



End of life at the top of the world—stakeholder perspectives for plastics and circular transitions in the Arctic

Emily Cowan¹ · Lacie Setsaas¹ · Vibeke Stærkebye Nørstebø¹

Accepted: 15 June 2023
© The Author(s) 2023

Abstract

Plastic pollution is a growing global concern. Although the pollution itself is transboundary and knows no borders—the accumulation of plastics can have a more detrimental impact depending on where it is. In this study, we focus on the Arctic, an area where fragile ecosystems are increasingly under pressure from human-made products such as plastics. Although plastic pollution takes place on a global scale, it will be up to the regional and local levels to implement solutions that work in practice. In light of this, we held a participatory stakeholder workshop in the town of Longyearbyen on Svalbard to identify local perceptions from sectors directly affected by and affecting plastic use and growing mitigation efforts on Svalbard. This was followed by a dialogue on best practices and roadblocks to shift towards a circular economy (CE) in the Arctic. We used a qualitative approach facilitating our workshop by building a group model with stakeholders in various sectors living and working in the Arctic coupled with semi-structured interviews that gain a more detailed understanding of the opportunities and pitfalls of the model. Our main goal was to better understand how the currently negotiated treaty to end plastic pollution may be better implemented at the national and local levels, starting with input from a smaller Arctic community heavily impacted by plastic pollution. In the end, participants stated a strong desire for top-down guidance to make it easier to implement changes at the local levels. Moreover, like that of the ongoing treaty negotiations, the importance of having the same definitions for a CE and its components was deemed vital to enact positive change.

Keywords Global plastic governance · Plastic pollution · Extended producer responsibility · Stakeholder integration · Arctic · Circular economy

Introduction

The United Nations Environmental Program (UNEP) made it clear that plastics will be a priority issue this decade (UNEP 2017). Since the first resolution on plastic pollution was adopted at the United Nations Environmental Assembly (UNEA) in 2014 (UNEP/EA.1/Res.6), the momentum has been shifting towards eventually creating a treaty, an attestation to the growing literature on the topic (Cowan and Tiller 2021; Walker 2022). The mandate to begin negotiations on

the treaty to end plastic pollution was adopted in the second half of the fifth UNEA session which took place in Nairobi, Kenya, in March 2022 (UNEA 2022). This was followed by the first round of negotiations in November 2023 followed by a second round at the end of May in 2023. Over the next two years, negotiations will take place between UN member states to determine what measures and core obligations the treaty must include. In the background of this, plastic production, however, continues to expand, particularly after the COVID-19 pandemic with the need for medical equipment and single-use items (Silva et al. 2020). Moreover, the annual global production of plastics has more than doubled between the years 1995 and 2010, to over 350 million tonnes—an increase of 157 million tonnes (Geyer et al. 2017). Recent studies confirm that plastic production is much further out of our control than previously believed, as we are already well over 420 million tonnes produced each year and rising, and of that, more than 20 million metric tonnes are mismanaged yearly (Bergmann et al. 2022a).

✉ Emily Cowan
Emily.cowan@sintef.no

Lacie Setsaas
Lacie.setsaas@sintef.no

Vibeke Stærkebye Nørstebø
Vibeke.S.Norstebo@sintef.no

¹ Department of Climate and Environment, SINTEF Ocean, Trondheim, Norway

This led some researchers to call for a cap on plastic production to be a component of the upcoming treaty (Bergmann et al. 2022b). Even with the efforts from the international community, the amount of plastics ending up in the Ocean has dramatically increased (Hugo et al. 2021; UNEP 2021). Moreover, without accountability or raw data on the sheer number of plastic materials we produce, use, export, and dispose of, the pollution problem will continue to persist.

Although our Ocean makes the problems with plastic pollution so inescapable, there are regions of the world where it tends to accumulate. One region in particular, the Arctic, has been an area of concern due to the utter amount of pollution found in the marine and terrestrial environments there, as well as in organisms and species (Trevail et al. 2014; Liboiron et al. 2021; Ramasamy et al. 2021). This is coupled with the Arctic, specifically, Svalbard, having a current focus on a green energy transition (Aquilina 2022). Plastic accumulates in the Arctic in many ways, as one review examines (Bergmann et al. 2022a) pollution can stem from marine industries including fishing, cruise, and shipping, as well as land-based sources in the form of clothing, containers, household items, and lack of waste infrastructure. The European Union (EU) began its transition to a circular economy (CE), via the Circular Economy Action Plan (European Commission 2020) with one of the five value chains being on plastics. The goal within the CE is to aid multiple industries, including plastics to have a more sustainable lifecycle starting from the production phase and better product design down to recycling and management. This framework aims to minimize plastic waste and subsequent environmental contamination by addressing the entire value chain (Syberg et al. 2021). Both the CE and the new plastic agreement must include measures at the national and local municipal level to take action into their own hands as solutions are never “one-size-fits-all.” Norway is an important nation to include at the core of this study as they operate with one foot in and one foot out of the EU, so although they do not contribute to developing new EU regulations, they still implement most of them. As one recent study indicates, Norway aligns with the EU action plan on the CE, moving its agenda towards the redesign of products and closing the loops (Hermann et al. 2022). The study at hand moves this idea forward by conducting stakeholder workshops that provide foresight into how other non-EU Arctic states can begin to transition to a CE of plastics. In preparation for the continued EU circular transition and the global plastics treaty negotiations in progress, we ask the question of what the barriers are to transition to a CE of plastics, specifically in the high north—and what proposals for improvement to address the barriers do stakeholders bring to the table in the largest populated town on Svalbard—Longyearbyen? Our research aims to uncover the systematic obstacles that prevent a circular model to be achieved in one Arctic settlement, and we bring together in this study voices from the local communities on how we can establish CE principles for plastics in the high north.

This research contributes to the growing literature on the best practices for implementing a circular economy as local municipalities are seen to best encourage sustainable development from the bottom up (Bolger and Doyon 2019). This study also contributes to the growing literature on discourses on what a CE means (Hermann et al. 2022) from the perspective of one Arctic community. Due to high costs of travel in the Arctic (Mallory et al. 2018), this is an understudied region when it comes to stakeholder inclusion in research, and this paper presents one example of how this can be conducted.

Pathways towards a circular economy in the Arctic

In recent years, academic discourse regarding the CE and how to achieve it has taken off due to concerns of climate change, sustainable development, and resource security (Ghisellini et al. 2016). Due to the lack of applicability of solutions across regions, it is important to examine the needs of individual nations and local communities when taking preventative measures to reduce plastic pollution. We, therefore, ask the question of what are the steps needed to create a CE which takes a full lifecycle approach of plastics in the high north? The CE is a highly understudied concept in the Arctic where few articles have been published and focus mainly on the Russian Arctic and found there is no unified and integrated strategy to help aid in the transition (Gutman and Teslya 2020). As plastics are not manufactured and designed in the Arctic, it is vital to examine their importance outside the Arctic and why they are so prevalent. New virgin plastics are the preferred material due to their low market price which has been credited to large subsidies for the oil and gas industry (Miliotis et al. 2018) as plastics are created from fossil fuels (Kane 2022). Recycling our way out of our plastic overconsumption problem is not a one-stop-shop either, as studies demonstrate it is the most energy-intensive material to produce (Dunkelberg et al. 2019). Notwithstanding, when plastics are recycled—or downcycled¹, they degrade and become more difficult to reuse, especially when competing on the market against cheaper and more durable virgin materials (Pohjakallio 2020). Moreover, products made of plastics are multifaceted and have various materials which cannot be separated in an average recycling facility (Eriksen et al. 2020). The CE provides a means to create better products from the start that do not

¹ Downcycle refers to recycling something into another product of lower value which cannot be reused again (Pohjakallio 2020). Secondary plastic products—examples and market trends. Plastic waste and recycling, Elsevier: 467-479.

include multiple complex layers, while including single materials that are made to be repurposed (Wiebe et al. 2023). For the aim of this paper, we define the CE by the EU's definition of a

“...model of production and consumption, which involves sharing, leasing, reusing, repairing, refurbishing and recycling existing materials and products as long as possible. (European Parliament 2015).”

To truly transition to a CE, we must extend the life of the products we use and aid in the transition of all world economies to have the infrastructure and materials to do the same. Currently, we still live in a linear economy where we are used to the pattern of take-make-consume-throw away. A CE, however, would do away with products' end of life and ensure they are designed to last generations. To guarantee this, various schemes have been hypothesized and developed to aid in the transition ranging from ways consumers can be part of the solution in the form of deposit return schemes (DRS) as well as product producers taking on more responsibility in their part of the problem via extended producer responsibility (EPR). EPR is a tool employed by policymakers to shift the focus from consumers to producers in terms of responsibility for plastics' end of life (Watkins et al. 2017; Raubenheimer and Urho 2020). The EPR scheme would also need to incentivize producers to design products that are simpler to recycle and reuse from the start (Cowan et al. 2021). The potential for such a scheme has been examined before and was found that, for EPR to function, plastic manufacturing, production, retail, and disposal must be accounted for and reported on a global scale (Deloitte 2020). We argue that for EPR to work, it must be integrated into the ongoing global treaty debates, leading to legal obligations for design and cleanup. DRS on the other hand is a program to incentivize consumers to properly dispose of containers, most commonly PET bottles. Essentially, consumers pay a small fee for buying products with a DRS label on them; they then take them to their local supermarket and return them and in turn receive their deposit back. To date, DRS is deployed in numerous countries across Europe, Asia, and South America (Watkins et al. 2019). It is estimated that in Norway DRS account for 97% of plastic bottles being eliminated from waste and instead refurbished into new products (Jones 2021). Germany's environmental agency stated that, by employing deposit return schemes, the PET bottles can be washed and refilled up to 25 times. This leads to 75 kg of carbon dioxide not being emitted per 25 bottles reused (Blue 2018). One supermarket spokesperson in Germany told reporters that after the DRS was implemented, the supermarket chain now uses up to 70% less virgin PET (Ruiz 2021). If these schemes have positive effects across the world, why are they not found in the Arctic?

According to Svalbard pollution and waste regulations, all waste is to be collected at the designated waste facility, and all recyclable and biodegradable waste other than food waste is to be transported back to the mainland for recycling. In addition, there is a landfill which is used for other types of waste, such as non-biodegradable or non-recyclable materials and biodegradable materials that are not allowed to be transported back to the mainland. The purpose of this current regulation is to ensure more control over the existing waste, due to the heightened level of direct contact with vulnerable nature. If these regulations were amended to allow for more user-friendly solutions and possibilities for reuse and recycling by individuals, this could allow for creative solutions to bloom. This is, however, a balance, to avoid residents and businesses simply not returning their waste under the guise of recycling, which leads to the risk of said waste not being handled properly and ending up in nature. Moreover, it is hard to justify the costs of a multimillion-euro facility in a place with under 3000 permanent residents.

In Svalbard today, both aluminum and glass materials are collected in their respective containers, but both plastics and general waste are collected in a container together with other burnable waste and shipped back to mainland Norway (Miljødirektoratet 2021). Thus, the routines for sorting materials are limited in the Arctic, making it difficult to establish a proper overview of the waste streams that exist in the high north and leaving residents with few options for developing CE. Implementing routines for sorting waste materials requires both space and capacity, which are factors that need to be considered when discussing regulatory implementation on Svalbard. Despite difficulties and limitations, however, Svalbard has high ambitions regarding their waste management. In Longyearbyen's strategic plan for waste management, two goals drive the entire strategy: *“Waste in Longyearbyen shall be handled in a way which profiles Longyearbyen as a worthy entrance point to one of the world's best-managed wilderness areas”* and *“The waste management in Longyearbyen shall be at least as good as the on the mainland in regard to resources and environment”* (Longyearbyen Lokalstyret 2017). Considering the potential opportunities of a CE on Svalbard, we held a workshop with local stakeholders in the town of Longyearbyen to identify how it can be implemented.

Methodology

Taking this into consideration, the current study assesses the perceptions, concerns, and desires of the local citizens and stakeholders living and working on Longyearbyen. This was to assess the challenges and opportunities for establishing a CE for plastics in the region. The methodological

backdrop of the workshop aimed to better understand what roadblocks exist for establishing a CE on the archipelago, as well as pathways for overcoming barriers to implementation. Therefore, our involvement of a variety of stakeholders in the workshop (research community, governance, tourism, and industry) was an important part of understanding how to best understand the current framework challenges while mapping out a road forward.

To understand these challenges and opportunities, we utilized the methodology of conceptual mapping and semi-structured interviews in this study. This was based on the desire to quantify a narrative-rich knowledgebase to make management decisions as witnessed in previous studies (Tiller et al. 2016; Cowan et al. 2021). Due to the longer nature of travel to Svalbard, we held a hybrid workshop that encompassed both in-person attendees and attendance via the Microsoft™ Teams platform. For this study, a participatory modeling approach called “systems thinking” was utilized for the workshop. This specific workshop methodology is an effective method for exploring real-world problems as identified by the stakeholders that inhabit a given system (Freeman 2010). Peter Checkland also refers to this as “consciously organized thinking” (Checkland 1999). This process takes the form of group conceptualization or group modeling (Sterman 2000); the concept models are used to structure a debate about change among actors in a problem situation, with the outcome to be solution-orientated (Jackson 1982) as seen in Fig. 2. This conceptualization process allows scientists to investigate a given system (barriers and opportunities for a CE on Svalbard in this case) by eliciting information from stakeholders (Forrester 1994). This study uses Freeman’s definition of a stakeholder “...any group or individual who can affect or is affected by the achievement of the organization’s objectives” (Freeman 2010). A benefit of utilizing this methodological method is that it allows for the exploration of a complex topic of a system at a local scale (Tiller et al. 2014). This method allowed for the combination of local and scientific knowledge in a collaborative mental mapping framework. The purpose of the conceptual map can either be used as a research tool to further explore connections towards achieving a CE in the Arctic or as a consensus-building tool among local stakeholders.

Our workshop was held with a wide range of stakeholders representing industry, local and national government, and interest organizations. These stakeholders were chosen due to their engagement with plastic usage in Svalbard. We developed a conceptual map (see Fig. 2) based on stakeholders’ perceptions using the freeware Vensim©. Stakeholders were encouraged to consider the barriers and opportunities for transitioning to a CE on Longyearbyen. We engaged them in an open discussion and in that process were able to identify key areas of importance from the local community. The conceptual map was first presented

to stakeholders on a blank screen with eight different drivers at the top, predetermined by the project group². The drivers were decided upon by the workshop organizers and researchers in the same field via a survey using the platform SurveyMonkey several weeks before the workshop. The drivers were selected based on the focus areas for this workshop and the ability of drivers to influence and affect each other when it comes to the CE. The organizers agreed upon the following drivers to lead the workshop discussion, with a focus on plastics and construction on Longyearbyen, and the variables that affect these:

Regulation Schemes Costs Availability Quality Littering Logistics Knowledge

One of the main aims of the workshop was to develop the conceptual map, and to build this, we started by asking the workshop attendees basic non-pointed questions such as “*how do regulations affect the possibility of a CE in Longyearbyen?*”. Multiple hands were raised, and we call upon all stakeholders to contribute to the conceptual map building. It is the stakeholders themselves who drive the conversation, and the goal of the facilitator is to make sure all the drivers are addressed. The process of creating this involved providing input to the science-policy interface with a bottom-up approach that included the opinions of the workshop’s stakeholders. The conceptual model from the systems thinking workshop is a graphical visualization of a basic construct of the system feedback structure. This is feedback which relies heavily on qualitative and subjective interpretations of a system (Bredehoeft 2005). In addition to the conceptual map, we conducted in-depth interviews with relevant stakeholders a couple of months after the initial workshop. The selected participants were chosen due to their expertise and involvement in their relevant sectors, and the selections were based on the main points of discussion from the workshop. There were also stakeholders who were not present at the workshop but highly relevant to the study’s results. As Svalbard is less densely populated than mainland Norway, there is a limited number of stakeholders in the region to choose from we believed the two subsequent interviews help to validate the conceptual mapping results. Due to geographical constraints, the interviews were conducted on the Microsoft Teams platform. During the in-depth interviews, researchers followed a semi-structured interview guide. This meant that there were several questions of interest relevant to the study, and the questions could vary slightly depending on which stakeholder was in focus. We considered, for this

² For a more detailed understanding of the methodology, please refer to Tiller et al. (2016). “Stakeholder perceptions of links between environmental changes to their socio-ecological system and their adaptive capacity in the region of Troms, Norway.” *Frontiers in Marine Science* 3: 267.

Fig. 1 Overview of the participants from each sector present at the workshop (blue) and interviews (orange)

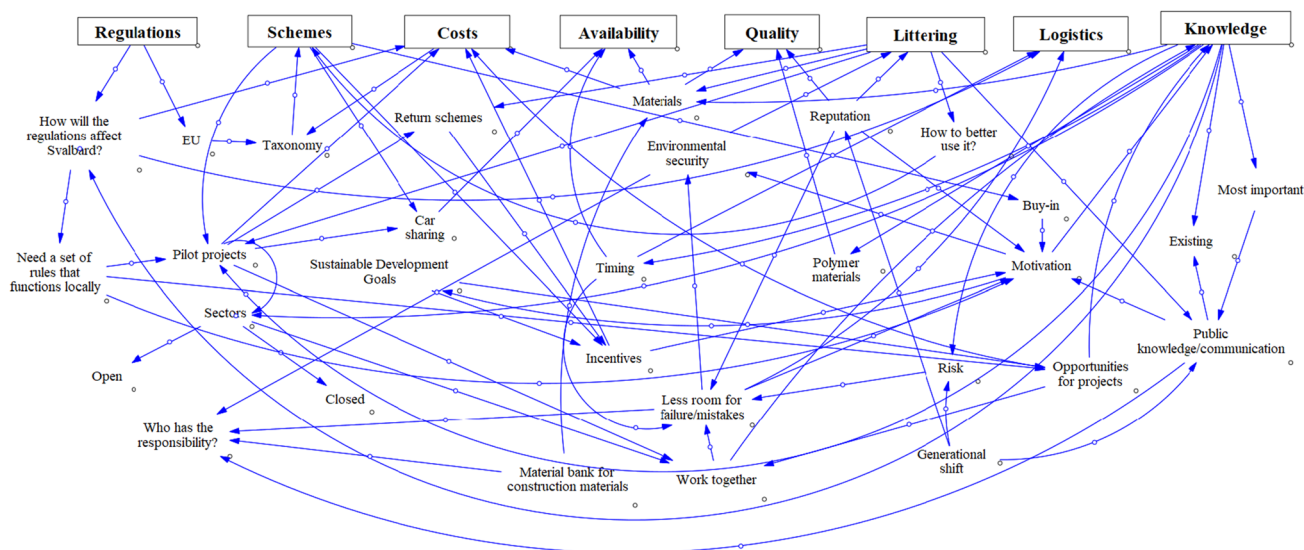
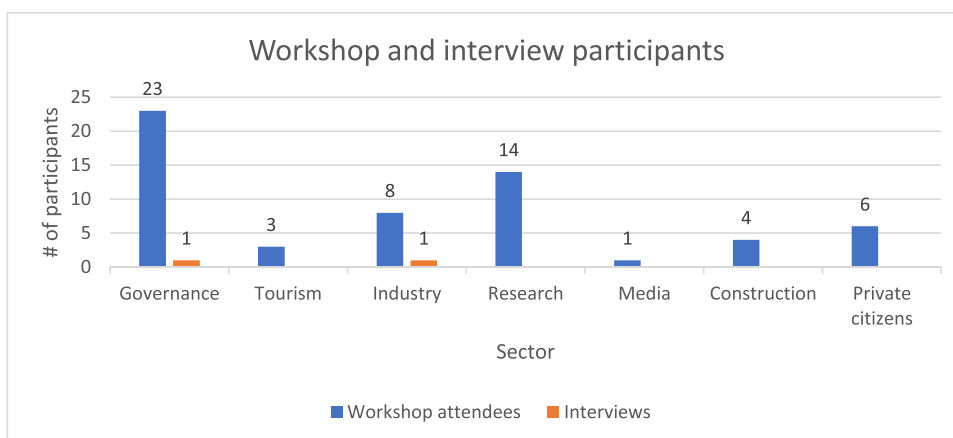


Fig. 2 Vensim diagram of the Svalbard workshop

study, that a more qualitative and conversational approach was the best fit, and the interview guide covered several different topics related to plastics and governance in Svalbard. It included various open-ended questions linked to the topic. Some examples included “What actions do you think can be taken to help establish a CE on Svalbard?” as well as “What hindrances do you see potentially limiting actions here?”. The questions also slightly changed based on the sector and stakeholders being interviewed.

Stakeholder selection

We first mapped the stakeholders for the CE workshop by consulting with the project group and creating an Excel sheet of relevant stakeholders and sectors to be invited. This was followed by a stakeholder matrix mapping where the various organizations of interest were ranked in terms of their power and interest in the topic. This decided who to reach

out to first and who were the most relevant stakeholders to invite. As a supplement to the perceptions collected at the workshop, we then conducted two semi-structured, in-depth interviews with selected stakeholders to further build upon the new knowledge. These stakeholders were chosen based on the sectors that most significantly represented the results of the discussion from the workshop based on their sector of expertise as demonstrated in Fig. 1 (overview of the participants from each sector present at the workshop (blue) and interviews (orange)). On the other hand, the interviews aimed to analyze and understand perspectives from different sources of stakeholders in terms of concrete action potentials and future scenarios for creating a CE with regard to plastics in Svalbard.

Both the workshop and interviews were held following personal data regulations through permits from NSD, Data Protection Services, in Norway where the research undertaken was located. The participants were given information

about the purpose of the workshop and interviews before attending and were informed that they could leave the study at any time without any questions from the facilitator.

As demonstrated in Fig. 1, the various sectors were chosen during a stakeholder mapping process where the project group discussed the categories of stakeholders that would be best suited to participate in this process to gain a comprehensive understanding of the situation in the case area. We define the governance sector as including stakeholders from local to national regions of Svalbard and mainland Norway who create policies around the CE, environment, and plastic. We chose the term *governance* rather than *politymakers* as it is more encompassing in ways that are useful for generalizing the political rule (Hooghe and Marks 2020). The tourism sector included local tour companies that were interested in integrating more sustainable tours and products into their organization. The industry sector included plastic manufacturers, producers, and retailers from Svalbard and mainland Norway. Researchers were those local to Norway that research plastic use and fate. The construction sector included construction companies, architects, and planners who have an interest in the Svalbard region and the reuse of materials. Finally, the media was a local media source that reports on Svalbard and other locales in the high north, and private citizens were locals living on Svalbard without relation to the other sectors.

As in any scientific research, any method used comes with its limitations. A possible limitation of this study is the fact that the CE workshop held on Svalbard was facilitated in Norwegian, meaning the participants of the workshop were individuals who understood the language. This left out individuals who do not speak Norwegian but still live and work on mainland Norway and Svalbard to provide vital information to the workshop. Thirty percent of Svalbard's population are foreign nationals, not all of whom speak Norwegian (SSB 2009). Thus, the representatives at the workshop were limited in this way. Additionally, of all the sectors represented at the workshop, those working in the local and national governments were by far the strongest stakeholder group represented. Therefore, a question can be raised as to whether or not the conversation was heavily influenced by their viewpoints or the results impacted by this. The workshop was ultimately decided to be held in Norwegian as Svalbard falls under Norwegian Sovereignty, and although Svalbard is multicultural, policies take place at the Norwegian level and the local government working language is in Norwegian. We argue that it is essentially up to leaders to make decisions that will impact the circular economy on Svalbard, and this workshop was important for bringing together various sectors' voices for how opportunities and challenges within the implementation process a first step and subsequent workshops can and should be held afterwards with a wider community.

Results

This section provides an overview of the results from the workshop and semi-structured interviews. The stakeholder's discussion was focused heavily on schemes, costs, pollution, and knowledge as main drivers for barriers to implementing a circular economy on Svalbard. As discussed in the "Methodology" section, the workshop included a facilitator who started with the eight drivers on the board and spend roughly two hours inquiring from the stakeholders how each point connects to each other and the potential for a CE of plastics on Svalbard. A summary of this can be viewed in the conceptual map in Fig. 2 as a way to systematically include all stakeholders' input. The workshop results were later transcribed to provide more detail to this section.

Throughout the workshop and in-depth interviews, stakeholders provided their perspectives on important questions and ideas for implementation regarding the creation of a CE in the Arctic. It is also valid to note that the CE does not mean the same thing to everyone, and although it is important to gain a common understanding of the definition, in this first workshop we did not want to influence the stakeholders' opinions in any way. Other studies examine the discourse of CE definitions (Alvarado et al. 2021) and break it down into three schools of thought: (1) waste as a resource, (2) sharing economy, and (3) reduced consumption. It was apparent during the workshop that the stakeholders viewed the CE as using waste as a resource and reducing the amount of waste used as the discussion was focused on downstream initiatives. During the workshop which produced the conceptual map in Fig. 2, some variables stood out as particularly important towards transitioning to a CE of plastics. The following topics were identified as the most important variables:

1. Need for regulatory change towards waste sorting
2. Opportunities for new pilot projects geared towards a CE
3. Spaces to facilitate knowledge- and experience-sharing
4. Need to map available sources for financing such ventures

Of all the discussion points, the need for regulatory change to enable the workings of a CE was the most discussed throughout the workshop. Currently, Svalbard does not participate in the collection schemes of the mainland, and their strategy is based on the collection and shipping of waste to Tromsø. This is in large part because Svalbard holds a unique jurisdictional position, being part of Norway in some senses, but not fully in others, as well as geographical and volume-related constraints. Participants agreed that it would be beneficial to examine the current waste management strategy in light of the CE and stated that they desired

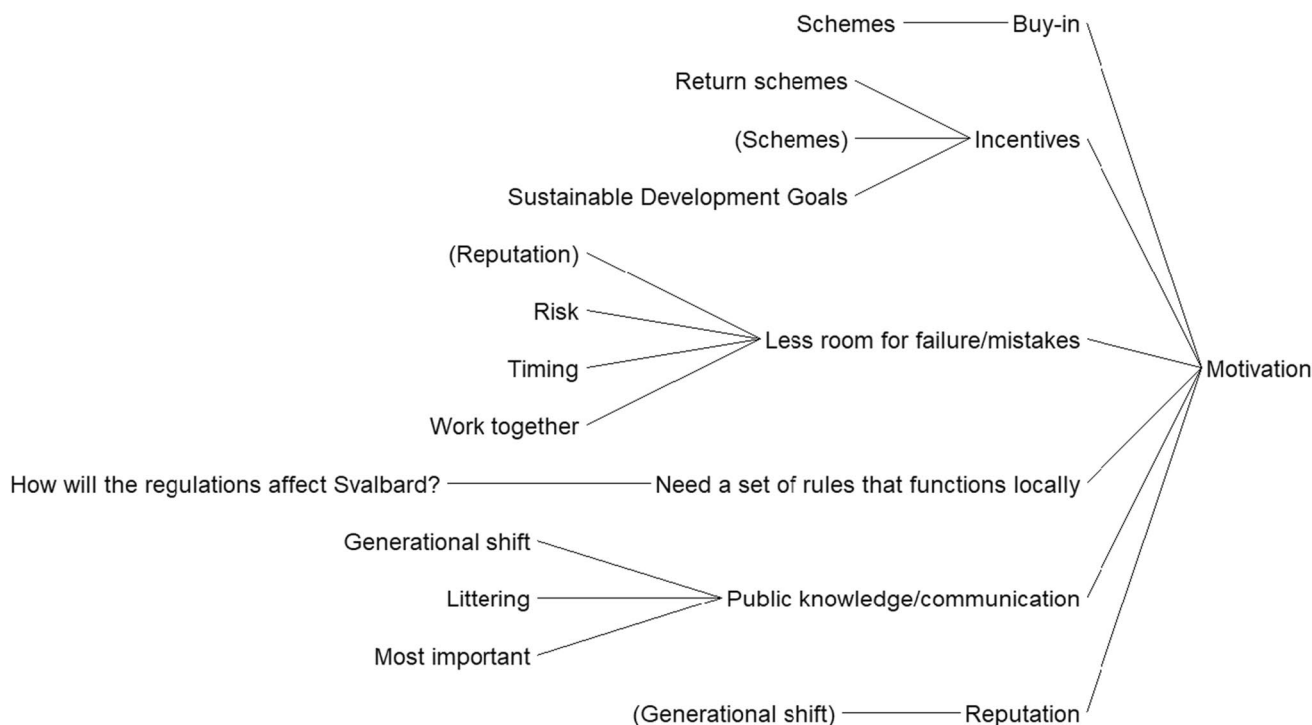


Fig. 3 Vensim dendrogram highlighting the stakeholder-identified elements connected to motivation to establish CE of plastics

strong guidance from the top levels to make it easier to require changes at the local level. A mandate from a higher level can give the local authorities backing for their initiatives and connect Svalbard to a larger network of actions and regulations. However, this top-level involvement is also a balance, as participants did also express how the bureaucracy of complicated frameworks can quickly become too tangled and end up strangling efforts to try something new.

Now that a new environmental station is open on Longyearbyen, which provides more storage capacity for sorted waste materials that can be utilized to make new materials and resources, it is easier to facilitate a more circular waste strategy. Moreover, it is vital that the new environmental station has a system in place to measure the volume of plastic materials present in the system, both those that can be reused and waste.

In terms of specific regulatory changes, creating incentives to motivate people to shift towards a CE as seen in detail in Fig. 3 can be an important driver. A typical example of an incentive concept is the collection points for plastic bottles. Widely found on mainland Norway, these machines give money back for the bottles the consumer returns, after they have paid a deposit at the time of purchase. Such an initiative on Svalbard could give new life to old plastic bottles, providing that the proper infrastructure is in place both for collection and after and that the volume is significant enough to justify the investment. While these incentive schemes that drive motivation can be helpful, stakeholders—particularly

those living on the island—were adamant about their intrinsic drive to enact change, as they felt the time was running out, leaving little room for carefree trial and error.

The current requirement to deliver all waste to dedicated collection points can also be experienced as limiting to those who wish to keep their waste in an attempt to reuse it. While businesses can apply for an exemption from the delivery requirement for the sake of repurposing or recycling their waste, the process is complicated, creating a barrier for more CE-based initiatives to blossom. On the other hand, however, such a process can be understood, as exemptions must be controlled to avoid businesses not returning their waste under the false guise of recycling, risking said waste then ending up in nature.

One possible solution is to implement concrete recycling goals based on weight percentage, as is done on the mainland as a part of the circular strategy. As it stands today, Longyearbyen is not a part of the DRS or EPR schemes that are in operation on the mainland, which raises discussion around the need to evaluate to what degree it could be beneficial to implement parts of these incentive schemes on Svalbard as well. How a Svalbard version of these schemes would look would need to be influenced by a regulatory statute set by an authority. One example is the possibility of a collection scheme with a lottery incentive. A participant with strong ties to the business sector on Svalbard explained that this concept had been previously considered but that such schemes require financial support, so they wished the

proper authorities could help set it into motion. This discussion came with one clear stipulation, however, that said return schemes should not benefit the mainland, but rather that the benefits remained on Svalbard.

Another option for consideration is to repurpose and reuse discarded plastic if regulations were adjusted to allow for such activities. By implementing a grinder machine, plastic materials can be ground into plastic pellets which then can be molded or 3D-printed into new products. This solution can be seen in parallel with the issue of beach litter, which is a very real environmental problem facing the Arctic states. During the Governor of Svalbard's annual expedition in 2021, they gathered more than 48 cubic meters of beach litter (Miljødirektoratet 2021). Utilizing this pollution as a resource could provide raw materials for plastic-repurposing operations. However, this can only be a short-term solution as the CE must start with design and prevent pollution to happen in the first place. Moreover, there are other barriers to the establishment of this model. The use of plastic pellets depends on the specific properties and quality level of the plastic at hand, and these properties must be considered when designing new products. Large quantities and qualities of plastic are needed to successfully run such a venture, thus rendering it uncertain if the supplies on Svalbard are plentiful enough for such models. It was therefore suggested that a mapping be done of the amount of plastic on Svalbard, to better understand what raw materials exist. This is indeed one of the hopes of the new waste collection station, which provides the necessary space required to properly sort plastic waste. The current shortage of sorting that exists today means that there is a lack of understanding about the flow of waste streams. Increased knowledge about this, however, can lead to improvement where needed along the supply chain.

It was clear throughout the workshop that the residents of the town of Longyearbyen were actively engaged in these topics. Multiple initiatives for circular usage of materials are already underway, such as social media pages dedicated to buying, selling, and trading furniture and goods, the opening of a used-item boutique, and the repurposing of buildings for various uses. The active and engaged environment on the archipelago fuels the drive to do as much as possible with the jurisdictional framework currently in place. Part of this engagement can be traced to the expectations that Svalbard holds from its tourists and the global society as a whole. Perception of this group of islands in the Arctic is that they are pristine and that nature is untouched. In reality, this is not the case, but nonetheless, this image prevails and influences the expectations of visitors who have come to Svalbard. The stakeholders expressed how tourists and visitors who went home feeling that the waste management on Svalbard was bad is an embarrassment to Svalbard's reputation. Thus, any such initiatives to help are welcomed. In many ways,

the geographical and sociological conditions on Svalbard could function as a test arena for trying out various new circular measures. The isolated area provides the opportunity to explore a semi-self-contained circuit for materials and waste, and the small but engaged population gives a good foundation for a pilot case.

To succeed with CE initiatives on Svalbard, knowledge and experience sharing both internally within the Archipelago and externally with the mainland is completely essential. Collaboration and knowledge sharing can provide a better understanding of the waste types that would be most beneficial to focus reuse and circular efforts on, both for the environment's sake and for the best use of available resources. But there is also a large need for collaboration with experts on the mainland. The population on Svalbard is small, and the knowledge internally within the community is limited. Thus, the majority of expertise within the field of CE can be found on the mainland, thus making it essential to strengthen the working dialogue between the locals located on Svalbard and the researchers, government representatives, and other experts on the mainland. Workshops such as the one from this study could be a beneficial tool to facilitate such collaboration.

Finally, the desire to impact change can only go so far if there are no proper funding sources to support the necessary activity. In particular, in Svalbard, high costs that arise due to geographical peculiarities can be deterring for entrepreneurs and act as a disincentive if the right sources of financing or subsidies are not in place. By undergoing a mapping process of the funding sources particularly relevant for Svalbard, entrepreneurs could be more encouraged to spawn new initiatives on the island. This, however, needs to be a joint effort between stakeholders on Svalbard and the mainland, since Svalbard is not currently included in all financing schemes that are valid on the mainland. By mapping which financing schemes and sources exist for Svalbard and even initiating new financing possibilities, the barrier to entry would be lowered. With so much agreement among the stakeholders present, it would seem that taking steps towards establishing a CE on Svalbard would be straightforward. Yet we know that the process is complicated and requires a collaboration between all local and national levels of power, not all of whom were present at the workshop. The drive to enact change was evident, but the path forward is long and winding.

In-depth interview—governance

As a supplement to the workshop results, one stakeholder working in the governance sector on Svalbard, as well as one stakeholder working in the industry sector on the mainland, was interviewed.

The stakeholder from governance reiterated the current reality that all waste from Svalbard, both from private households and from industry actors, gets collected by the Longyearbyen Lokalstyret and shipped back to the mainland. Lokalstyret is the only waste collection point for the whole town, and while sorting for paper, glass, and metal is already practiced, there is currently no sorting for plastics. The stakeholder mentioned their excitement for the new environmental station and that they can sort and potentially repurpose more materials. They explained that they aim to start with plastics from the industry. *“We plan to start with plastic from businesses since that will be more one type of plastic, rather than from households, which includes many different types of plastic. With this, we hope it will make it easier to recycle the materials.”* Since the recycling process depends heavily on the type of plastic involved, focusing on the circularity of one type of plastic could be a good place to start and will also help build up a knowledge base on how much of the various waste types are in circulation on Svalbard, allowing them to operate with concrete data.

Norwegian law now from 2023 requires people to sort plastics on the mainland, and the local community should practice this on Svalbard too, even though it is not currently an official jurisdictional requirement there.

The stakeholder expressed that a better approach to a full CE would be to limit what comes up to Svalbard in the first place since their geographical uniqueness allows them the opportunity to have stricter control over imports. This includes, among other things, the large pallets of goods that get wrapped in plastic before being sent north, which could be an example of how to control that less plastic ever reaches Svalbard, to begin with. One example the interviewee included was related to grocery stores: *“We asked them [local store] to stop selling Q-tips with plastic sticks and instead start with the paper ones, which they eventually did. There is a lot they can control in terms of what they do and don’t take in to sell, and it seems that they are interested in doing good.”* In addition, they argued that current practices should be examined to ensure that the most environmentally responsible alternative is being employed. *“Perhaps it would be proven to be better that we burn the plastic here on Svalbard and use the warmth, rather than using energy to press the plastic into balls and sending it off to Tromsø, where it is often sent further to recycling plants in Germany,”* they explained. This ties back to the need for collaboration with experts on the mainland and with those responsible for instating regulations, to examine the best practice for Svalbard’s case.

Finally, the interviewee shared interesting insights about the sociological peculiarities of living on Svalbard. With such a shifting population on Longyearbyen, the strong engagement in these topics comes and goes, making it difficult to harness the motivation for a long enough period to lead to real change. This provides an extra challenge to enacting the change needed for a CE on Svalbard. In addition, the stakeholder mentioned

how when an individual moves to Svalbard, there is a steep learning curve with an enormous amount of information that needs to be taken in, making it so that any potential additional information about waste sorting could make new residents feel like they are *“drowning in information.”*

In-depth interview—industry

The interviewee from the industry comes from an organization focused on producer responsibility for packaging that works to ensure packaging is properly collected and recycled after use. Norwegian law states that all producers who are responsible for the production of 1000 kg or more of goods are required to be a member of such an organization. Unfortunately, this regulation does not compare to Svalbard. The interviewee stated that their organization *“...had an agreement with Svalbard several years ago, where a container with packaging plastic was sent to Tromsø. However, this became too expensive, and the quality was bad, so the shipping company pulled out from the agreement.”*

The interviewee expressed that their organization focuses on assisting producers in the design phase so that the entire life cycle is considered, making it easier to recirculate these products in the stream of goods later. In addition, they focused on facilitating access to proper collection and recycling facilities, so the CE can have the infrastructure necessary to function. However, this situation becomes complicated when bringing Svalbard into the mix, because, while the producers of the products are found on the mainland, their plastic products are imported to the archipelago, where these collection and recycling facilities are not in a place like they are on the mainland. This once again leaves Svalbard to its own devices.

Since that time, the interviewee shared that there have been multiple attempts to try to get the initiative up and running again, but that the costliness of the venture has been a limitation. *“We are open to establishing the initiative again if there is interest in it and money for it, but part of the problem is that there are so few people there that it will mostly be a matter of principle rather than large volumes making a difference.”* Such an attitude can most certainly affect the motivation to enact a change, and if the authorities who control regulations do not prioritize the issue, change will not occur. Thus, a mix of motivation and regulation is needed to stimulate a CE on Svalbard.

Conclusion

There is no magic “one-size-fits-all” system when it comes to implementing a CE of plastics across Europe, let alone in the Arctic. The ongoing global treaty negotiations to

end plastic pollution will apply pressure on both national and subsequently local governments and ensure a smooth transition to a CE and aid in ending plastic pollution. It will be vital to hear voices outside of policymakers during the treaty negotiations which is one of the reasons we held a workshop related to a local community in the Arctic. The workshop brought together various sectors of society on both Svalbard and digitally from mainland Norway (governance, industry, research, tourism, etc.) to examine the challenges and opportunities that will come with transitioning to a CE in Longyearbyen. Although the makeup of the workshop revealed many participants working within governance, overall participants stated that they desired strong guidance from the top levels to make it easier to require changes at the local levels. With the inclusion of many local governing actors—guidance from mainland Norway will be key. However, when attempting to influence policy or have local voices heard, it is important to have the same definitions of what the CE entails. It was clear from reviewing the literature on the CE from a Norwegian perspective (Alvarado et al. 2021) that discourse is highly variable. The workshop attendees were focused on a CE of plastics being mainly related to a product's end of life, ability to repurpose them, and eventually using less plastic to begin with. Possibilities were identified in adjusting regulations as they currently are to enable more circular practices within the jurisdictional framework that already exists, which could include incentives, subsidies, and EPR schemes.

Workshop attendees expressed their fear of failure as there is little time to reach global environmental goals by 2030. This is in addition to the fact that environmental impacts are stronger felt in the Arctic, so failure is not an option. Those involved in the workshop demonstrated a strong desire for change, but with a lack of financial support, assistance would be needed from the mainland where a stronger knowledge base for circular solutions is present. Financial assistance was expressed to be demonstrated in the form of funding for new pilot projects on Svalbard, as well as mapping of available resources for such ventures. Stakeholders pointed out that large quantities and qualities of plastic materials are needed to successfully run a hypothesized venture such as turning waste into new products, thus rendering it uncertain if the supplies on Svalbard are plentiful enough for such models, which is why plastic waste had been shipped back to mainland Norway in the past. It was therefore suggested that a mapping be conducted on the number of plastic materials being imported to Svalbard, which would provide a better understanding of what raw materials exist. Running a plastic mapping exercise on a smaller scale could provide input on the best practices to do so nationwide and eventually on a global scale. Another path forward was return schemes and how

they are not in place on Svalbard like mainland Norway, as material supplies are not enough. The stakeholders discussed that if these machines were installed in Longyearbyen, they should not benefit the mainland, but rather that the benefits remained on Svalbard to aid in new pilot projects. The same idea can be seen on mainland Nord via the Handelens Miljøfond, where a tax is taken from each plastic bag sold, which goes to a fund to help finance new research and innovation in solving plastic pollution and environmental harm. Future works should map out plastic materials both in the market on Longyearbyen and in the new recycling facility. It is vital to have monitoring and transparency around plastic materials being produced as well as what is available for reuse as a first step in the transition to a CE. As global governance will need to be taken up and implemented at the national and more-so the local level, this study is a first step towards identifying the best practices from local communities. It is recommended that future research can include other Pan-Arctic communities to compare results and discourses within circular economy transitions in the Arctic.

Disclaimer This publication reflects the views of the authors, and the Research Council of Norway can be held responsible for any use which might be made of the information contained therein.

Funding Open access funding provided by SINTEF. The publication is part of a project that has received funding from the Research Council of Norway under project number 315402-GOMPLAR and 318730-PLASTICENE.

Declarations

Conflict of interest The authors declare no competing interests.

Open Access This article is licensed under a Creative Commons Attribution 4.0 International License, which permits use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons licence, and indicate if changes were made. The images or other third party material in this article are included in the article's Creative Commons licence, unless indicated otherwise in a credit line to the material. If material is not included in the article's Creative Commons licence and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder. To view a copy of this licence, visit <http://creativecommons.org/licenses/by/4.0/>.

References

- Alvarado IAO, Sutcliffe TE, Berker T, Pettersen IN (2021) Emerging circular economies: discourse coalitions in a Norwegian case. *Sustain Prod Consum* 26:360–372
- Aquilina E (2022) Arctic towns in transition: Norway's commitment towards a new energy solution on Svalbard. The Arctic Institute. <https://www.thearcticinstitute.org/arctic-towns-transition-norway-commitmenttowards-energy-solution-svalbard/>

- Bergmann M, Almroth BC, Brander SM, Dey T, Green DS, Gundogdu S, Krieger A, Wagner M, Walker TR (2022a) A global plastic treaty must cap production. *Science* 376(6592):469–470
- Bergmann M, Collard F, Fabres J, Gabrielsen GW, Provencher JF, Rochman CM, van Sebille E, Tekman MB (2022b) Plastic pollution in the Arctic. *Nat Rev Earth Environ* 3(5):323–337
- Blue M-L (2018) What is the carbon footprint of a plastic bottle? Retrieved August, 2022 <https://sciencing.com/carbon-footprint-plastic-bottle-12307187.html>. Accessed 07.09.2022
- Bolger K, Doyon A (2019) Circular cities: exploring local government strategies to facilitate a circular economy. *Eur Plan Stud* 27(11):2184–2205
- Bredenhoef J (2005) The conceptualization model problem—surprise. *Hydrol J* 13(1):37–46
- Checkland P (1999) Systems thinking. Rethinking management information systems, pp 45–56. https://books.google.co.uk/books?hl=en&lr=&id=QJJEp5LdG4C&oi=fnd&pg=PA45&ots=WpaqymCGNB&sig=85VcN_c3TJFzfSaBkX40xtNNDG8&redir_esc=y#v=onepage&q&f=false
- Cowan E, Tiller R (2021) What shall we do with a sea of plastics? A systematic literature review on how to pave the road toward a global comprehensive plastic governance agreement. *Front Mar Sci* 8(1745)
- Cowan E, Booth AM, Misund A, Klun K, Rotter A, Tiller R (2021) Single-use plastic bans: exploring stakeholder perspectives on best practices for reducing plastic pollution. *Environments* 8(8):81
- Deloitte (2020) Reducing plastic pollution and creating a true circular economy for plastics through extended producer responsibility. p 56. Report May 2020 link chrome extension://efaidnbmnnnibpcajpcgclefndmkaj/https://media.wwf.no/assets/attachments/Report_Deloitte_AS_WWF.pdf
- Dunkelberg H, Weiß T, Mazurek F (2019) Energy-and ecologically-oriented selection of plastic materials. *Procedia Manufacturing* 33:240–247
- Eriksen M, Borgogno F, Villarrubia-Gómez P, Anderson E, Box C, Trenholm N (2020) Mitigation strategies to reverse the rising trend of plastics in Polar Regions. *Environ Int* 139:105704
- European Commission (2020) Communication from the commission to the European parliament, the council, the European economic and social committee and the committee of the regions brussels, 11.3.2020 - COM(2020) 98 final
- European Parliament (2015) Circular economy: definition, importance and benefits Retrieved August 2022, <https://www.europarl.europa.eu/news/en/headlines/economy/20151201STO05603/circular-economy-definition-importance-and-benefits>. Accessed 12.05.2022
- Forrester JW (1994) System dynamics, systems thinking, and soft OR. *System Dynamics Review* 10(2-3):245–256
- Freeman RE (2010) Strategic management: a stakeholder approach, Cambridge University Press
- Geyer R, Jambeck JR, Law KL (2017) Production, use, and fate of all plastics ever made. *Sci Adv* 3(7):e1700782
- Ghisellini P, Cialani C, Ulgiati S (2016) A review on circular economy: the expected transition to a balanced interplay of environmental and economic systems. *J Clean Prod* 114:11–32
- Gutman, S. and A. Teslya (2020) Potential for transition to circular economy in regions of the Russian Arctic. IOP Conference Series: Earth and Environmental Science 539(1):012064
- Hermann RR, Pansera M, Nogueira LA, Monteiro M (2022) Socio-technical imaginaries of a circular economy in governmental discourse and among science, technology, and innovation actors: a Norwegian case study. *Technol Forecast Soc Change* 183:121903
- Hooghe L, Marks G (2020) A postfunctionalist theory of multilevel governance. *Br J Polit Int Rel* 22(4):820–826
- Hugo TG, Løvold M, Lindebjerg R, Maes T (2021) Exploring the option of a new global agreement on marine plastic pollution –a guide to the issues. GRID-Arendal Policy Brief, Arendal
- Jackson MC (1982) The nature of soft systems thinking: the work of Churchman, Ackoff and Checkland. *J Appl Syst Anal* 9(1):17–29
- Jones SM (2021) Waste management in Norway. Advancing a Circular Economy: A Future without Waste?. Palgrave Pivot, Cham, pp 111–139. https://doi.org/10.1007/978-3-030-66564-7_6
- Kane S, Van Roijen E, Ryan C, Miller S (2022) Reducing the environmental impacts of plastics while increasing strength: Biochar fillers in biodegradable, recycled, and fossil-fuel derived plastics. *Composites Part C: Open Access*, p 100253
- Liboiron M, Zahara A, Hawkins K, Crespo C, de Moura Neves B, Wareham-Hayes V, Edinger E, Muise C, Walzak MJ, Sarazen R (2021) Abundance and types of plastic pollution in surface waters in the Eastern Arctic (Inuit Nunangat) and the case for reconciliation science. *Sci Total Environ* 782:146809
- Longyearbyen Lokaltstyre (2017) Avfallsplan Longyearbyen 2017-2020, p 57. <https://www.lokalstyre.no/rullering-av-avfallsplan-2017-2020.5881021-209814.html>
- Mallory ML, Gilchrist HG, Janssen M, Major HL, Merkel F, Provencher JF, Strøm H (2018) Financial costs of conducting science in the Arctic: examples from seabird research. *Arctic Science* 4(4):624–633
- Milius L, Christensen LH, McKinnon D, Christensen C, Rasch MK, Eriksen MH (2018) Plastic recycling in the Nordics: A value chain market analysis. *Waste Manag* 76:180–189
- Miljødirektoratet (2021) Sirkulær økonomi på Svalbard: muligheter og utfordringer, p 22. <https://www.miljodirektoratet.no/publikasjoner/2021/desember-2021/sirkular-okonomi-pasvalbard-muligheter-og-utfordringer/>
- Pohjakallio M (2020) Secondary plastic products—examples and market trends. In: Letcher TM (ed) Plastic waste and recycling. Academic Press, pp 467–479
- Ramasamy EV, Sruthy S, Harit AK, Mohan M, Binish MB (2021) Microplastic pollution in the surface sediment of Kongsfjorden, Svalbard, Arctic. *Mar Pollut Bull* 173:112986
- Raubenheimer K, Urho N (2020) Rethinking global governance of plastics—the role of industry. *Mar Policy* 113:103802
- Ruiz IB (2021) How does Germany’s bottle deposit scheme work?, DeutscheWelle. <https://www.dw.com/en/how-does-germanys-bottle-deposit-scheme-work/a-50923039#:~:text=Adventurous%20bottles&text=There%2C%20it%20is%20cleaned%2C%20refilled,re%2Duse%20rate%20at%2025>
- Silva ALP, Prata JC, Walker TR, Duarte AC, Ouyang W, Barcelò D, Rocha-Santos T (2020) Increased plastic pollution due to COVID-19 pandemic: challenges and recommendations. *Chem Eng J* 126683
- SSB (2009) Population of Svalbard, 1 January 2009. Online source <https://www.ssb.no/en/befolkning/statistikker/befsvabard/arkiv/2009-03-05#:~:text=A%20total%20of%20%20085,Svalbard%20was%20around%20%20570>
- Sterman J (2000) Business dynamics: systems thinking and modelling for a complex world. McGraw Hill Higher Education, Boston
- Syberg K, Nielsen MB, Clausen LPW, van Calster G, van Wezel A, Rochman C, Koelmans AA, Cronin R, Pahl S, Hansen SF (2021) Regulation of plastic from a circular economy perspective. *Curr Opin Green Sustain Chem* 29:100462
- Tiller R, De Kok J-L, Vermeiren K, Richards R, Ardelan MV, Bailey J (2016) Stakeholder perceptions of links between environmental changes to their socio-ecological system and their adaptive capacity in the region of Troms, Norway. *Front Mar Sci* 3:267
- Tiller RG, J Mork, R Richards, L Eisenhauer, Y Liu, J-F Nakken and ÅL Borgersen (2014) Something fishy: assessing stakeholder

- resilience to increasing jellyfish (*Periphylla periphylla*) in Trondheimsfjord, Norway. *Mar Policy* 46(0): 72-83
- Trevail AM, Gabrielsen GW, Kuhn S, Bock A, Van Franeker JA (2014) Plastic ingestion by northern fulmars, *Fulmarus glacialis*, in Svalbard and Iceland, and relationships between plastic ingestion and contaminant uptake (No. 029). Norsk Polarinstitutt. Online report chrome-extension://efaidnbmnnnibpcajpcgiclfefindmkaj/<https://edepot.wur.nl/334485>
- UNEA (2022) Draft resolution - end plastic pollution: towards an international legally binding instrument. United Nations, Nairobi, p 4
- UNEP (2021) From pollution to solution: a global assessment of marine litter and plastic pollution. <https://wedocs.unep.org/handle/20.500.11822/32238>
- UNEP (2017) Draft resolution on marine litter and microplastics. United Nations Environment Assembly of the United Nations Environment Programme, Nairobi, Kenya
- Walker TR (2022) Calling for a decision to launch negotiations on a new global agreement on plastic pollution at UNEA5. 2. *Mar Pollut Bull* 176:113447–113447
- Watkins E, Gionfra S, Schweitzer J-P, Pantzar M, Janssens C, ten Brink P (2017) EPR in the EU plastics strategy and the circular economy: a focus on plastic packaging, Institute for European Environmental Policy (IEEP). Online report chrome-extension://efaidnbmnnnibpcajpcgiclfefindmkaj/<https://assets.change.inc/downloads/ieerapport-epr-price-modulation.pdf>
- Watkins E, Schweitzer J-P, Leinala E, Börkey P (2019) Policy approaches to incentivise sustainable plastic design. OECD Environment Working Papers, No. 149. OECD Publishing, Paris. <https://doi.org/10.1787/233ac351-en>
- Wiebe KS, Norstebø VS, Aponte FR, Simas MS, Andersen T, Perez-Valdes GA (2023) Circular economy and the triple bottom line in Norway. *Circular Economy and Sustainability* 3(1):1–33

Publisher's note Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.