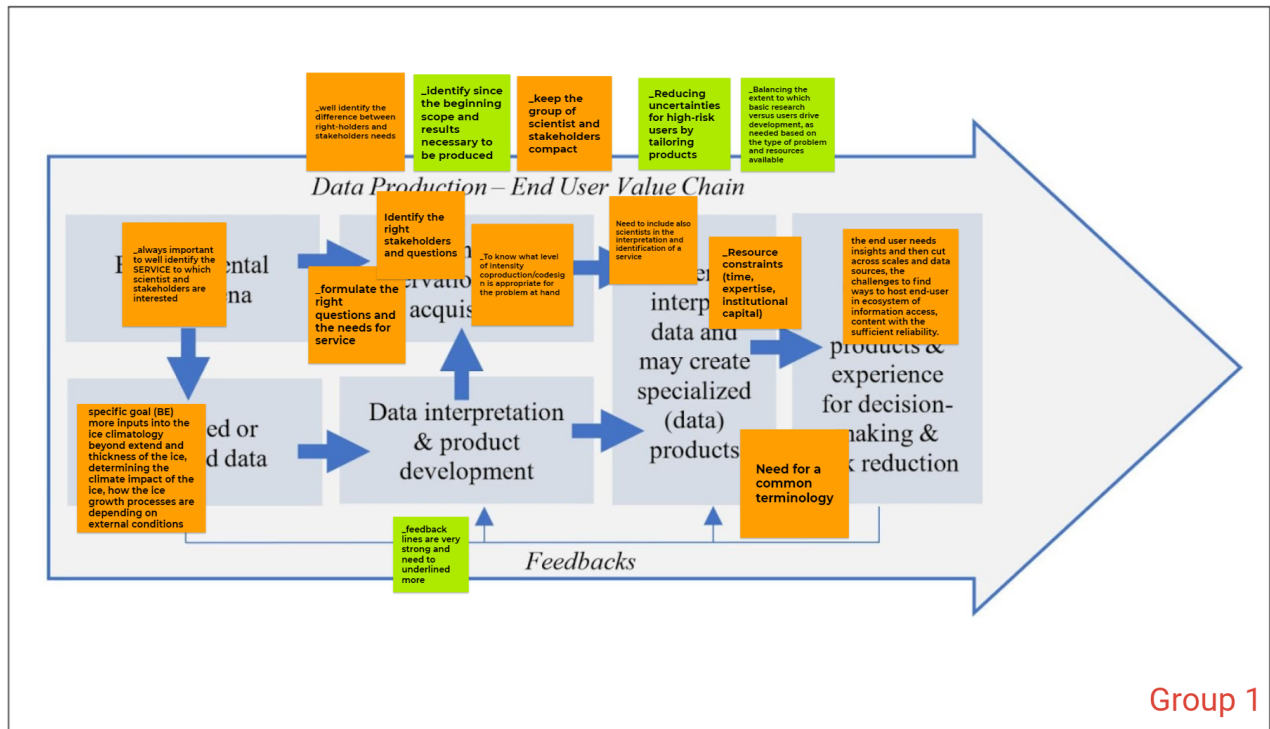




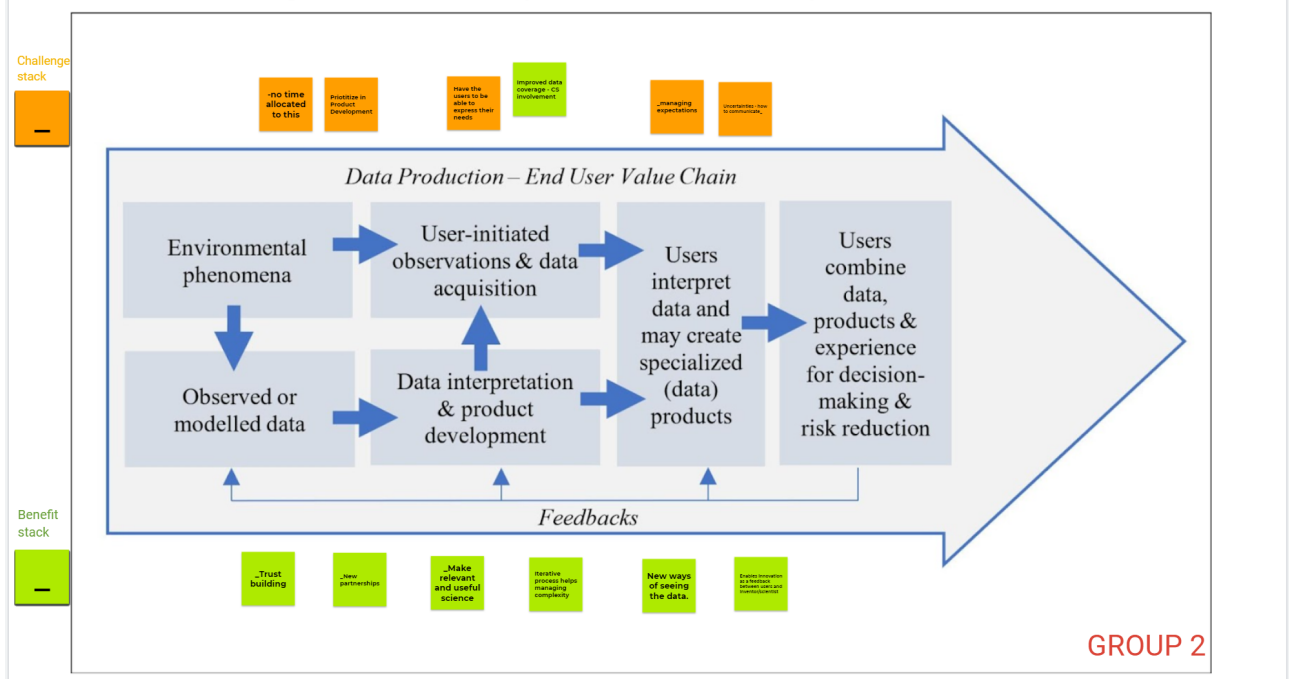
## ii. Jamboards

### Jamboards Breakout Session 1

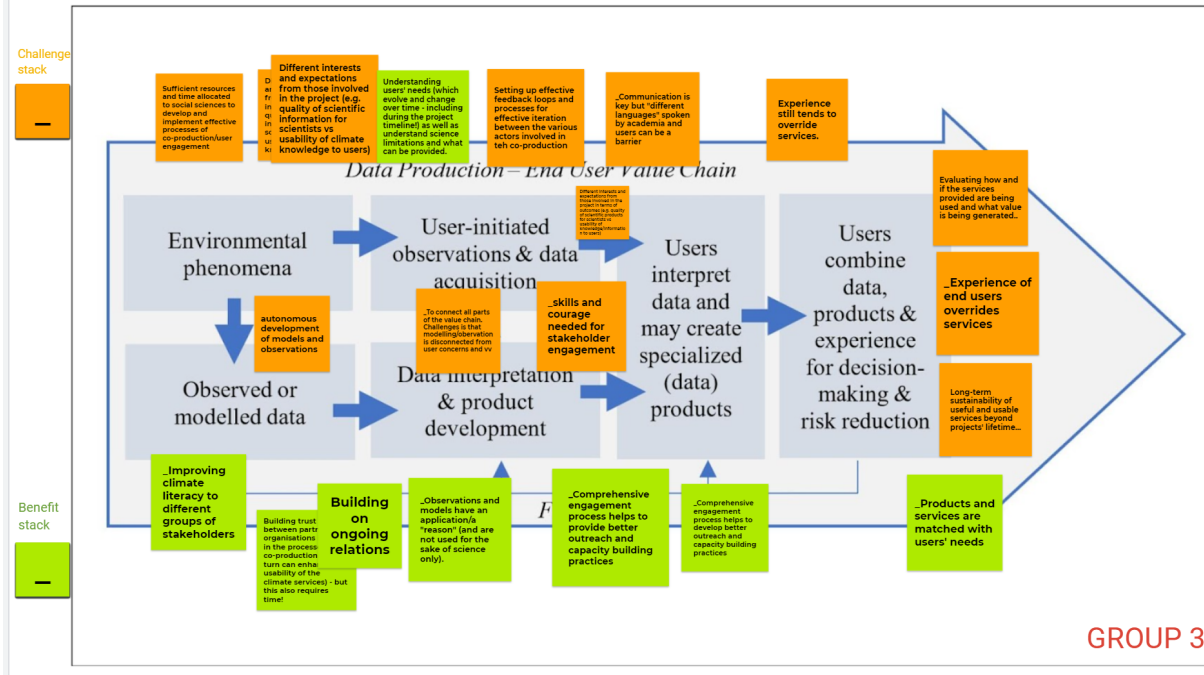
What are the challenges and benefits of co-production across the data production to end-user value chain?



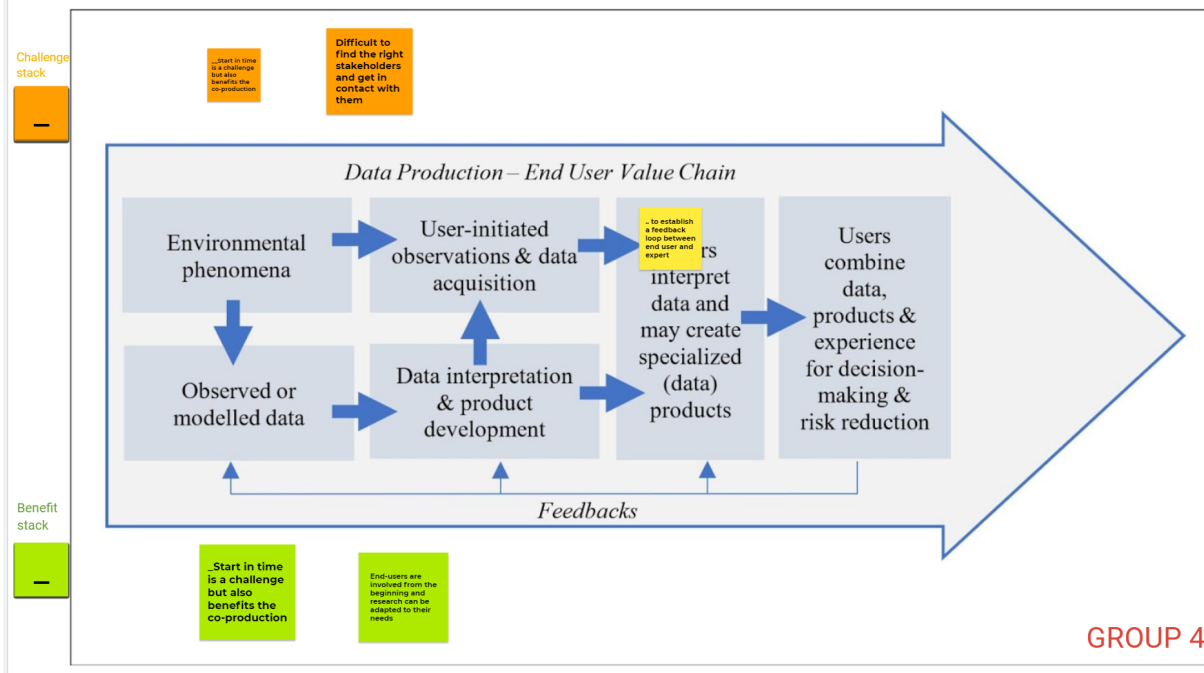
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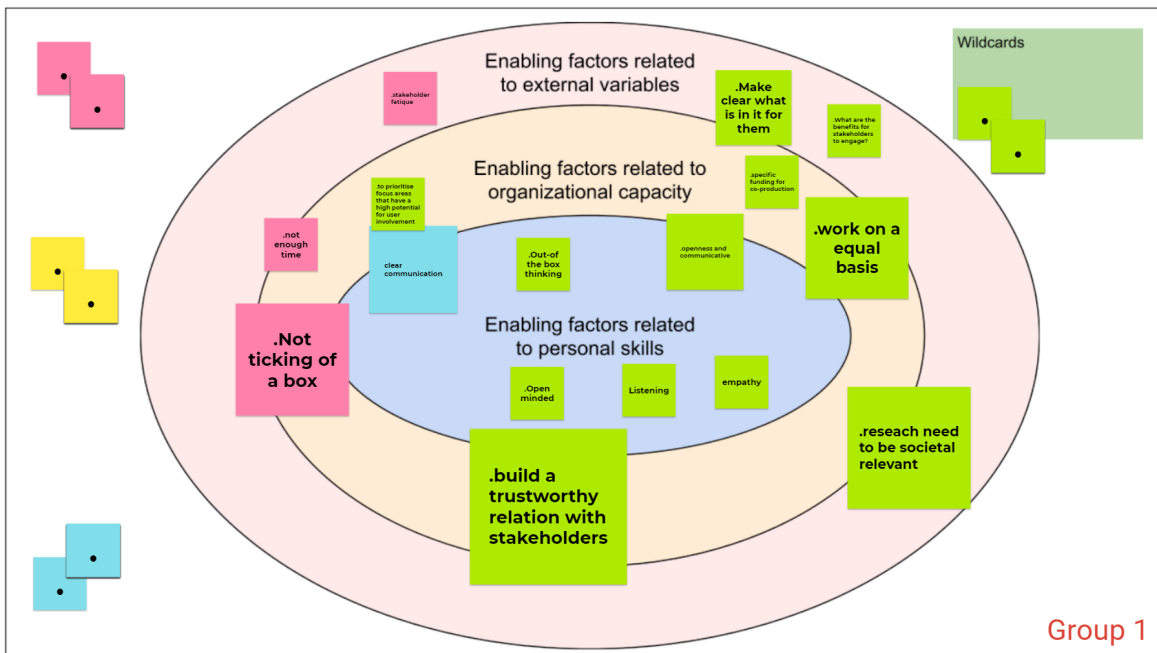
Challenges
<p><i>Identification of starting points</i></p> <ul style="list-style-type: none"> <li>● Formulate the right questions and the needs for service</li> <li>● Identify the right stakeholders and questions</li> <li>● Difficult to find the right stakeholders and get in contact with them</li> </ul>
<p><i>Upstream input from users</i></p> <ul style="list-style-type: none"> <li>● The end user needs insights and then cut across scales and data sources, the challenges to find ways to host end-user in ecosystem of information access, content with the sufficient reliability</li> </ul>

<ul style="list-style-type: none"> <li>● Specific goal (BE) more inputs into the ice climatology beyond extend and thickness of the ice, determining the climate impact of the ice, how the ice growth processes are depending on external conditions</li> <li>● Prioritize in Product Development</li> <li>● Autonomous development of models and observations</li> <li>● To connect all parts of the value chain. Challenges is that modelling/observation is disconnected from user concerns and vv</li> </ul>
<p><i>Outcome salience</i></p> <ul style="list-style-type: none"> <li>● Always important to well identify the SERVICE in which scientist and stakeholders are interested</li> <li>● Well identify the difference between right-holders and stakeholders needs</li> <li>● Uncertainties - how to communicate</li> <li>● Experience still tends to override services</li> <li>● Different interests and expectations from those involved in the project in terms of Outcomes (e.g. quality of scientific products for scientists vs usability of knowledge/information to users)</li> <li>● Evaluating how and if the services provided are being used and what value is being generated</li> <li>● Long-term sustainability of useful and usable services beyond projects' lifetime</li> </ul>
<p><i>Form and process of co-production</i></p> <ul style="list-style-type: none"> <li>● To know what level of intensity coproduction/codesign is appropriate for the problem at hand</li> <li>● Keep the group of scientist and stakeholders compact</li> <li>● Need to include also scientists in the interpretation and identification of a service</li> <li>● Have the users to be able to express their needs</li> <li>● Managing expectations</li> <li>● Setting up effective feedback loops and processes for effective iteration between the various actors involved in the co-production</li> <li>● To establish a feedback loop between end user and expert</li> <li>● Communication is key but "different languages" spoken by academia and users can be a barrier</li> <li>● Need for a common terminology</li> </ul>
<p><i>Resources</i></p> <ul style="list-style-type: none"> <li>● Resource constraints (time, expertise, institutional capital)</li> <li>● No time allocated to this</li> <li>● Sufficient resources and time allocated to social sciences to develop and implement effective processes of co-production/user engagement</li> <li>● Skills and courage needed for stakeholder engagement</li> <li>● Start in time is a challenge but also benefits the co-production</li> </ul>
<p><b>Benefits</b></p>
<p><i>Starting points</i></p> <ul style="list-style-type: none"> <li>● Identify since the beginning scope and results necessary to be produced</li> <li>● Understanding users' needs (which evolve and change over time - including during the project timeline!) as well as understand science limitations and what can be provided</li> <li>● End-users are involved from the beginning and research can be adapted to their needs</li> <li>● Building on ongoing relations</li> <li>● Start in time is a challenge but also benefits the co-production</li> </ul>
<p><i>Connecting process and product</i></p> <ul style="list-style-type: none"> <li>● Balancing the extent to which basic research versus users drive development, as needed based on the type of problem and resources available</li> <li>● Iterative process helps managing complexity</li> <li>● New ways of seeing the data</li> <li>● Comprehensive engagement process helps to provide better outreach and capacity building practices</li> </ul>
<p><i>Outcomes product</i></p> <ul style="list-style-type: none"> <li>● Reducing uncertainties for high-risk users by tailoring products</li> <li>● Improved data coverage - CS involvement</li> <li>● Make relevant and useful science</li> <li>● Observations and models have an application/a "reason" (and are not used for the sake of science only)</li> <li>● Products and services are matched with users' needs</li> </ul>
<p><i>Outcomes process</i></p> <ul style="list-style-type: none"> <li>● Feedback lines are very strong and need to be underlined more</li> <li>● Trust building</li> <li>● Building trust between partner organisations involved in the processes of co-production (this in turn can enhance the usability of the climate services) - but this also requires time!</li> </ul>

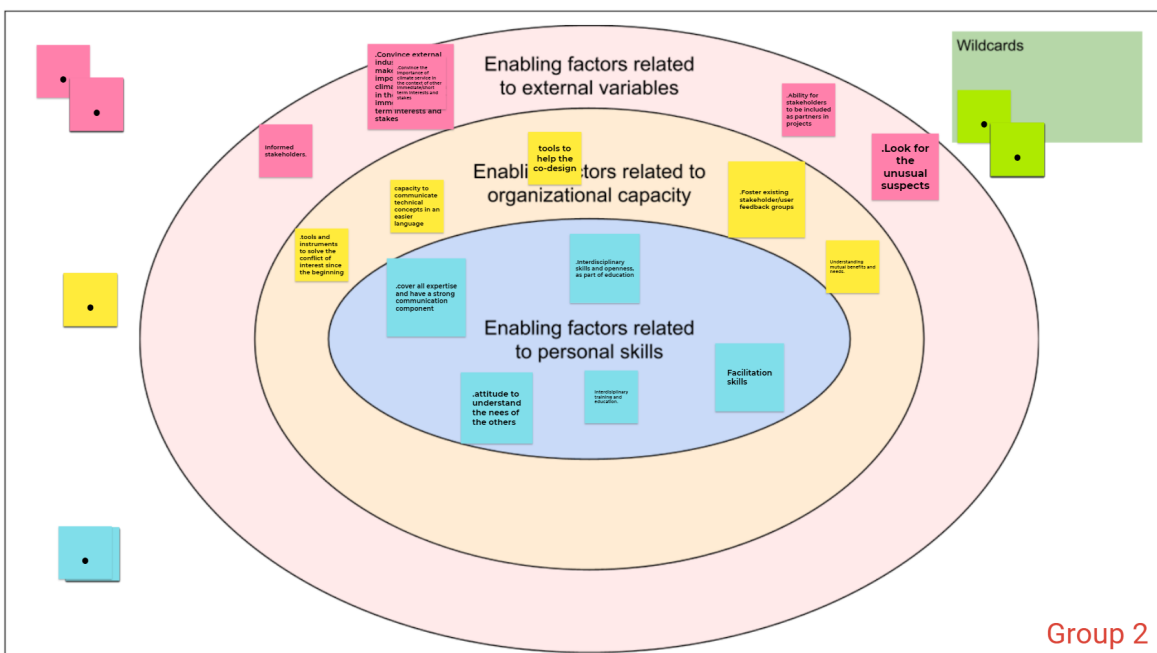
- New partnerships
- Improving climate literacy to different groups of stakeholders
- Enables innovation as a feedback between users and inventor/scientist

## Jamboards Breakout Session 2

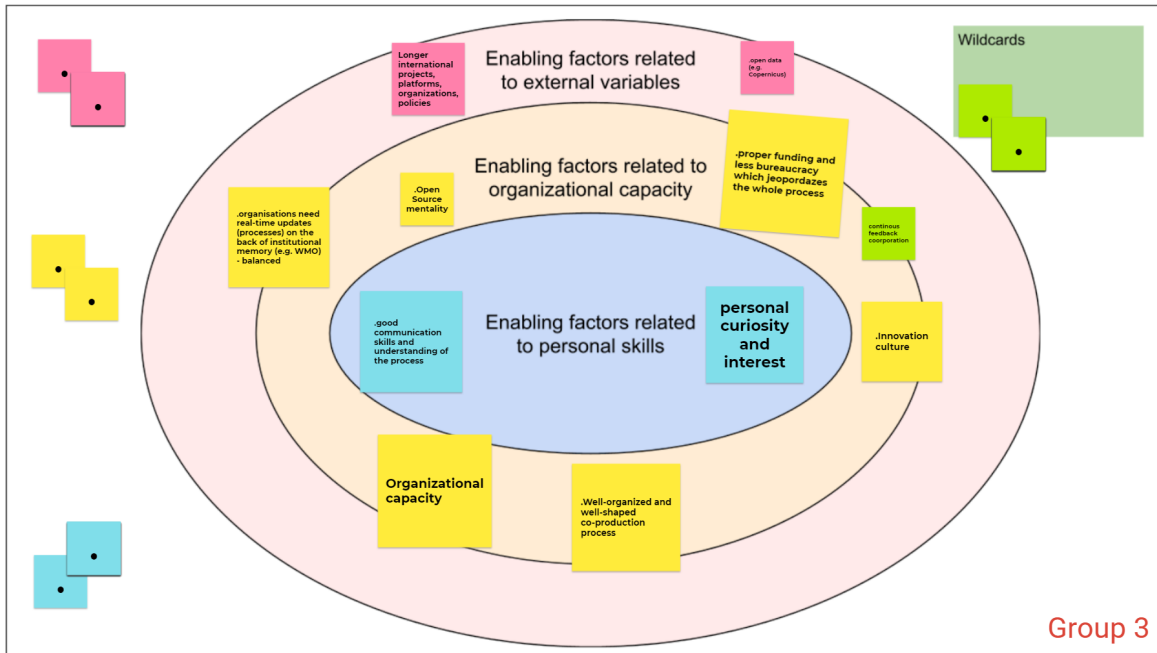
What are the individual, organizational and external factors that enable the potential of co-production approaches?



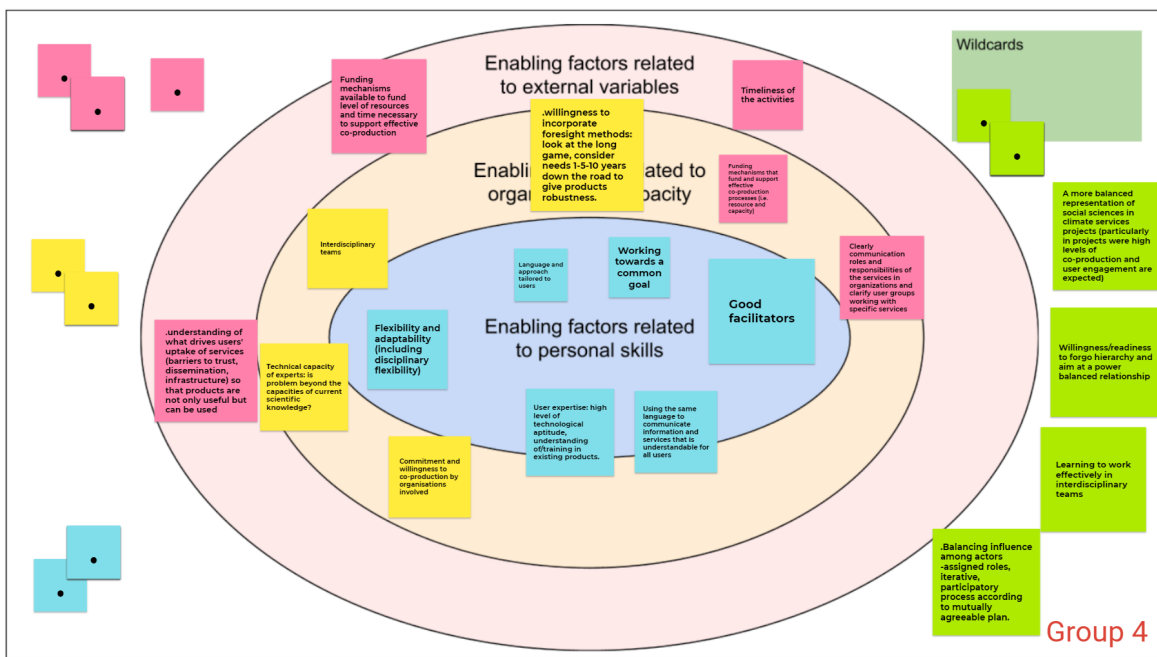
What are the individual, organizational and external factors that enable the potential of co-production approaches?



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What are the individual, organizational and external factors that enable the potential of co-production approaches?



**Personal factors**

**Communication and collaboration skills**

- Clear communication
- Cover all expertise and have a strong communication component
- Openness and communicative
- Open minded
- Listening

<ul style="list-style-type: none"> <li>● Empathy</li> <li>● Facilitation skills</li> <li>● Good communication skills and understanding of the process</li> <li>● Good facilitators</li> </ul>
<p><i>User-oriented</i></p> <ul style="list-style-type: none"> <li>● Language and approach tailored to users</li> <li>● User expertise: high level of technological aptitude, understanding of/training in existing products</li> <li>● Using the same language to communicate information and services that is understandable for all users</li> </ul>
<p><i>Interdisciplinary skills</i></p> <ul style="list-style-type: none"> <li>● Personal curiosity and interest</li> <li>● Attitude to understand the needs of the others</li> <li>● Interdisciplinary training and education</li> <li>● Out-of the box thinking</li> <li>● Interdisciplinary skills and openness, as part of education</li> <li>● Flexibility and adaptability (including disciplinary flexibility)</li> <li>● Working towards a common goal</li> </ul>
<p><b>Organizational factors</b></p>
<p><i>User-oriented</i></p> <ul style="list-style-type: none"> <li>● Build a trustworthy relation with stakeholders</li> <li>● To prioritise focus areas that have a high potential for user involvement</li> <li>● Understanding mutual benefits and needs</li> </ul>
<p><i>Funding</i></p> <ul style="list-style-type: none"> <li>● Funding mechanisms that fund and support effective co-production processes (i.e. resource and capacity)</li> <li>● Specific funding for co-production</li> <li>● Proper funding and less bureaucracy which jeopardizes the whole process</li> </ul>
<p><i>Methodological and technical capacity</i></p> <ul style="list-style-type: none"> <li>● Tools and instruments to solve the conflict of interest since the beginning</li> <li>● Capacity to communicate technical concepts in an easier language</li> <li>● Tools to help the co-design</li> <li>● Technical capacity of experts: is the problem beyond the capacities of current scientific knowledge?</li> <li>● Organisations need real-time updates (processes) on the back of institutional memory (e.g. WMO) - balanced</li> <li>● Willingness to incorporate foresight methods: look at the long game, consider needs 1-5-10 years down the road to give products robustness</li> <li>● Clear communication roles and responsibilities of the services in organizations and clarify user groups working with specific services</li> </ul>
<p><i>Organizational culture</i></p> <ul style="list-style-type: none"> <li>● Open Source mentality</li> <li>● Work on a equal basis</li> <li>● Innovation culture</li> <li>● Well-organized and well-shaped co-production process</li> <li>● Foster existing stakeholder/user feedback groups</li> <li>● Interdisciplinary teams</li> <li>● Commitment and willingness to co-production by organisations involved</li> </ul>
<p><b>External factors</b></p>
<p><i>Outcome justification</i></p> <ul style="list-style-type: none"> <li>● (Not) ticking of a box</li> <li>● Make clear what is in it for them</li> <li>● (Limited) stakeholder fatigue</li> <li>● Research need to be societal relevant</li> <li>● What are the benefits for stakeholders to engage?</li> <li>● Understanding of what drives users' uptake of services (barriers to trust, dissemination, infrastructure) so that products are not only useful but can be used</li> <li>●</li> </ul>
<p><i>User resources</i></p> <ul style="list-style-type: none"> <li>● Timeliness of the activities</li> <li>● (Not) enough time</li> </ul>

- Ability for stakeholders to be included as partners in projects
- Informed stakeholders
- Look for the unusual suspects

*Science-policy connections*

- Funding mechanisms available to fund level of resources and time necessary to support effective co-production
- Longer international projects, platforms, organizations, policies
- Convince external industries, policy makers of importance of climate information in the context of more immediate/short term interests and stakes
- Convince the importance of climate service in the context of other immediate/short term interests and stakes
- Open data (e.g. Copernicus)

**Wild cards**

*Interdisciplinarity and social science integration*

- A more balanced representation of social sciences in climate services projects (particularly in projects where high levels of co-production and user engagement are expected)
- Learning to work effectively in interdisciplinary teams

*Equity*

- Balancing influence among actors -assigned roles, iterative, participatory process according to mutually agreeable plan.
- Willingness/readiness to forgo hierarchy and aim at a power balanced relationship
- Continuous feedback and cooperation