SVALBARD AS A SYMBOL

FOR A SUSTAINABLE APPROACH TO RESEARCH ACTIVITIES

77.8750° N, 20.9752° E

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MASTER THESIS:

SVALBARD AS A SYMBOL

FOR A SUSTAINABLE APPROACH TO RESEARCH ACTIVITIES

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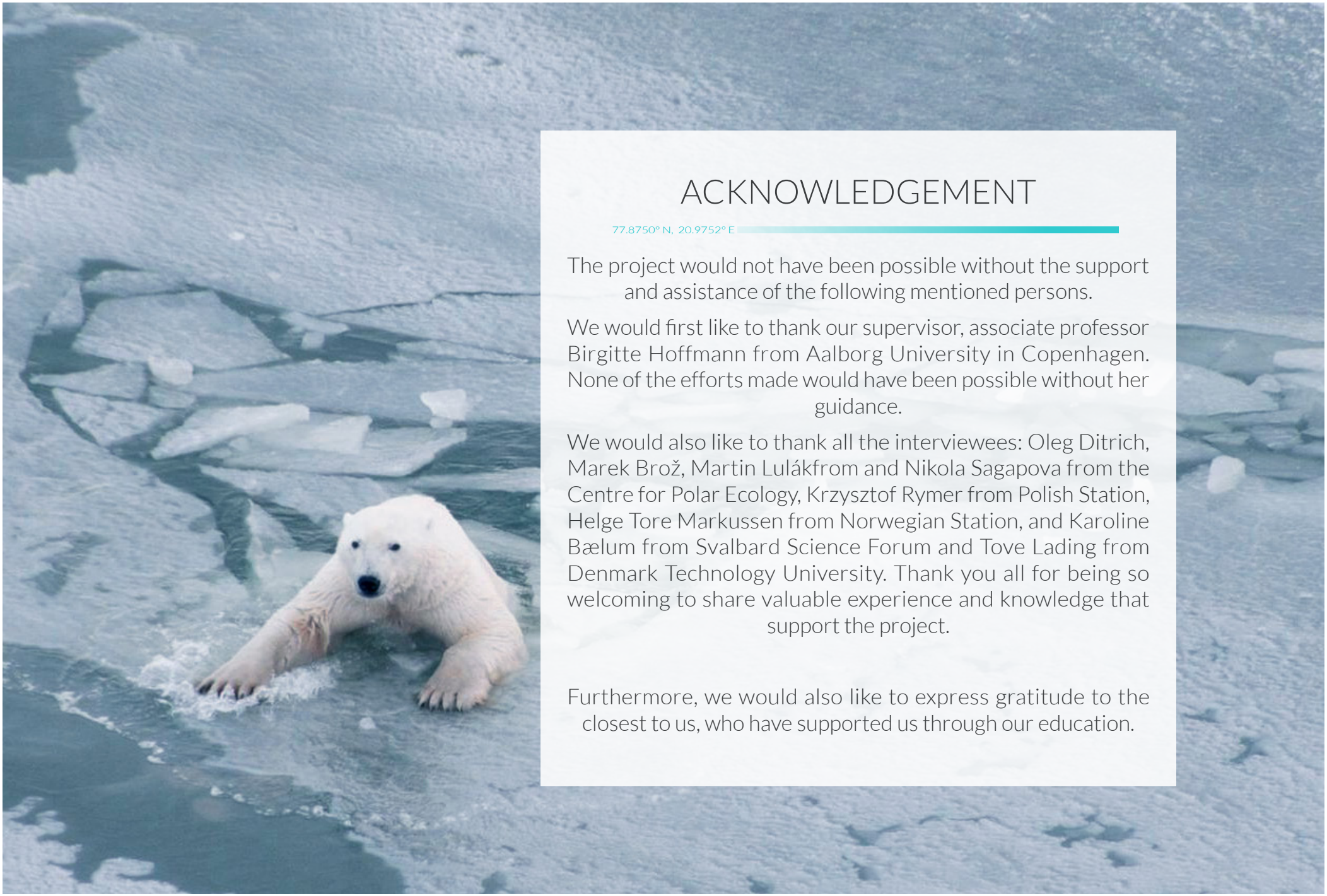

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ABSTRACT

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Under the pressure of increasing environmental issues, the need for conducting relevant scientific Research is more significant than ever. As an important research destination, polar areas have been seen as the last directly intact areas with a pristine condition, which is highly valued for research purpose. However, the vulnerable local environment is challenging by the increasing number of visitors. In order to continue investigating the environmental issues and to maintain the wilderness environment, it is essential that exploring ways to change the current research activities into a sustainably conducted research approach so that contributing to global scientific research development and local, sustainable development.

This project is based on a case study and research communities in Svalbard Archipelago, offering a perspective of the understanding of sustainability in the specific context. Regarding research activities, we conceive the specified sustainability "As research activities contribute to the world knowledge are executed without compromising the environment and therefore able to continue for a long time". Based on this understanding, the paper also suggested a possible way of tackling sustainability issues - environment footprints, with a focus on interactions between research practice and environmental impact. A Material Flow Analysis concerning research activities is conducted as a concrete visual tool to explain the link and thereby raise awareness of sustainability relies on everyone every day's activities and equip knowledge of where has the potential to improve.

Moreover, practice theory was used to develop a more action-guiding strategy:a substantive part of changing researchers practices to more sustainable ones, which in this paper means a smaller environmental footprint. The core of this strategy is the strategic plan providing an overview of improvement areas. It contributes to further guidance for how to conduct Research in a sustainable manner, for example, sharing experience, research data and research plan, applying renewable energy supply, and so on. Through developing the strategic plan into action guide, thereby changing researchers routines, we aim at contributing to Svalbard of being the leading symbol of Sustainably conducted Research in the international research community.

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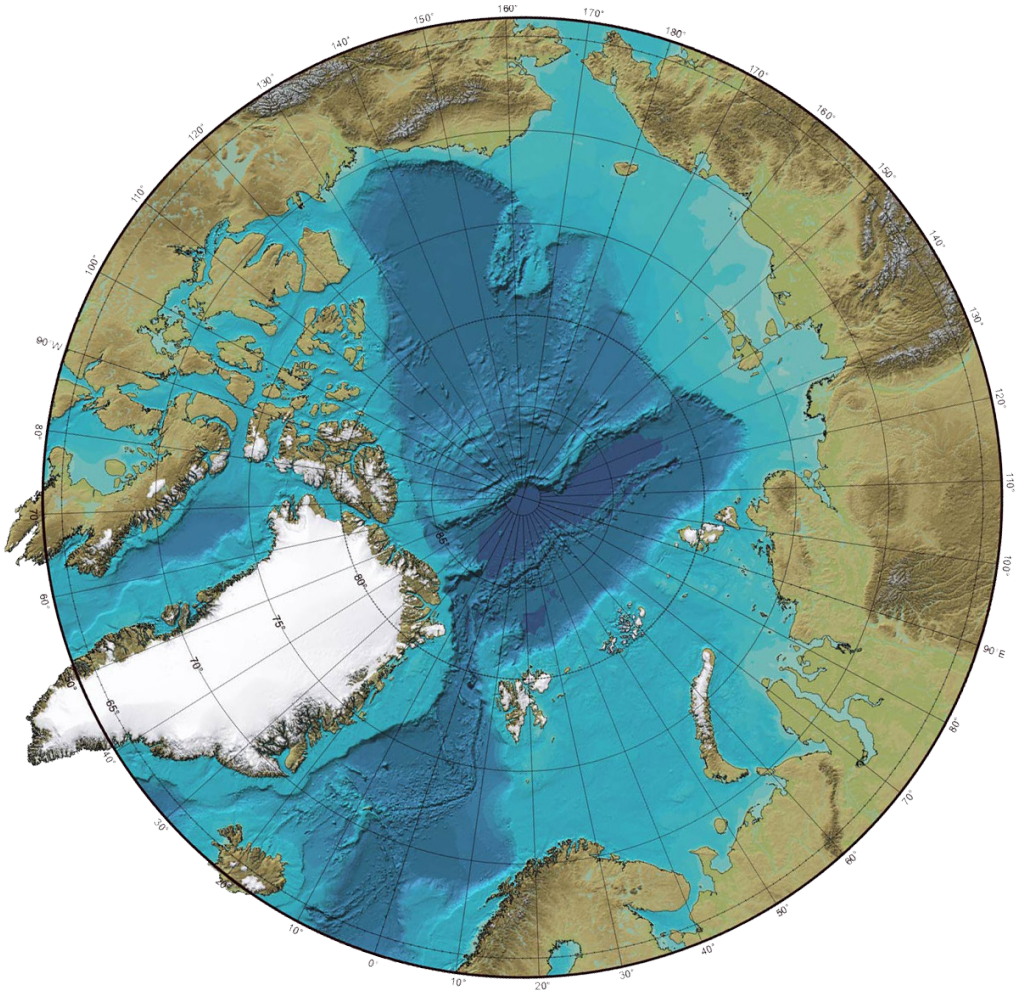

Figure 1: Arctic circle by the American Polar Society, n.d.

1. INTRODUCTION

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As environmental issues are arising, the need for related scientific research is more significant than ever. As the most affected area by climate warming, the Arctic has high scientific value for its geographic location and unique natural environment. This research makes a crucial contribution to Sustainable development in terms of providing up-to-date knowledge. Therefore sustainable development genuinely depends on quality research knowledge. The Arctic, as a host of the increasing number of visiting researchers, witnessed the growing number of human activities. As the last directly intact areas with a pristine condition in this area, it is vulnerable for many reasons. For the future research and the sake of the local environment, its wilderness should be maintained. Therefore, protecting the local environment and investigating the changes in the Arctic is essential for sustainable research and boosting global sustainable development.

This project objective aims to explore the possibilities of having research been carried out in a way that causes the least environmental impact. Due to the lack of localized knowledge regarding sustainability in the Arctic, in this project, we choose to focus on research in Svalbard Archipelago. The northmost inhabited, it is a vital research community which plays an significant role in international environmental research. Even though the goal of the Svalbard Science Forum is encouraging smaller Environmental Footprint relat to research activities, they are struggling to answer why they set this goal and how it could be achieved.

The strategy for this is to establish a strategic plan leading to ideal scenario of researching in a sustainable manner (based on practice theory) while answering the question how sustainability could be conceived in the context of Svalbard and how to explore the issues. The strategic plan serves for further action plans and assists the sustainable development regarding research activities that contribute to the world knowledge and is executed without compromising the environment and therefore, able to continue for a long time.

1.1. Sustainabilitwy in Sustainable Research

Recently, climate change draws more public attention and becomes a hot topic all around the world. Numbers of academic projects, political agendas and organisations are set up to tackle this wicked problem in order to understand it and slow down the predicted trend of climate changes.

Scientific research is at the forefront edge of sustainable development. Researches regarding environment analysis, as the source of the knowledge, is responsible for human response to these changes and since their scientific reports have a significant influence on policy decision making and scholar study. In the past scholars started to frame the notion of Sustainability, which nowadays became for public sort of symbolic tag for the possible framework to tackle this climate change problem. Knowledge is a continuous spiral with increasing tendency, public with time delay reflect academic work and academic reflects the topic in general public. Hence, a large number of projects and published research papers regarding Ecology, Geology and Environmental impacts witnessed the remarkable increase of research request in polar areas. The rising number of scientific projects responded to the need of analysing future sustainable scenarios. Also, the need for knowledge is still growing.

Considering the fact that the growing research need have been and will be conducted in polar areas, almost the last directly intact areas with a pristine condition, in our minds, these questions arise “Are the research practices conducted in a sustainable way? Do the researcher’s practices help to contribute towards protecting the environment while being studied? Do research stations merge with the local environment unharmingly?” Based on overall literature research and analysis, we concluded that this topic requires further research. It is not only for the sake of the local environment but also for the symbolic meaning for steering sustainable research in a sustainable way at the forefront edge of sustainable development.

In this project, we choose to focus on Svalbard archipelago, which is located in the Arctic, because of the reachable resources and its important position played in research. In the following chapter, we will discuss why the Arctic and particularly Svalbard, is a vital interest for our project. [see : Figure 3]

Figure 2: Equipment transport to the research site by Centre for Polar Ecology, Svalbard, n.d

1.2. The Arctic

The Arctic is crucial not only for the sake of research but also for the rest of the world. “Because it helps keep our world’s climate in balance. Arctic sea ice acts as a huge white reflector at the top of the planet, bouncing some of the sun’s rays back into space” [WWF| Arctic,2019] which lowers down the world’s temperature. Also, due to the thermohaline circulation, the Arctic’s thick, reflective sea ice moderates ocean temperatures around the world, helping circulate the world’s ocean currents, moving cold and warm water around the globe. [Oceanservice.noaa.gov, n.d.]

However, it has been already noticed that the Arctic is experiencing in terms of climate warming also social transformation, but now the periods of changes are even faster than ever and are predicted to have a continuously rising trend in the future [AMAP, 2017; Pearce et al., 2012; Larsen & Fondahl, 2014]. Let be one of many examples the Arctic sea and air warming over the past few decades – actually about twice as much as the global average according to IPCC’s 4th assessment report in 2007[Parry et al., 2007]. In a kind of vicious circle, as the sea ice melts, there is “less to reflect the rays, and more heat is absorbed by the ocean, magnifying the warming effect.” [Pearce et al., 2012]

Though the warming effects will come gradually, the changes are far more complex than just rising temperature or changing patterns of precipitation. At the local level, there are more immediate effects - in particular, more intense and frequent extreme weather event such as intense rainfall or snowfall, storms and dry spells [AMAP, 2017]. Furthermore, extreme weathers are more unpredictable and variable with more significant extremes and ‘surprises’. At a global level, present climatic changes are affecting this global environmental “balance”. The disbalance leading to any change in the Arctic will have profound and ripple effects for the rest of the world regarding ecosystems and human societies. [Pedersen et al., 2015]

We are talking about global effects given the Earth is composed of ecosystems connected and affecting one another, so are the socio-economic systems.

Therefore, protecting the local environment and investigating the changes in the Arctic is essential for sustainable research and boosting global sustainable development. It is in need to find a way of conducting sustainable research in the Arctic in a sustainable way, which will be contributing to the goals.

1.3. Svalbard as a symbol

Svalbard as the northernmost human habitat is a powerful example for researchers exploring these rapid changes and thus for us to explore possible sustainable improvements regarding research activities. Svalbard is an archipelago with a rich and complex past. It is modern history counts back to 1596 when a Dutch explorer named Willem Barents discovered it. [Avango, 2005] Who is mostly known by Barents sea in the Arctic Ocean named after him. [Enc. Britannica | Barents Sea, 2019] On the about 61 000 square kilometres of land, more than half of it is covered by snow and ice, for more details see chapter 3.4 Svalbard archipelago. The most well-known “Global Seed Vault’ is located here, which shows it is valued for its geographical location and resources.

Since its discovery, Svalbard plays a significant role in scientific research and has been a symbol of research communities with a focus on sustainability-related subjects [Sysselmannen | A, 2012]. Svalbard Archipelago is experiencing rapid environmental changes as other areas in the Arctic. From 1954 to 2003, Barents area, where Svalbard is located in, has experienced an average of 1-2°C temperature increase. During winter, warming is even stronger [AMAP, 2017] as the interests for conducting research in Svalbard is higher than ever. Its ‘strong scientific community, unique natural environment, geographic location, ease of accessibility and modern

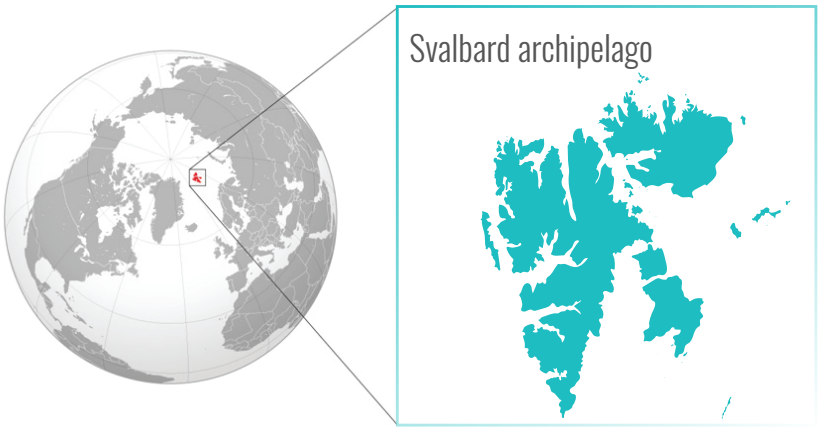

Figure 3: Svalbard location by Geng & Halatova, 2019

infrastructure make Svalbard highly valuable for international research [Norwegian Ministries, 2018, p. 4,11].

Besides, "Svalbard plays an important role in the collaborative global knowledge effort and serves as a hub in several international observation networks. At the same time, its location provides outstanding opportunities for, among other things, space research and Arctic Ocean research. … International interest in research in Svalbard contributes to knowledge development in the Arctic and provides a basis for strengthened international research collaboration. Increased activity actualises the need to minimise the environmental footprint, to preserve the unique Svalbard nature and secure its role as a reference area for research." [Norwegian Ministries, 2018, p. 4,11] More than 1,000 researchers from about 30 different countries visit Svalbard every year. Among the slightly over 2000 population in Svalbard, half of the residents are research related. Therefore, research activities are the leading local activities [Svalbard white paper, XXX]. We could conclude that research activities are influential to the Svalbard and vice versa.

Although Svalbard represents a tiny, tiny part of global sustainable development, and the researchers themselves, if acting Sustainably, do not bring additional perceptible change in lowering global environmental footprints. Nevertheless, what is extra important is the Symbolism - when the researchers' study sustainability and their research is also brought on a higher level from Sustainable development perspective - then this becomes an example that others can look up to Svalbard, the Sustainably approached Research activities Symbol. Additionally, the local environment is essential in terms of doing environmental research; keeping its pristine condition is necessary for future research. Therefore the sustainable goals should be more strict than elesewhere on the planet.

However, the complexity of all phenomena that must be included in thoughts, what is and is not a notion of Sustainability, is so complicated that practically there is no possibility for a clear definition or strict boundary determining Sustainability as such. Accordingly, we cannot decide what Sustainability is or not. However, we, as researchers and designers, can formulate different approaches to understand and suggest how to work with this notion. Perhaps also come up with tools, designs or strategies towards better co-existence with natural processes and usage of Earth resources.

1.4. Problem formulation

In the very beginning of this project, we scanned the internet for: 'sustainable research station', most results present on the internet are about modern passive-houses. It is quite a common understanding of what sustainability means in terms of polar researches. Though a fancy building is a way to reduce the environmental impact regarding research activities, which is undoubtedly sustainable, only a few can get funding for that. Sustainability is not only to build a few modern buildings but to improve the large ratio of the existing research structure based on our understanding of sustainability.

According to the literature research, and analysis of data obtained through interviews, we have been presented with several sustainable issues regarding research in Svalbard. Some are specific for the case station, some are a general problem for all researches (see in the problem discussion chapter). Since there is no determined sustainability concept and approach in this context. Even though the Svalbard Science Forum (an organisation maintaining registration platform for scientists and networking in regard of research activities in Svalbard) aiming at reducing the footprints of research, our investigation showed that Svalbard Science Forum does not have tools for either clear definition and goals in terms of environmental footprint and sustainable development. Therefore we have identified our problem formulation:

HOW CAN SUSTAINABILITY BE FRAMED IN RELATION TO RESEARCH ACTIVITIES IN SVALBARD CONTEXT and HOW CAN WE EXPLORE RELATED ISSUES and WHAT STRATEGY CAN HELP TO ADDRESS THEM?

Figure 4: Drowning Polar Bear Brazil, 2019

2. Project Design

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We are two Master student in Sustainable Design, coming from both culturally diverse and Cross-disciplinary backgrounds - Architect & Civil Engineer from the Czech Republic and Visual Designer & Marketer from China. We have sought to take advantage of the ranging skills set in this project. We are taking our background knowledge and common knowledge from the master education we have chosen to work with different methods to dig in the sustainable issues and come up with solutions.

Following we are presenting how we approached this project, how we selected our main Case research station and secondary cases related to the main topic. Further on, how we performed our Research and analysis of the complex data.

When trying to get a grasp on the magnitude and scope of Sustainable Research Activities and it's we identified several different areas that were important to research in order to comprehend the different possible aspects of our project better.

What is Sustainable Research in the Svalbard context

What are the conditions Researchers are facing

How is the Research conducted in an extreme environment

What is the available infrastructure and how it is formed and what types of facilities do researchers have at hand.

Research activities: in this project, we refer to what researchers do during their stay in research stations. It includes cooking, cleaning, office working, field working, and so forth. Daily practices.

Research development: in this project, we refer to stations, transportation, government organizations covering Research at Svalbard.

Information organization

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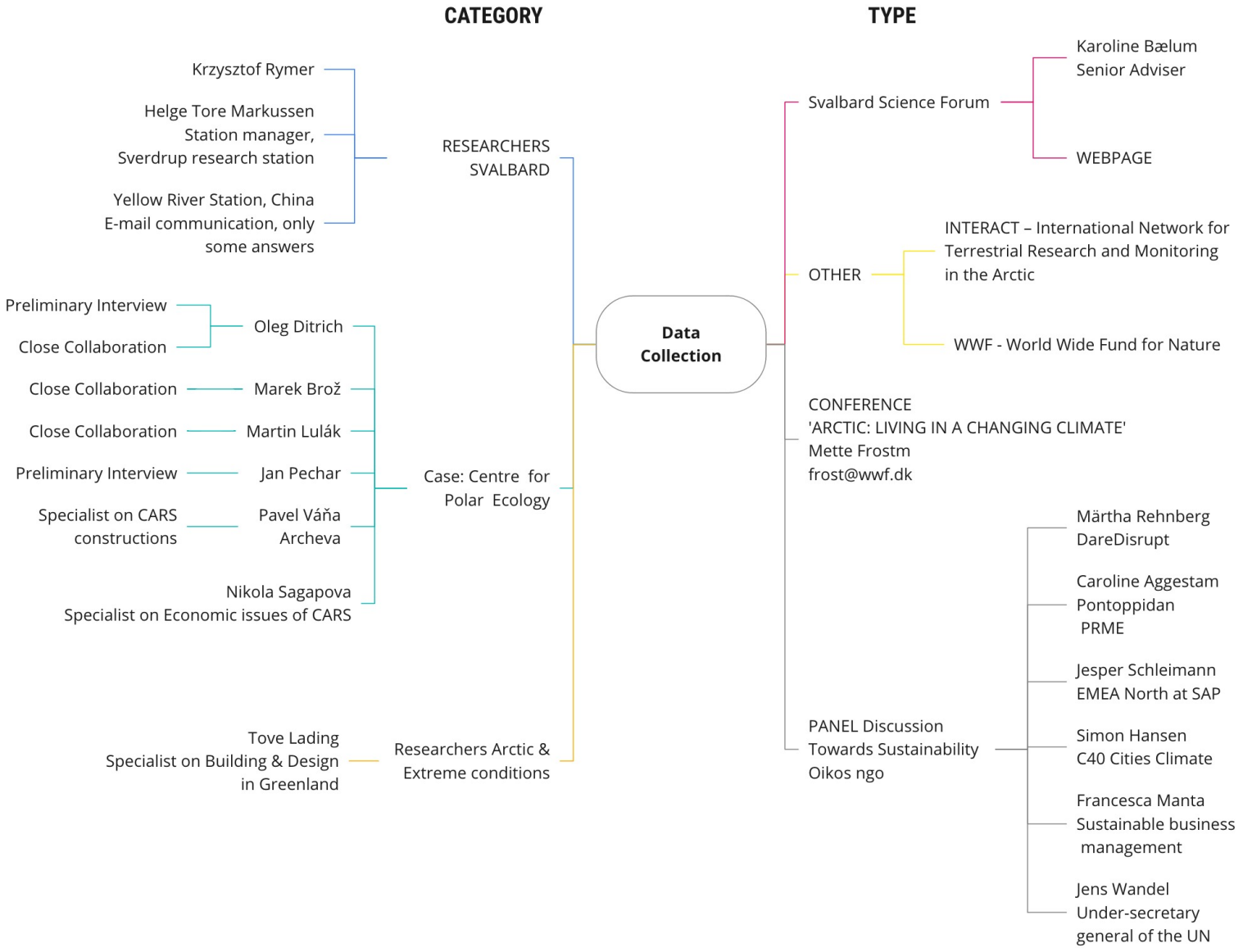
Figure 5: Data collection by Halatova & Geng, 2019



2.1. The project dynamic

This project is based on the Explorative research approach to data collection, followed by a hermeneutic approach to data analysis [Brinkmann and Tanggaard, 2010]. Together, visualized in the shape of the Double Diamond with the process of boarding up of the initial study topic narrowing down to the thesis question, then diverging again with specific ideas followed by narrowing down to a final solution. As illustrated below [Figure 6], in the discover and define diamond phase, we have analyzed sustainability in theory and practical situations presented by the researchers in literature, documentaries and interviews.

We defined our problem based on desk research knowledge with consideration of realistic circumstances. After that, we broadened the ideas based on analysis and finally define and develop the solution with interaction with researchers who struggle with these problems and whom we have identified as most probable to take action in the future.

It was also planned to evaluate and co-design the solution via workshop or design game with researchers before they go to the research station in the Arctic. However, it did not succeed, since they went to Svalbard sooner, then the time for the workshop approached. [see chapter: 8. Discussion] Hence, we have communicated the actual result of this project via e-mails, since this was the only available communication tool for the researchers at that time.

The daily project practice was strongly inspired by the SCRUM method to plan and steer weekly sprints, respectively, daily research plan throughout the project [Sutherland, 2015].

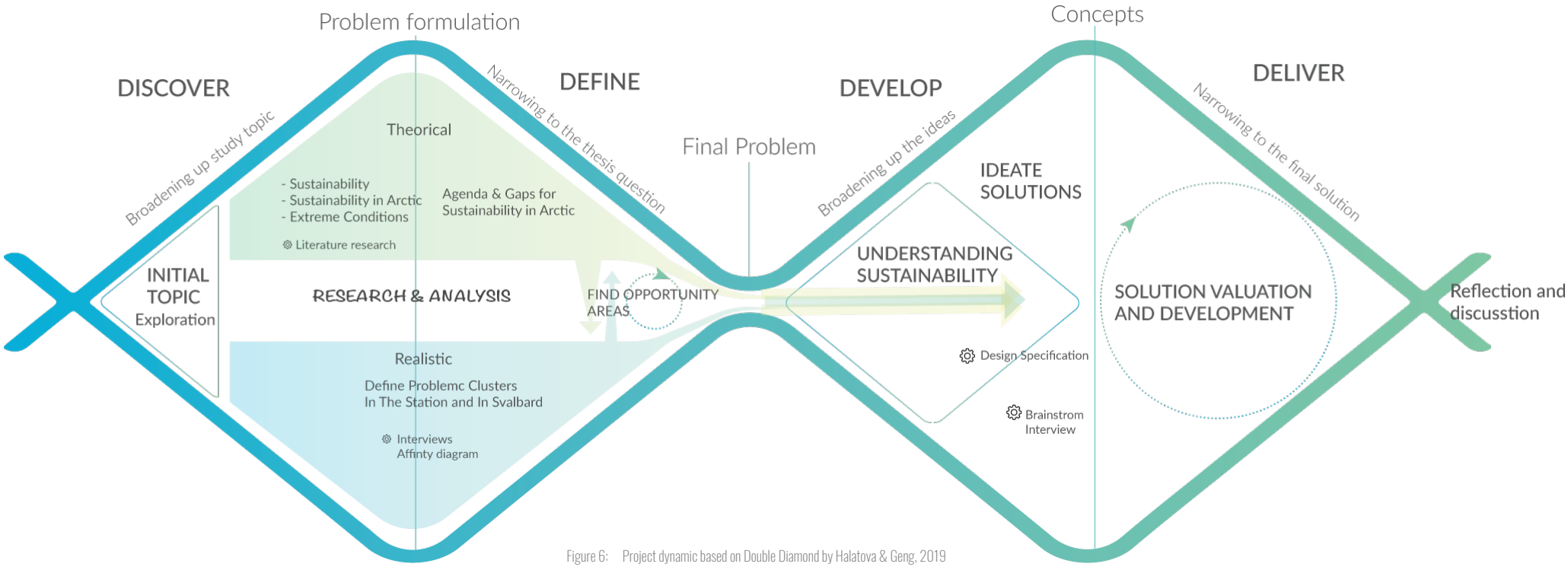


Figure 6: Project dynamic based on Double Diamond by Halatova & Geng, 2019

2.2. Data collection

This paper data collection is based on exploratory ethnographic research. The general ethnographic research engages three kinds of data collection: documents (literature), interviews and observation.[Genzuk, 2003] The project research was conducted remotely. Therefore, physical observation was not possible. Accordingly, we have watched documentaries about researchers' life on Svalbard. [Between Mars and Svalbard, 2012] [Cestománie - Špicberky Za punocním sluncem, 2003] Together, combined with asking the researchers to walk us through their daily routines on Svalbard - each researcher was interviewed on this topic several times during the whole period of the project research to reduce the likelihood of practice omissions.

2.2.1 Literature

Moreover, the presented material is synthesised from several different sources to create a holistic viewpoint of the Theoretical Framing. The desk research was conducted in Czech, Chinese and English, respectively. Based on the inception from a debate with one of the researchers from the Czech Republic, the initial literature research began in January 2019, by researching broad information through scientific papers, reports and articles to gain a broader understanding of the field, with the following being the main topics presented above. This initial research was a necessity in order to explore the scope and the current configuration of the knowledge within the field of research. Results of the literature framework used in this project are discussed in the following chapter 3.Theoretical framing and Empirical literature analysis.

2.2.2 Interviews

To gain a better understanding, most of the interviews were conducted as qualitative unstructured or semi-structured ones. Unstructured interviews were done to establish an open relationship with the participants, and make them comfortable to share their insights while still being thematic on the researched topic. Semi-structured interviews were conducted to clarify or validate already existing assumptions or to investigate a new topic. The thumb rule for our interviews was based on Beyer's and Holtzblatt's approach: "Steer the conversation to meaningful topics by paying attention to what falls within project scope and ignoring things that are outside of it" [1997, p 154]

However, we have not used a uniform set of questions either procedure. Instead, we adapted the tool to the purpose of each situation. Note that all of our interactions included behaviour observation (video chat) because we aim to deliver a strategy to be used by people; this will become part of the practice.

Each interaction with participants/co-workers was followed by an "Interpretation session" [Holtzblatt and Beyer, 2017], providing a context for the team to understand the data from a user interview in depth. Given that some interviews were conducted in native languages of both of us as designers, therefore some of the interviews were later translated to ordinary language - English, this, of course, comes with an obstacle of - what is lost in translation. Hence, we have recorded interviews and also introduced the emphatical descriptions to information exchange between us (designers) to comprehend the conditions under each statement expressed.

Figure 7: Specialist interview - left Mari right Tove

Interview contacts

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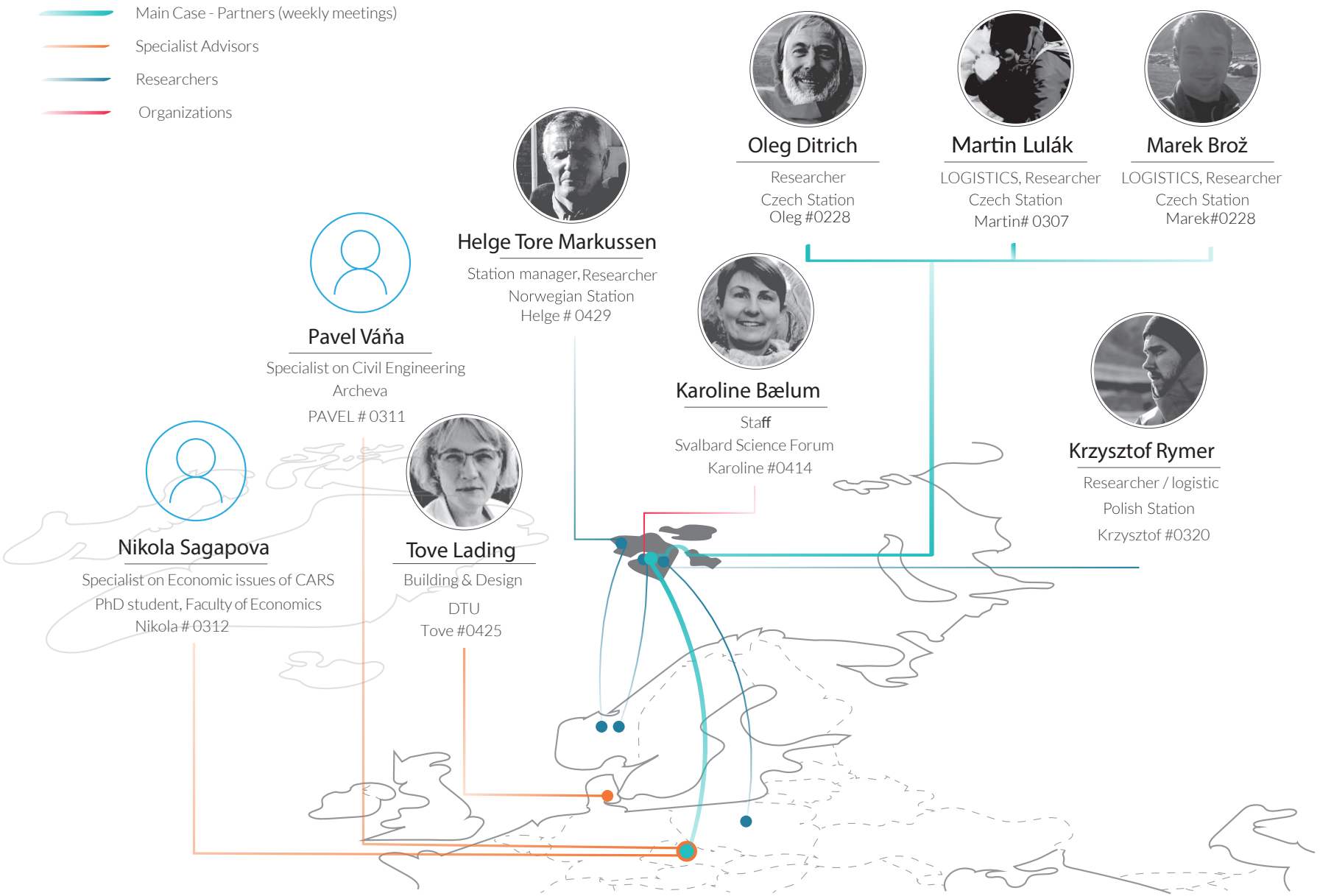
Figure 8: Interview map by Halatova & Geng, 2019



2.2.3 Panel Discussions and Conference

Participation in panel discussion and conferences provided the opportunity not only to get an overview of the Sustainability topic as it is but also to be able to contact easily some of the researchers or directly bring up discussion regarding our topic.

Figure 9: Panel discussion: Sustainable Future, Oikos, 2019

2.3. Data analysing methods

2.3.1 Affinity diagram - structure information

Due to nature of this thesis focused on working with remote areas, this project was firmly based on interviews which produced a considerable amount of data requiring further analysis in alignment with our approach, where we as researchers do not approach the information at all without bias, but there is always present some preliminary understanding. Therefore, we have appraised each interview and the data collected for relevance to our research. The Affinity Diagram is a method which benefits a structure to consolidate acquired data into clusters according to their affiliation. [Holtzblatt and Beyer, 2015]

By clustering the thoughts from researchers and other people experienced with working in such conditions and opinions around the problem field, it gave a better overview which is essential to get a deeper understanding of the topic and facilitate the analysis of individual notes.

“By reading the affinity, a designer not only learns the key issues but can see the exact data that contribute to identifying each issue in work.” [Beyer and Holtzbatt, 1997, p 154]

The practical value of the Affinity Diagram increases when two conditions are met: The first is that the interviewees generate multiple data points, ideally with useful information. ... The second relates to the quality of the sorting. When some of the insights are not clear, then the related quality of sorting based on knowledge from conducting this research can enhance the information outcome and still provide sufficient insight. [Gray, Brown and Macanufo, 2010, p. 56]

As many of the tools used in the out project the Affinity diagram empowered us, to work with complexity and fluid nature of our topic, with the possibility constantly reshuffle the sticky-notes with insights into different clusters. This visual recombination shows the relationships among extracted insights and data. Moreover, using Affinity Diagram technique helped us discover embedded patterns.

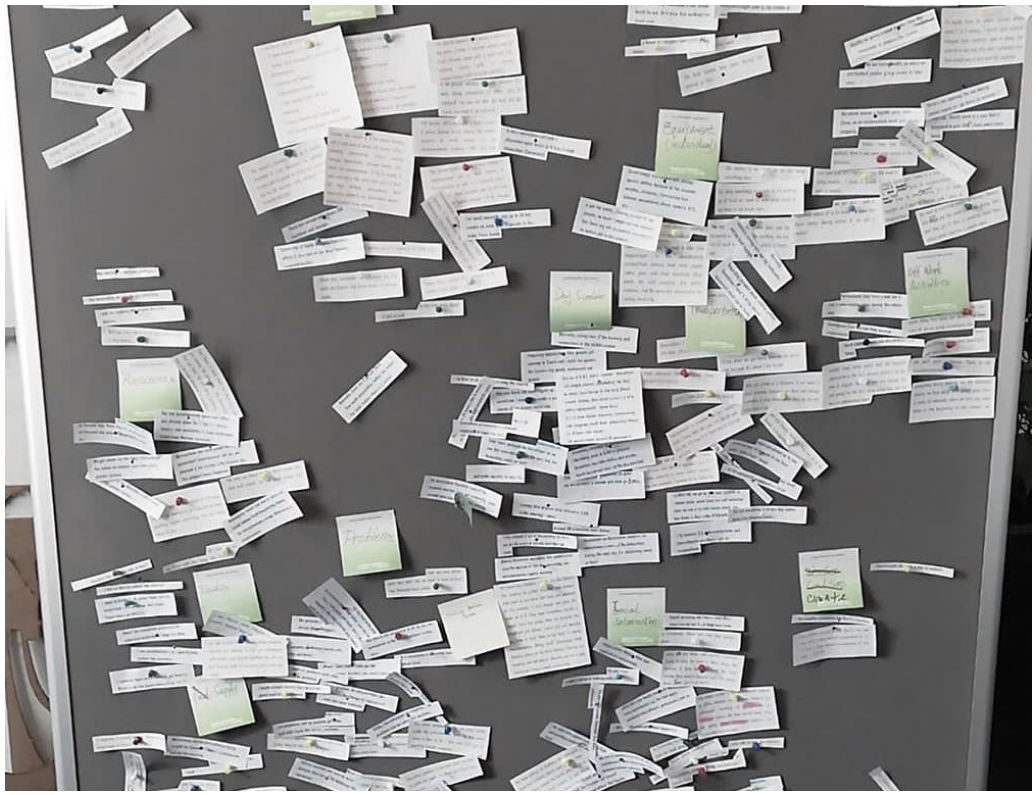


Figure 10: Affinity diagram initial problem formulation

2.3.2 Mind Mapping

A type of non-bullet point note-taking with a natural structure that radiates from the centre and use lines, symbols, words or colour. The centre represents a topic, and in the closest radius, there are key thoughts related to the topic, secondary, tertiary and so one branch represent streams of thoughts related to the original thoughts. Mind mapping advantages that we could put our ideas down in any order, as soon as they popped into head. We used this method to note down brainstorming outcomes, interviews, and completion of the affinity diagram.

2.4. Visual Thinking & boundary objects

Let's start with a premise, that relatively large part of our brain is dedicated to being able to process visions into information. Therefore, Visual Thinking is taking an important role in understanding problems and finding their solutions - seeing is the way how our brain starts to make a model of how the world works whether it means 2D sketch or 3D object.

2.4.1 Boundary Objects

Usage of Visual material presented above can be described as a notion of Boundary objects. As these objects were physically or throughout the interviews and discussions to represent discussed topics and concepts alignments, mainly during analyzing Svalbard's research structures, or mapping research activities. [Carlile, 2002] Boundary objects were also used during desk research and later analysis, including data-sheets for visitors of the stations, statistical charts, technical data representation to facilitate sharing of knowledge with actors.

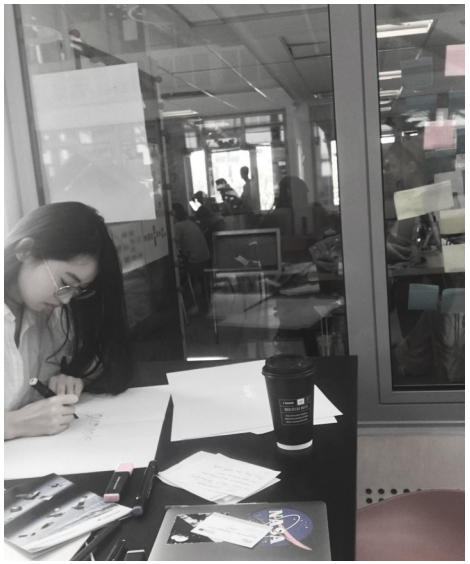


Figure 11: Visual thinking and boundary objects for interviews - left: Wenfang, right: Mari

2.4.2 Sketching

Any problem that we can think of we can articulate infinitely more through pictures; however, we are not talking about extremely complex pictures, preferably very simplified sketches because the creation of a simple picture can clarify a complex idea.

2.4.3 Blueprints

Blueprints are sketches or accurate drawings that visually communicate how something functions or is constructed. Such materials follow a strict conventions constitution help to ensure that the drawings are unambiguous. Different levels of tangibility also contribute to an easier cross-disciplinary understanding of shared information. During research on our case study, particularly the NOSTOC remote station and Josef Svoboda station in Longyearbyen our partners from Centre for Polar Ecology shared their technical drawing of these stations and they become essential for communicating ideas of engineering and moreover for understanding the practices within these spaces (see: 5.3 Facilities).

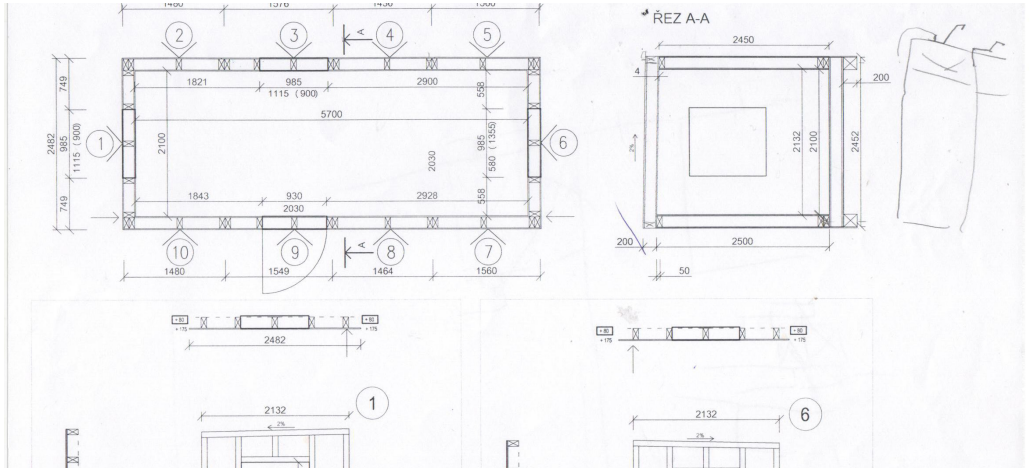


Figure 12: Blueprints of Nostoc station by Archeva, 2019

2.5. Design Methods

2.5.1 Design Specification

A design specification is a design engineering tool to concretize and assess design features. It has been used to determine the focal point of strategic steps in the last part of this paper.

This tool has been developed after Nigel Cross [2008], where the goal is to determine criteria and wishes for a product or concept to make arguments on whether or not to choose or continue developing the design. Where the criteria are imperative and must be met while wish is a way how to add more value to the concept, that would be nice to attend. This tool serves as a reference to the later created solutions.

2.5.2 Brainstorming

We have used various brainstorming techniques for data analysis. Brainstorming sessions were embedded in our project practice and used whenever a new project phase was approached to make the objectives crystal clear from the beginning. These sessions led to concepts that were used to create interest for researchers and other actors to participate in this project, other time to generate ideas addressing the issues that hinder the Sustainable strategy to be achievable or for sorting these ideas and excluded the least relevant of them.

Most of our structured interviews were based on the Stepladder Technique “Developed in 1992; this style of brainstorming encourages every member in the team to contribute individually before being influenced by everyone else.” [Wrike, 2017] With two trigger questions: What are we trying to find? And under what constraints are we operating? Followed by brainstorm so-called Starbursting, which “challenges the team to come up with as many questions as they can about your topic.” [Hansen, 2018] As a result of this approach, we have been able to incorporate previous knowledge and use our varied backgrounds to create comprehensive and straightforward guides for our qualitative interviews.

Figure 14: Unsplash by Miro, n.d.

3. Theoretical framing and Empirical literature analysis

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The objective of this chapter is to present our desk research, followed by empirical literature analysis. This chapter is divided into four sections, where the first one presents the reader a theoretical basis of Sustainability followed by Practice theory which represents the departure point to formulating current knowledge about sustainable research development in the Arctic and Svalbard in next section, which leads to the thorough description of Svalbard archipelago explaining its uniqueness.

This chapter is closely connected to the following one; Research infrastructure in Svalbard and main Case: Czech Research Arctic Station (see: chapter 5) as the analysis of the later chapters will derive on findings hereof.

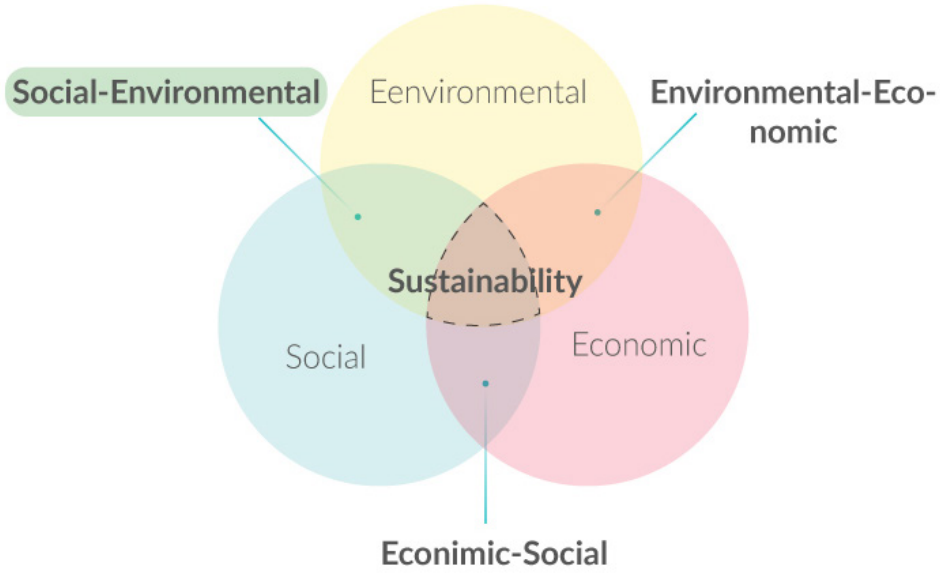


Figure 13: Sustainability and our focus area based on The Three Spheres of Sustainability (Peet & Watts, 1996)

3.1. Sustainable theories

Sustainability as a policy concept originates in the Brundtland Report of 1987. Sustainable development, in the Commission's words:

"...development that meets the needs of the present without compromising the ability of future generations to meet their own needs. ..." [Brundtland, 1987]

Over time, the concept has been re-interpreted as encompassing three dimensions, namely social, economic and environmental [Helming et al. 2008; Robert et al. 2005; Parris and Leiserowitz, 2005; Tracey and Anne, 2008]. The idea of sustainability having three dimensions stems from the Triple Bottom Line concept, coined by Elkington [Elkington, 1994]. Since that time, there have been two significant developments in the concept of sustainability: First, its interpretation in terms of three dimensions, which must be in harmony: social, economic and environmental. Second, the distinction between 'strong' and 'weak' sustainability. [Adams, 2006]

The IUCN Programme 2005-8, adopted in 2005, used the interlocking circles model to demonstrate that the three objectives need to be better integrated, with action to redress the balance between dimensions of sustainability. In this paper, we, as the designers are more focus on the Social - Environmental bearability.

Needed to point out that Sustainability is such an abstract concept that requires a specific framing whenever the Sustainable Development has been applied to a specific context. Although, previously presented understanding of sustainability set the basis for this paper.

Knowing, there are several ways to tackle sustainable issues, in this project we look at the problem from a practice point of view, which explained in the next sector.

3.2. Practice Theory

We assume that to create a more sustainable approach to conducting research, we need to figure out what defines everyday researchers practices. To provide insights and understanding of the current practices and provide framing to the practice from a user perspective.

The theory suggests that practice is a usual widespread activity, commonly shared within a given social world [Shove and Spurling, 2013]. "Methods for analysis aim to gain an understanding of existing practices in order to inform and inspire the design and find opportunities for change." Our goal within a practice theory is to identify areas of possible development that can create changes to the established practices. "Methods for design aim to generate possible less resource intensive reconfigurations of practices." [Kuijer, 2014, p. 49] This can help us understand what transitions towards sustainability might be involved, and how the transition towards sustainable research might be achieved.

Practices are identified by observing societal patterns of human behaviour. They shape the activities we humans carry out in our everyday life and create the basis for institutional and social structures. [Røpke & Christensen, 2013] Every actor who is performing practice can recognize it and also understand why they perform it in a particular way. However, as they are so deeply embedded in daily routines, an active awareness of performing them is not present, and these practices are automatized in particular social world, in our case the social world of researchers.

"Social practices form the historically shaped, concrete interaction points between, on the one hand, actors, with their lifestyles and routines, and on the other hand, modes of provision with their infrastructures of rules and resources, including norms and values." Verbeek and Mommaas [2008, p. 634]

Therefore, practices consist of groupings, element and multitudes of links which in theory are described as Meaning (images), Skills (competences) and Stuff (material), which are linked together. A change of one affects the other interconnected groups, therefore, Changing patterns of behaviour (groups of people) by addressing and changing materiality or Meaning or competences used within the practices. During our research, we concluded that a substantive part of changing researchers practices to more sustainable ones (in terms of lowering the environmental footprint) is their realization of their daily routines and more importantly what shapes them.

It is essential to understand the practice as an entity (a generalization of many specific performances) and as a performance (one specific performance) to see the difference between them and understand that there necessarily are not any chronological order to a social practice grouping and elements. The performance-driven understanding describes the practices as a more specific goal of the particular practice, and the practice-as-entity describes a practice with several groupings (performances) that can provide an entity to describe the consumption of the practice [Spurling, N. and McMeekin, A., 2013, p. 20-24].

The theory also offers an approach of how to understand and analyze social practices. Thus, We have used Practice theory as a tool for mapping entities coming in to play when research is conducted.

3.3. State-of-the-art: Sustainability in the Arctic context

Purpose of this section is to introduce the current knowledge of the Sustainability notion concerning the Arctic environment. We mainly focus on the explanation of the current knowledge about the problematic. To see where our project contribution can be valuable. Secondarily, we are mentioning theories and methods are used to address this notion in other papers.

3.3.1 Current understanding of the state of the Arctic

Sustainable development in the Arctic is based on understanding the fast-changing circumstance. For example, the social trends, together with projected changes in average and extreme air temperature and precipitation, sea temperature, sea level and snow and ice cover on land and at sea, play essential roles in shaping the future of the Arctic. These changes affect terrestrial, freshwater and marine ecosystems, peoples and societies. It is agreed that action needs to take at both local levels (adaptation to direct and indirect impacts) and national level (governance for adaptation to complex issues), and at the international level (cooperation on shared challenges) [AMAP, 2017]. It is suggested that at the local level, adaptation option (including adjustment to climate and its effects) and mitigation actions (including the essential mitigation of greenhouse gases) should proceed in parallel.

3.3.2 Basic Concept and the core feature of sustainability development

Build upon the necessary consensus, the long-term interactions of social-ecosystem has been addressed in the sustainable development in the Arctic, as stated in recent publications [Forbes et al., 2009; ICARP II, 2005c; ICARP II, 2005b, ICARP III, 2015; Kofinas, Chapin, & Love- craft, 2014; Petrov et al., 2016]. As reported by Petrovas through the Arctic-FROST network, sustainability in the development of the Arctic understood:

"as development that improves health, human development and well-being of Arctic communities and people while conserving ecosystem structures, functions and resources' [2014, p.14]."

Today, the core feature of the sustainability science and sustainable development research in the Arctic is identified in the ICARP III [2015]. Apart from the abovementioned point that the primary unit of analysis is the long-term interactions of the social-ecological system, another feature is the sustainability issues are 'wicked problems' associated with non-linear processes, changes and transformations. Additionally, arctic sustainability research is problem-focused and addressing 'grand challenges', such as climate change, well-being and economic development, co-management and governance.

3.3.3 Identified gaps and agenda

There are several general gaps based on Arctic researches identified by sustainable reports [Petrov et al., 2016, pg. 172] . A general gap in Sustainable Research is the 'limited connectivity between conceptual work and action research'. Present sustainable research is not capable of instructing and setting up the action, even though the development in action research in recent studies. Additionally, regarding sustainable research in the Arctic, a noticeable gap is the lack of regional-specific information on sustainability issues for different social groupings. The non-traditional urban contexts not fully considered regarding sustainable issues [Petrov et al., 2016; AMAP, 2017]. Moreover, most of the Arctic sustainability Literature cope with the problem of indigenous communities and societies[Petrov et al., 2016]. However, in many Arctic regions, especially in Svalbard, the majority of the population is non-indigenous. More knowledge is also needed about the non-indigenous communities, for example, researchers, tourists [AMAP, 2017].

3.3.4 Arctic Monitoring and Assessment Programme - for Barents Area

In the new agenda for the future Arctic sustainability research is listed the need for determining actionable research directions to support the sustainable development of non-indigenous social groupings [Petrov et al., 2016]. To produce information to assist local decision-makers and stakeholders in developing adaptation and mitigation. Also, to provide tools and strategies for advanced dealing with climate change and other pertinent environmental stressors. Arctic Monitoring and Assessment Programme (AMAP), which is a working group under the Arctic Council, divided the Arctic area into three pilot study regions in the Adaptation Actions for a Changing Arctic(AACA) project:

- The Baffin Bay/Davis Strait Region
- Barents Area(includes the Svalbard archipelago the northern parts of - Finland, Norway, Sweden and North-western part of Russia)
- Bering-Chukchi-Beaufort region (includes the Chukotka Autonomous Okrug in Russia, northern parts of Alaska and western Canada and adjacent marine areas).

As reported in the AACA Barents Area overview report, general societal, environmental, economic trends and strategic suggestion are put efforts into, while there is less information that is specific to Svalbard, which is very different society from the other parts of northern countries. (see chapter: 3.4.3 Svalbard Uniqueness)

3.3.5 Svalbard - 'A research focus'

In terms of sustainable development of Svalbard, protecting the local distinctive nature wilderness and maintaining the peace and stability in the area has been the constants in Norwegian Svalbard policy [Norwegian Ministry of Justice and Public Security, 2016]. As reported in the white paper, based on its internationally significant natural and cultural heritage, Svalbard shall be one of the world's best-managed wilderness areas, so that meet the need for reference areas for climate and environmental research [Norwegian Ministries, 2018]. It is agreed that it is crucial to successfully develop Svalbard as a world-class scientific hub, using the archipelago's available resources and natural strengths to best advantage.

However, at the same time the high level of interest puts pressure on vulnerable areas in nature, creating a need for more precise coordination of research activity in Svalbard, in other words, there is a need to minimize the environmental footprint in terms of the increasing research activities [Norwegian Ministry of Justice and Public Security, 2016]. The local government has the desire to facilitate the continued advancement of best practice in research activities in Svalbard. Work to ensure that research and higher education in Svalbard develop in a forward-looking, sustainable manner [Norwegian Ministries, 2018]. The objective is for this to happen following Norwegian research policy, which emphasizes international research and infrastructure cooperation and on open access to data and publications.

The Norwegian Ministry of Education and Research in Svalbard identified the principle for the future development of research activities.

- The first principle is to use established communities and research stations. For example, activities in protected areas of the archipelago should generally be limited to what cannot be done elsewhere.
- Other suggestion is to share project information and coordinating field activity. The Government expects everyone to register and share information about projects and field activities, and that they use such information as a basis for coordinating field activities and improving the utilisation of field equipment and research vessels. This is done through active use of the Research in Svalbard (RiS) database will introduce later).

In conclusion, under the pressure of rapid social-environmental changing in the Arctic, the growing interests of research in Svalbard had drawn attention. The research community has realized the research activities should be conducted in a sustainable manner, which means a smaller environmental footprint regarding research practices. Also, for the future development of research activities, the idea of sharing data and better coordination between research projects is encouraged.

3.4. Svalbard Archipelago

In this section, we present a closer look at the island to understand how Svalbard becomes a centre for the international research community and how it has a historical influence on the research infrastructure and highlighting its environmental-social uniqueness since it is very different from what we familiar.

Svalbard, north most habitat in the Arctic Ocean, is an archipelago with a rich and complex past. “Svalbard” means “cold coasts”; however, the archipelago has a relatively mild climate compared to other areas at the same latitude. It’s known for its rugged, remote terrain of glaciers and frozen tundra, polar bears, Svalbard reindeer and Arctic foxes. This draws constant attention of travellers all around the globe. Although Svalbard is recognized as “Sustainable Destination” [Visit Svalbard, 2019], the increasing yearly number of visitors is inevitably affecting the increase of emissions. Taking, the most common way to travel to Svalbard is by plane, to the administrative centre and largest settlement of the islands, Longyearbyen. (see chapter 8: Discussion)

Nevertheless, the most well-known “Global Seed Vault” located here, shows archipelago is valued for its geographical location and resources. Since it’s discovery, Svalbard plays a significant role in scientific research. [Sysselmannen | A, 2012]

3.4.1 History

Svalbard archipelago is unincorporated area, which means that is not part of Norwegian country, but a governor appointed by Norway runs it. It was determined by The Svalbard Treaty effective since 14 August 1925. “The Svalbard Treaty recognises Norwegian sovereignty over Svalbard, including Bjørnøya (Bear Island), and that Norwegian law applies within the archipelago. The treaty also provides certain rights for the other signatories, including that their citizens may reside and engage in business activities, hunting and fishing in the archipelago.” [Visit Svalbard, 2019]

Figure 15: Svalbard Archipelago - research settlements by Halatova & Geng, 2019

The hunting eras

In 1600-1700, Svalbard wwitnessed a large number of whales caught, approximately 1250 whales in a year. The bowhead whale was eventually annihilated throughout the area around Svalbard. The reminds of whale-hunters buildings are still present.

After the annihilation of some whales species, the hunters turned to inland animals (reindeer, seal, fowl and collecting eggs). New setup hunting-stations were able to open all year-round, which means they were able to hunt more. This era lasted 150 years, resulting in over 70 stations left.

Around 1850 The Norwegians had the same interests in the products as Russian but developed a cyclic schedule. For example, they hunt polar bear in the winter, birds in the summer, reindeer in the autumn. The hunters spread in the area; their tools were developed, which Seriously threatened the polar bear population.

The mining Era

Extraction of minerals and coal stirred much interest from the start of the twentieth century. The first and only uninterrupted deposit was coal. However, Svalbard experienced several other mining periods of sulphur, gold, zinc, lead, copper, and marble. Mining companies draw attention to the fact that Svalbard Archipelago was a NO-MAN-LAND which created chaos and tensions among mining stakeholders. Although Svalbard belongs to the Kingdom of Norway, two settlements in the archipelago are mostly populated by Russians and Ukrainians based on Svalbard treaty. Extraction of minerals changed the landscape relief and its characteristic around the colonies. [Svalbarði, 2019] “Mining is the only commercial activity that has survived for more than a hundred years. It formed the basis for permanent settlements in Longyearbyen, Sveagruva, Pyramiden, Barentsburg and Ny-Ålesund.” [Sysselmannen | B, 2012]

Research and expeditions era (1850 - NOW)

As more people were coming to Svalbard, they informally chartered the geography, mainly for their purposes. Together with Norwegian hunters a series of professionally organized expeditions with a scientific purpose were held. In the times Svalbard archipelago lied on the border of the known world. Therefore the number of the expedition was increasing every year, and academic circles valued the findings. Teams studied a variety of phenomena from geography, geology, botanic to ocean currents, northern lights and glaciers. The collected knowledge shed new light on climate and other global issues. The year 1882 becomes the first international Polar year, during this year several scientific measurements were conducted, for example during winter a Swedish expedition measured the latitude and tried to determine the exact Earth’s shape based on this data.

Later on, the focus moved even far, and Svalbard becomes a starting point for expedition reaching the North Pole. “Roald Amundsen, too, and the Italian Umberto Nobile flew from Svalbard towards the North Pole. In 1926, they flew together, crossing the North Pole in the airship Norge. They had left from Ny-Ålesund, and the mast to which the airship had been moored still stands there.” Nonetheless, the expeditions were scientifically important; there were planned as a matter of National and personal Prestige.

3.4.2 Svalbard as an example of the changing Arctic

Svalbard is experiencing the rapid environmental changes as other areas in the Arctic. From 1954 to 2003, Barents area, where Svalbard is located in, has experienced an average of 1-2 temperature increase. During winter the warming is even stronger. According to RCP4.5, a mid-range scenario for emission growth, a 3-10° rise in average temperature would happen during 2010-2080[AMAP, 2017]. The warming temperature and thereby decrease in sea ice are predicted to cause an increase in precipitation. In the Arctic, it is forecast to increase up to 50 per cent precipitation with more rain than snow.

Moreover, the rise in rainfall is likely to be more extreme and harder to predict, for example, heavy rain, rain-on-snow events, flooding. [AMAP, 2017]

The changes are far more complex than just rising temperature and changing patterns of precipitation.

As a consequence of these changes, permafrost is predicted to reduce the extent and depth. Sea ice melt leads to ocean temperature, salinity and density structure change,

and Local food webs will be influenced. This process is extra visible Species, like Polar bear, relying on sea ice will be affected negatively [AMAP, 2017]. These changes will have profound and ripple effects for the rest of the world regarding ecosystems and human societies. [Pedersen et al., 2015]

These changes are happening in the whole Arctic, and Svalbard is a powerful example for exploring this rapid changes Not only because "climatically, but the region is also heavily influenced by its proximity to the sea and its high latitude. The North Atlantic Current (a northern branch of the Gulf Stream) makes the entire Barents area far warmer than comparable areas at similar latitudes, but parts of the region still possess glaciers, permafrost and environmental features typical of the Arctic." However, also, "it is experiencing environmental change driven by increasing human activity, in parallel with changes in socio-economic systems driven by a range of environmental, political, societal and cultural conditions." [AMAP | Barents sea, 2017, p. 9] At Svalbard interlinkages within a unique historically embedded research activity and above presented many complex environmental and societal changes, represents a different example for Sustainable Research Development.

3.4.3 Svalbard Uniqueness

Following section is mapping out the uniqueness of the local environment and society, the Svalbard archipelago is different in many aspects from the healthy society we are familiar with. Our study is based on research stations and research practices. Therefore the diagram [see: Figure 16] could help us visualize the local living conditions, and remind us - to not take things for granted from our experience' and the uniqueness of the polar region during the project going.

Many projects dealing with the extreme environment are conducted by researchers, designers or engineers from usual-climatic zones, and what more, from cities which pose a completely different environment and challenges from the polar areas. Many of these projects failed due to lack of knowledge of local conditions. For example, according to Tove Landing, an Associate Professor at DTU Civil Engineering [Appendix | Specialist discussion Tove #0425, 2019] speaking about housing design in Greenland, Architects and Engineers made new design houses with large format windows, which

Figure 16: The six categories regarding non-traditional society and environmental aspect by Halatova & Geng, 2019

is popular and welcomed in Europe and even all around the world due to accessible view to beautiful surroundings. However, it turned out as a big mistake for the project in Arctic conditions. For a few reasons, firstly because the house would be 'heated' by the sun 24 hours a day in the summer, which would result in indoor temperature would be too high to stay. Secondly, because during rainy seasons when combined with the strong wind, the angle of rain-drops can reach more than 90°, which means that it is horizontally raining, so the building needs to be protected and sealed. These new highly effective windows are not providing enough ventilation, and therefore, a building needs to have another ventilation opening which contradicts with the need for rain and when freezing frost protection. From the interview with Tove Landing, we have developed a relatively unobstructed view of the need to emphasize that the professionals who will in the future be in charge of design, development, or construction in extreme conditions. Become thoroughly familiar with the conditions of the site and surrounding area.

Moreover, they become aware of all the needs of people using the infrastructure so that their design would not represent an increase in environmental footprint while being used. On the contrary, it should also allow future sustainable infrastructure development and anticipate developments in emission-reducing technologies and practices. Therefore, with the following text, we would like to, in the readers' minds, draw an image of Svalbard conditions and express the specifics of living and doing research.

Based on our research, we summarized six categories regarding non-traditional society and environmental aspect:

- Extreme weather
- Nature environment
- Arctic Circle seasons (midnight sun, and polar night)
- Climate Change
- Social Worlds
- Settlement
- These categories are divided into the six sectors simply because they are the most necessary feature to point out for our project. The principle is they are not separated, instead, they have a strong relation between each other and all co-influence the development.

ENVIRONMENTAL:

Extreme weather

The local weather is characterized by strong wind and coldness. Svalbard is where cold polar air from the north and mild, wet sea air from the south meet, creating a low pressure, changeable weather and strong winds, particularly in winter. If we look at the coldness then it is influencing the already existing structures (wooden foundations of vernacular buildings - are weakened by moisture from thawing permafrost [Flyen, 2018], for new build, and generally all the buildings moisture and coldness represents design and technical challenge which depending on the technology leaves more or less environmental impact.

Although Svalbard is most of the year covered by ice and snow and the main transport is a snowmobile, to extreme weather, it is classified as a desert. The cold temperatures and low humidity (it is dry as it would be in a 'hot' dessert) and rocky ground, it can be classified as 'Arctic desert'. [Nikel, 2019]

Natural environment

The island is generally known as a place where "no one is allowed to die", which is not entirely accurate and it had happened in past that people die there (often due to encounter with wild animals when not following rules). Although there are strict rules to protect the local environment and treating it as a vulnerable one. [Norwegian Ministries, 2018, p. 4] Burials are not possible, because of the permafrost causing that bodies simply won't decompose, and bodies would be attracting animals, which causes a threat not only for people living there but with a rising number of inhabitants also a potential threat to the animals (mainly due to diseases and microbes spreading). However, there is a small cemetery, as a reminder of past times.

In some parts of the Arctic, the flora is protected by law, in others not. However, Association of Arctic Expedition Cruise Operators regards all flora on Svalbard as protected and without special research permission one is not allowed not to pick flowers or other plants, this also applies to step on flower beds. [Visit Svalbard, 2019]

Polar bears are potentially dangerous animals but also vulnerable. Although each expedition or a group must have a guide with a rifle, it is of the utmost importance that a direct polar bear encounter is avoided. If a polar bear is killed, a thorough investigation is held, and usually, there is a fault on the side of the group members. [Appendix | Interview Oleg #0228, 2019]

Due to nature protection, any Svalbard settlement has very strictly restricted development areas. Together with arctic environment results in a not far future problem of providing housing to new inhabitants (which in many cases they are scientists). Recently a Longyearbyen town lost 10% of the housing capacity due to sudden avalanche (caused by rising average temperature) which resulted in need of building new housing facilities. [Appendix |interview Karoline #0414, 2019] If a new facility is being built, it needs to be approved by the Sysselmannen (Governor of Svalbard, under Norwegian administration). Regarding remote stations and generally all new buildings, the rules are quite detailed. For an example when the remote station NOSTOC [see chapter 5: Main case and project partners] built the architectonic company had to not only fulfil the dimensional, footage, climate conditions but also the specific exterior colour in order to lower the interference with the environment.

Climate change

Svalbard is warmer than other Arctic region, due to the warming influence of ocean currents and prevailing winds, through lies in the higher latitude. And the Barents sea is forecasted to become the first Arctic region without sea ice covered all year round by 2050s [AMAP,2017]. Consequently, permafrost temperature in Svalbard also warmer, which supposed to decrease with latitude increase [Romanovsky et al.,2010; Sato et al.,2014]. As the growing temperature, permafrost has started to thew since the 1990s [AMAP,2017]. On sea results in opening new shipping routes and consequently increased the number of tourists leads to increased emissions (carbon dioxide (CO2) and black carbon (BC, soot)) [Jenssen, 2010], while on ground thawing causes structural stability of buildings, avalanches and unstable environment for local animals. [Flyen, 2018]

Arctic Circle seasons (midnight sun, and polar night)

Svalbard located in the polar circle, most of a year would be a perpetual day (summer) or night (winter), caused by astronomical processes of Earth's tilted axis rotation. [Brázdil, 2013] Svalbard starts to emerge from the winter darkness in March when there is a daily average of 3.17 hours of daylight.

The summer season starts from June to September. The 24 hours light has a considerable influence on people's lives, so it is essential to keep the regime for people lives there, and the same for winters when there is no light 24 hours.

Seasons also result in population number changes. During summer, apart from tourists, many researchers, students, are coming to the island and the population doubles.

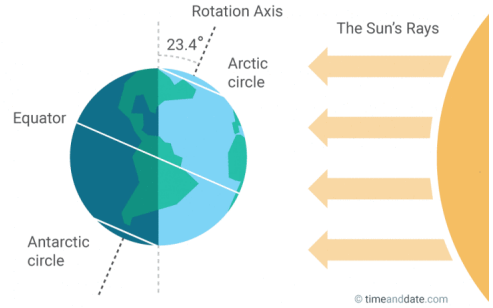
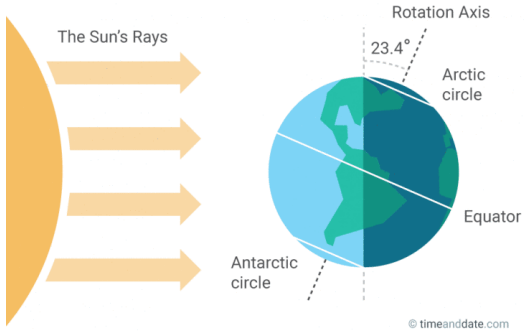


Figure 17: Arctic June solstice Midnight sun in summer by Timeanddate, 2019

Figure 18: Arctic December solstice polar night in winter by Timeanddate, 2019



NON-TRADITIONAL SOCIETY:

Settlement

Svalbard is sparsely populated, and the local settlement is dispersed. The most significant settlement is Longyearbyen local communities will be introduced detailed in later [see chapter 4: research infrastructure in Svalbard]. There are few other settlements which are permanently inhabited by few, counted on one hand. However, from historical (Pyramiden) and climatic reasons, these are not permanent inhabitants, but they take turns in having a "watch" over the place. Nobody who lives on Svalbard shall be unemployed, and most of the people are living there by few years contracts and then returning to the mainland. Mainly due to the strict rules of protecting the local environment:

- Based on its internationally significant natural and cultural heritage, Svalbard shall be one of the world's best-managed wilderness areas.
- There shall be large and mostly pristine nature areas in Svalbard that meet the need for reference areas for climate and environmental research.
- The extent of wilderness areas shall be maintained.
- The possibility to experience Svalbard's natural environment undisturbed by motorised traffic and noise shall be ensured, including areas that are easily accessible from the inhabited locations.
- [Norwegian Ministry of Justice and Public Security, 2016]

These settlements represent a limited livable space, and therefore the development of the communities is also limited. There is a very low possibility to expand the settlements, for the sake of the local environment. As a result, live space per person is much smaller than that in the mid-latitude area. These conditions are also reflected in the social distribution of the population, which is very specific.

Social Groups

Svalbard is an international territory with no Indigenous habitats. A governor appointed by Norway runs it but still shared by the world to some extent, especially in terms of scientific research.

A woman should not give birth on Svalbard. When a pregnant woman has 3 weeks remaining before her due date, she travels to the mainland (Norway) to give birth, because a hospital in Longyearbyen is tiny and not equipped to provide suitable facilities for births. Nonetheless, there are plenty of children living in Longyearbyen. The unique thing about children presence is that they occur only in Longyearbyen. As it is also the only town with facilities supporting family life, Longyearbyen is a representation of the only settlement with mixed social groups, and it is the settlement closest to the social conditions we as Central Europe are familiar with.

Since 1859, Svalbard has witnessed research activities from different countries implementing throughout the archipelago and nearby sea area. The archipelago is valued for science researches for various reasons. Specifically, its unique geographic location and natural environment providing an outstanding opportunity for monitoring and analyzing climate, environment, space and Arctic Ocean [Norwegian Ministries, 2018]. These research activities lead to a change in the local settlement. Among 2000 residents in Longyearbyen, half of them are researchers or research activities related.

To conclude, it Is a Challenging Master Thesis project due to such uniqueness and complexity, but all the more meaningful due to:

- Svalbard is a strong example for exploring strategies deal with these rapid environmental changes,
- moreover, for pioneering relevant knowledge regarding conducting researches in a sustainable way with a local focus.

Figure 19: The map of 277 active fieldwork locations today (Research in Svalbard database, 2019)

4. Research infrastructure in Svalbard

77.8750° N, 20.9752° E

Purpose of this chapter is to clarify how research is structured at the archipelago in regards to the vital infrastructure and administrative management.

As mentioned above, increasing research activities are happening here. In 2015 alone, more than 500 researchers from close to 30 different nations are listed with active projects (RiS) in Svalbard. The research activities mostly take places in the four permanently manned research communities in the archipelago, which are Ny-Ålesund, Longyearbyen, Hornsund and Barentsburg.

INFRASTRUCTURE

in this context is understood as: the basic physical and organizational structures and facilities (e.g., buildings, access points and power supplies) needed for the operation of a society or enterprise.

4.1. Research communities

In Svalbard, the research community consists of permanently manned research settlements and remote field stations. There are in total of four long-term research settlements, namely, Ny-Ålesund, Longyearbyen, Hornsund and Baretsburg [shown in the Figure 15. Among them, Longyearbyen is the biggest town with residents other than researchers; Ny-Ålesund is a research-focused town; only research activities are allowed. These two are the main communities with a complex international feature, which will introduce later. The other two are Russian and Polish settlements with few permanent stuff. Barentsburg is a hub for Russian research and monitoring programs in Svalbard, and it is run by Arktikugol, which is a Russian coal mining company; Polish Academy of Sciences has permanently manned the Hornsund station with a permanent staff of 11.

Additionally, Field research takes place across entire Svalbard, from Vesle Tavleøya in the north to Bjørnøya in the south, from Prins Karls Forland in the west to Kvitøya in the east, as well as in the surrounding waters.

4.2. Longyearbyen - a town with mixed social groups and practices

Longyearbyen is the administrative centre of Svalbard, which hosts the two most prominent research institutions in Svalbard; The University Center in Svalbard (UNIS) and the Norwegian Polar Institute. Also, a place of an important organisation that managing the research activities, the Svalbard Science Center.

“The majority of researchers resident in Svalbard live in Longyearbyen. Longyearbyen also hosts the widest variety of scientific activities and disciplines in the archipelago – from basic to applied research, from biology to Arctic technology. Much of the activity in Longyearbyen is related to field studies in surrounding areas and the use of nearby research infrastructure.” [Norwegian Ministries, 2018, p. 4] The EISCAT Svalbard Radar, run by an institution from China, Finland, Japan, Norway, Sweden and the United Kingdom, is located on the outskirts of Longyearbyen[Svalbard Science Forum, 2019].

Although there is no statistic of people living permanently in Longyearbyen given that the - permanency is understood as several years stays and counted according to permanent addresses Statistic that in the year of 2018 there are 2258 inhabitants registered in Longyearbyen and Ny Ålesund. Based on the industry statistic, the proportion of research days and projects, we can say that half of the inhabitants are research related. [Ssb.no, 2019]

Longyearbyen is a dynamic and influential centre for research, higher education, science communication and information.

Figure 20: Longyearbyen features (source: Visit Svalbard), n.d.

4.3. Ny Ålesund as a research town

In Ny-Ålesund, Kings Bay AS, a government enterprise owned by the Norwegian, plays an essential role in the international research community. Apart from the cruise passengers, Ny-Ålesund is not open to the general public, which makes it the northernmost Research town in the world. As a landowner and manager, Kings Bay AS hosts researchers from Asia, Europe and North America by offering research facilities and logistics services. In addition, there are 14 permanent stations in Ny-Ålesund, and research institutions manage them from 10 different countries. [Kings Bay AS, n.d.] The population consists of between 30 and 35 people throughout the year, with an increase in the summer to about 120 people.[Ssb.no, 2019]

The whole town infrastructure serves the purpose of Researchers. This gives a unique opportunity to all the researchers coming from different backgrounds to have close interaction.

Figure 21: Research town by Harvey Barrison, (source: Flickr: Ny-Ålesund_2013 06), 2013)07_3603

4.4. Remote Stations

A significant share of all research projects originates in stations located inside the four permanently manned research communities. However, field research, takes place across entire Svalbard from the south to North, from the West to East and the nearby sea area. [Research in Svalbard Database, 2019]

Most of the researchers' habitats for remote work are either tents or repurposed old hunting huts (identified as Research Huts). The newly built "container" alike stations, appeared in the last 15 years, (identified as Remote Research Stations). Even though the general approach to remote stations/cabins is rigorous. For example, an application for permission to establish a new, permanent base near old Polish hut was turned down. "To protect the wilderness character of the area and because it is a general policy that science shall mainly be carried out from existing infrastructure." [Strange, 2011]

This system has two implications:

- First very relevant for our research is the approach of general policy which give us a clear clue - the focus of Sustainably conducted Research in Svalbard needs to be within already established infrastructures, they hold the key research activities
- Second is more of a question - if the number of the research project and interest in Svalbard rising, how the Norwegian Government will stand to the issue of housing and other research capacities in the already established settlements which are reaching saturation.

4.5. Svalbard Science Forum (SSF)

In 1998 the Norwegian authorities set up the Svalbard Science Forum to increase cooperation, coordination and information sharing between all the research sites in Svalbard (Longyearbyen, Ny-Ålesund, Barentsburg and Hornsund) as well as to strengthen cooperation between individual researchers and research institutions in Svalbard, both Norwegian and international. The Norwegian Research Council heads Svalbard Science Forum and operates the Secretariat. The Secretariat administers schemes to support cooperation in research and fieldwork, with both Norwegian and international actors eligible to apply. The support schemes have been essential to the establishment of joint flagship research topics in Ny-Ålesund and the Kongsfjord area. [Norwegian Ministries, 2018, p. 4]

Since research activities are characterized as international. Duplication and country barriers automatically occur. Svalbard Science Forum is set up in order to achieve better coordination of research activities in Svalbard, thus encourage smaller CO2 footprint from research in Svalbard. Svalbard Science Forum aims to provide integrated and easily accessible information about research currently ongoing in Svalbard, and to expand and strengthen collaboration between individual researchers and research institutions-both Norwegian and foreign - that are involved in research activities in Svalbard." Moreover, to "make it easier for Norwegian and foreign researchers and research institutions to obtain the support and guidance they need concerning the infrastructure and services available to researchers in Svalbard."[Forskningsradet.no, 2019]

All research projects that need to be carried out in Svalbard should register in a research portal called Research in Svalbard(RiS)as required from Svalbard Science Forum. By doing so, RiS could help researchers gain an overview of all current ongoing project throughout, providing open access to all relevant information in one place. It helps coordination and cooperation among the researches activities in Svalbard.

The previously mentioned white paper, Report No. 22 (2008-2009) to the storing Svalbard; signalled a stronger coordinating role for the Svalbard Science Forum. It is composed of the key national and international research actors in Svalbard, with representation by the four research locations: Longyearbyen, Ny-Ålesund, Barentsburg and Hornsund

Research in Svalbard (RiS) database

The Svalbard Science Forum secretariat is also responsible for the Research in Svalbard (RiS) database, a portal for registering all types of research projects in Svalbard and surrounding marine areas. [Research In Svalbard.no, n.d.] It offers a possibility for the researchers to register their project topic, the time range and area where this research will take place. Once an organization is registered, it also has the opportunity to see other projects if they wanted to network. RiS also provides an overview of publications and open data to the researchers. However, this project registration is not mandatory. Thus, there does not exist a complete overview of projects and number of researchers operating on Svalbard.

RiS is also a tool used for ordering services in Ny-Ålesund from Kings Bay AS, as well as applying for permits to research in parks and reporting on them to the Governor of Svalbard. In this case, registration at RiS database is mandatory.

Figure 22: Research in Svalbard (RiS) database by SSF, 2019

4.5.1 Evaluation of existing system and support provision

By interviews from the opposite side of this research community, the researchers themselves, we got information about the problems the Czech Research Stations are facing. The problems are more practical than presented in literature regarding the need for action, regarding daily routines of exact steps and usage of resources. More importantly, we look at research activities as group practice.

Since research activities in Svalbard are characterized as international, duplication and country barriers automatically could occur. Svalbard Science Forum is set up in order to achieve better coordination of research activities in Svalbard, thus encourage smaller CO2 footprint from research in Svalbard. As Svalbard Science Forum claims they aim to "provide integrated and easily accessible information about research currently ongoing in Svalbard and to expand and strengthen collaboration between individual researchers and research institutions-both Norwegian and foreign - that are involved in research activities in Svalbard." Thus to encourage a smaller CO2 footprint of research activities [SSF, 2019].

However, staff from Svalbard Science Forum, their role is simply facilitators who help and suggest researchers research in a more 'sustainable' way, which is sharing data so far. Karoline Bælum, the Senior Adviser from Svalbard Science Forum, stated: "It is tough to measure the impact or research activities at Svalbard. …. We at Svalbard Science Forum are not researchers, we are just trying to make them cooperate with each other. …" When it comes to the statement of lowering CO2 footprints caused by research, there is no framework either system at hand to the researchers to help them with achieving the goal. Moreover, even though the Svalbard Science Forum is trying to encourage environmental/sustainable awareness, we have can say that they are missing a clear idea of what the real goal is. "Nobody knows what sustainability is. We cannot define it. It is hard to measure how it works. … Is it true that the building can affect the environment?" [Appendix |Interview Karoline #0414, 2019]

We have concluded, Svalbard Science Forum does not have the power forcing researchers to do as they suggested, researchers do their work depend on their own. Plus, they do not know how research activities affect the environment. So, in fact, could not provide a convincing sustainable suggestion for researchers. How they define a sustainable future of research communities remain unanswered.

Figure 23: Logo by Centre for Polar Ecology, n.d. (source: Facebook page)

5. Main case and project partners

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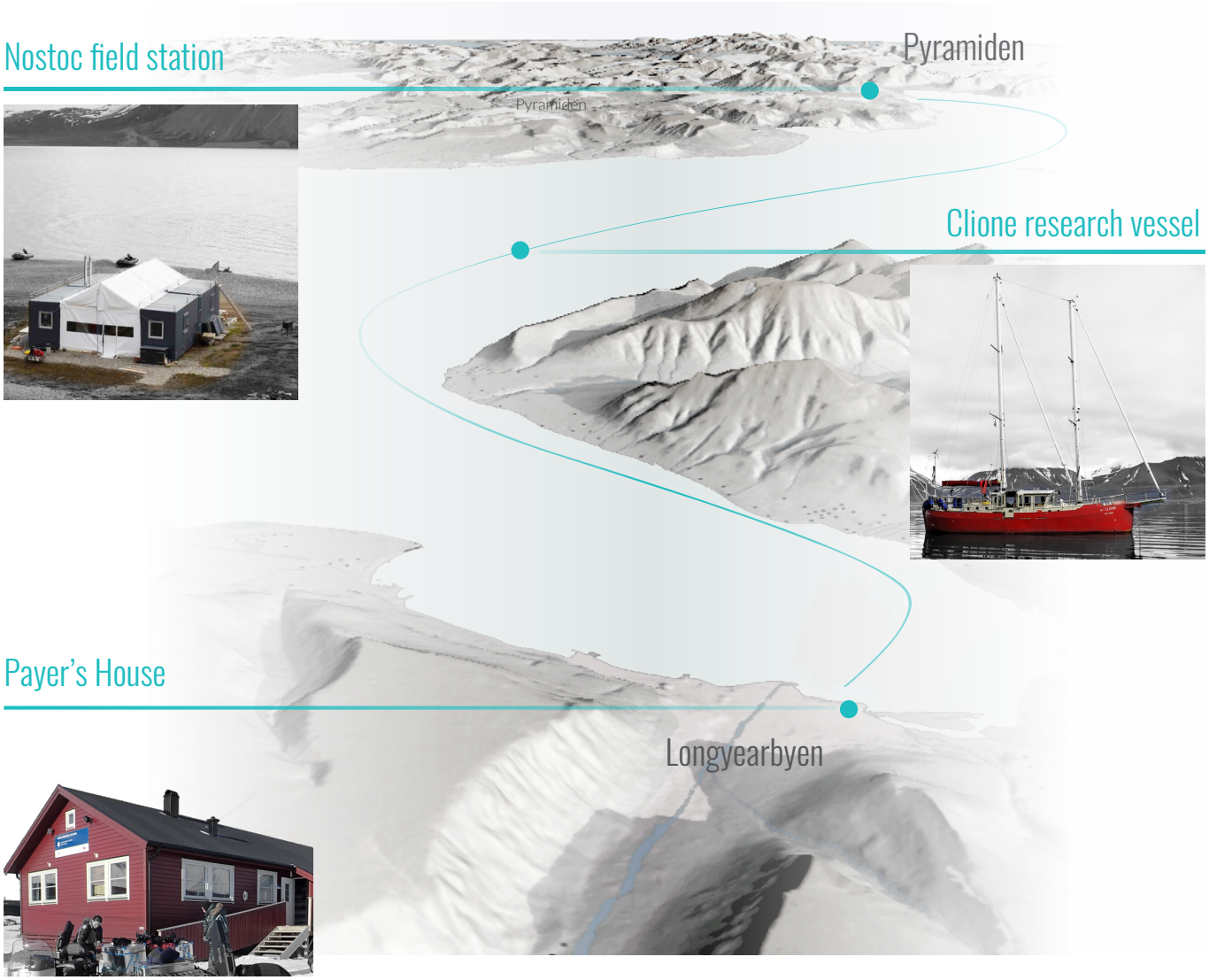
Purpose of this chapter is to introduce our main case study, projects partners with a local focus on the conditions of the stations (both in town and remote), research practices and problems presented from researchers' point of view. The lack of literature localized on knowledge of Research in Svalbard leads this project to a more local focus. The designers, aiming at designing for regional research groups. So we took a closer look at the problem with the specific station as a case study to see what are the real issues. Several stations were contacted at the beginning of the project, such as Josef Svoboda Arctic infrastructure (CARS) under Centre for Polar Ecology (Czech Republic), Yellow River Station (China), Petuniabukta station Adam Mickiewicz University(Poland), Sverdrup Research Station.

As one of the group members is from Czech, the Czech station showed great interest to help with the project. Although the other group member is from China, the Chinese station was reluctant to reply; there were several stages of official permissions which the designers had to obtain to be allowed to reach the information (required for the project) of the station. Moreover, it is not convenient to contact by voice or video call with the office. As a result, the non-classified information we could obtain about this station is minimal. Except for the Czech and Chinese station, we contacted other stations to geographically expand (Greenland) to do an extensive analysis of sustainability issues regarding research practice. Unfortunately, the other stations do not cooperate enough for us carrying out the project, and the further the project goes, the more reasonable a local focus approach. Therefore, in this project, case study mostly based on Josef Svoboda infrastructure and information from Polish station.

5.1. Centre for Polar Ecology and it's Czech Arctic Research Infrastructure

Figure 24: Operation of the Josef Svoboda station research infrastructure by Halatova & Geng, 2019



The Centre for Polar ecology aims to promote and facilitate research and education in polar ecological sciences at the Faculty of Science, the University of South Bohemia in Ceské Budejovice. It also represents the scientific community of the Czech in the International Arctic Science Committee. Besides, the Centre for Polar Ecology offers several courses related to polar ecology. When part of the education is fieldwork which takes place on the Josef Svoboda research station in Svalbard. [Prf.jcu.cz., 2019] The Infrastructure was named after Czech-Canadian Arctic plant-ecologist, Josef Svoboda, professor emeritus of University of Toronto and is also reffered to as Czech Arctic Research Stations.

The Josef Svoboda research station is located in the central part of Svalbard and consists of three units:

- Payer's House Longyearbyen
- Field station Nostoc
- Research vessel Clionew

5.2. History of the buildings

In this section, we give the word mainly to the researchers, to explain to the reader how the station infrastructure evolved since the first idea? Also, to show the complex situations steering initially Sustainable ideas towards less sustainable ones. Mainly because of a lack of international political support and secondly due to funding restrictions.

As introduced by Nikola Sagapova, Faculty of Economics, the University of South Bohemia in Ceské Budejovice: "The primary reason why the Czech Republic wants to have their own research station is it is cheaper to own one then renting accommodation from Norway."

Back in the time 2008, Centre for Polar Ecology (CPE)was planning to build their own research station in Svalbard, based on a recommendation from Svalbard Science Forum, Funded by the Czech Ministry of Education. The Norwegian ministry of trade and industry proposed to the Centre for Polar Ecology to develop a plan for passive research station, with maximum use of renewable resources, this new project should be partially funded from Kings Bay company operating and owning most of the infrastructure in Ny-Alesund. However, Kings Bay company added to the initial project a huge lecture hall for 100 people, which was out of the Czech Funding possibilities. However, this was a possibility to overcome if there was no second problem. "Also, the initial plan to have a station in Ny-Ålesund had to been stopped, because the procedure of direct choosing a construction company from Norwegian part was not legitimate to Czech Republic laws, which require to have an open competition when funding of the station construction." [Appendix |Interview Nikola # 0312, 2019] Therefore, the project for passive research station had to be cancelled.

As a result, instead of building a new station, Czech Researchers had to buy a family house in Longyearbyen to serve as a station. This solution posed several challenges the Centre for Polar Ecology needed to overcome. Because, though in Longyearbyen are some unused houses, there is not an open register of the owners and therefore no access to contact them for buying one. In the end, they were lucky to know one seller. The Czech station also builds container alike remote station Nostoc and a research vessel Clione for field studies. [Appendix |Interview Oleg #0228, 2019] The full description of historical reasons leading to the current state of the Czech Arctic Research Infrastructure can be found in [Appendix |interview Nikola # 0312, 2019]

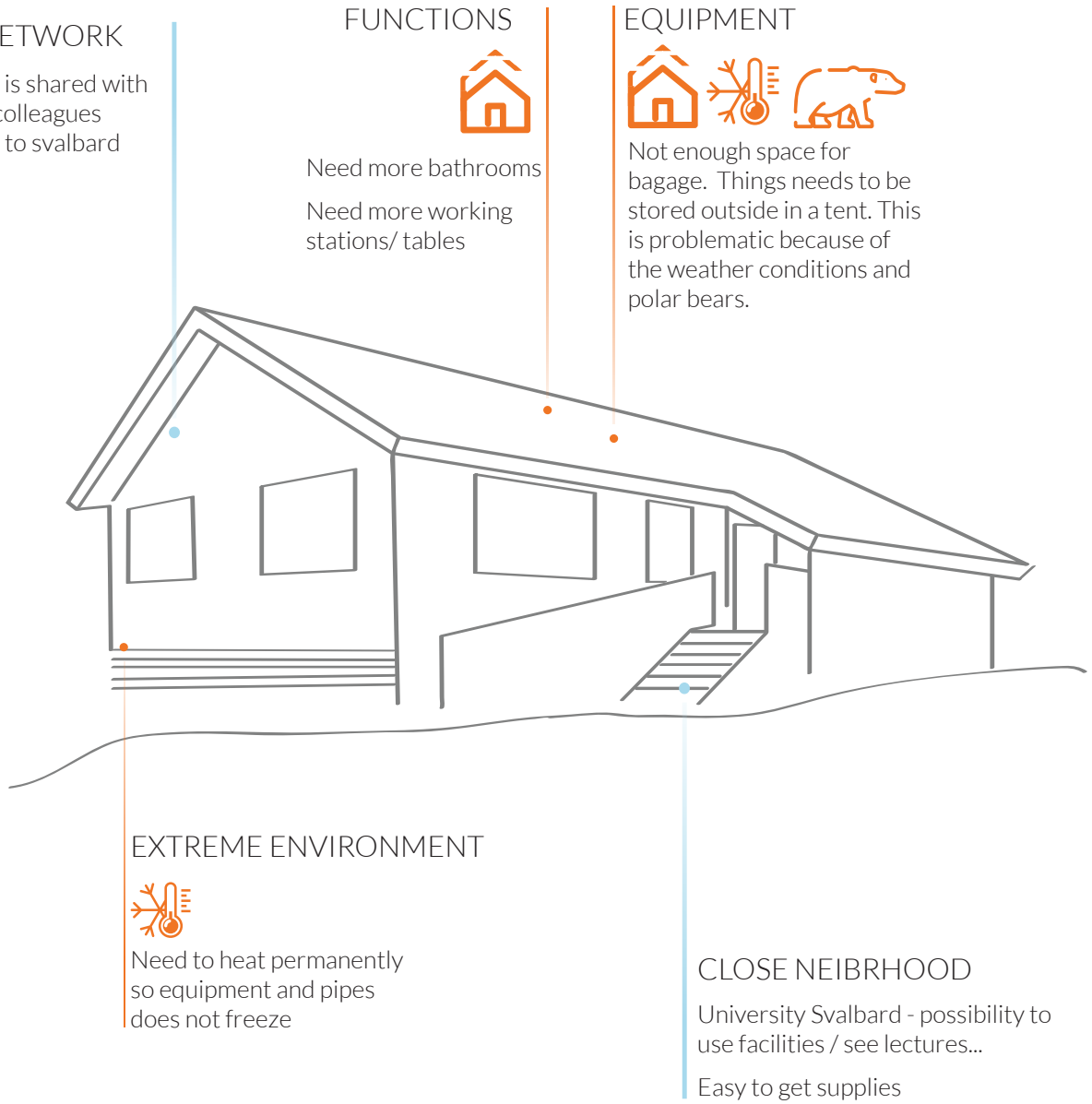
This story proves that researchers affiliated with the Centre for Polar Ecology are keen to participate in lowering Environmental Footprints and acting sustainably. Therefore, they are perfect partners for developing our project.

Re-purposing buildings bring several problems while solving the emerging issues, we are mainly aiming to devise a strategy for this Main Case Station (and minor case stations) to be able to take action aligned with the concept of Sustainability.

5.3. Facilities

Josef Svoboda Station in Svalbard consists of several facilities located in central Svalbard with easy access to Svalbard Airport (LYR). The infrastructure includes a base station called 'Julius Payer house', which is located in Longyearbyen and a 'field station Nostoc' in Petuniabukta, as well as a 'Clione research vessel', motorboats, snow scooters and an off-road car providing logistic support.

ISSUES | BENEFITS



Julius Payer house

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Figure 25: Facilities in Payer's house and highlighted issues(source: personal collection)

Location: LONGYEARBYEN

Opened in 2013

Facilities:

- 3 bunk-bedrooms
- Lounge area (suitable for small lectures and presentations)
- Bathroom and laundry
- Fully equipped kitchen
- 2 laboratories (more info here)
- Workshop
- Fridges, freezers and storage space
- Firearm flare and weapon
- Wi-Fi

Summer season

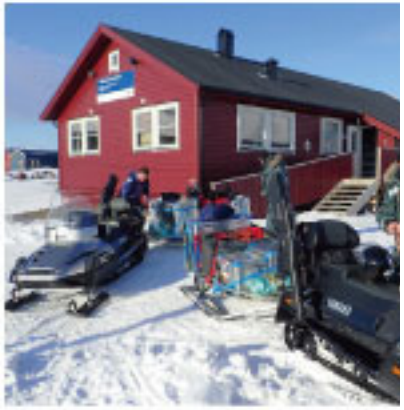
(exeptionaly winter)

12

Julius Payer house

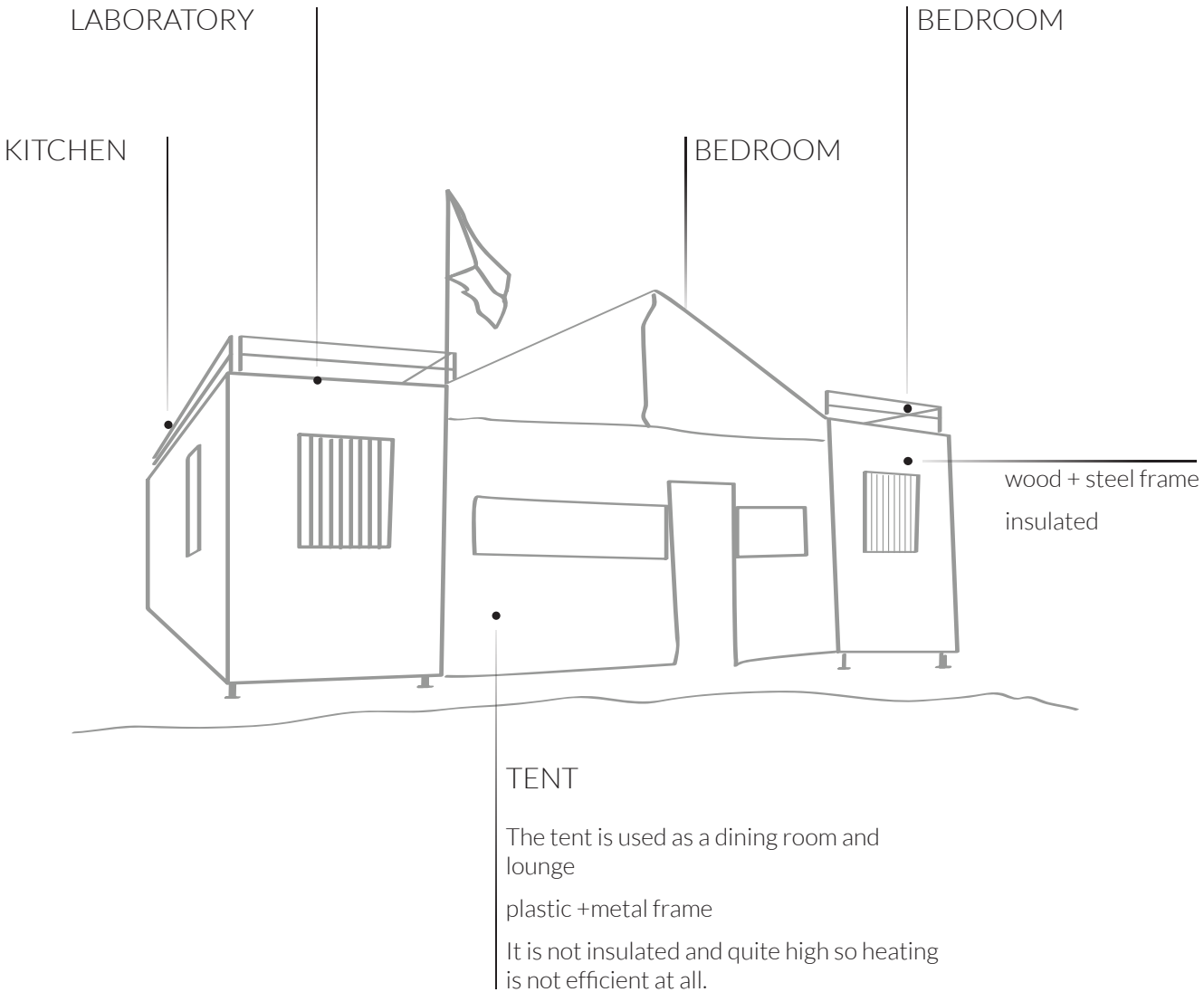
77.8750° N, 20.9752° E

Figure 26: The map of 277 active fieldwork locations today (Research in Svalbard database, 2019)



House in the winte

LAYOUT



Nostoc remote station

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Figure 27: Facilities in Nostoc field station layout (source: personal collection)

Location: Petunia Bay

78.69°N, 16.46°E, 60 km from Long-yearbyen

Constructed in 2015

Facilities:

- Station contains of 4 huts:
- 2x bedroom
- fully equipped kitchen
- lab
- heated tent in the middle
- dry outside toilet
- Tent is used as dining room and lounge
  Capacity of station is 15 persons.
  Temporarily 20 persons overnight.

Summer season

15

Safety: Polar Bears area

LOGISTIC & TRANSPORT

Nostoc remote station

77.8750° N, 20.9752° E

Figure 28: Facilities in Nostoc field station and highlighted issues (source: personal collection)

ISSUES | BENEFITS

KITCHEN

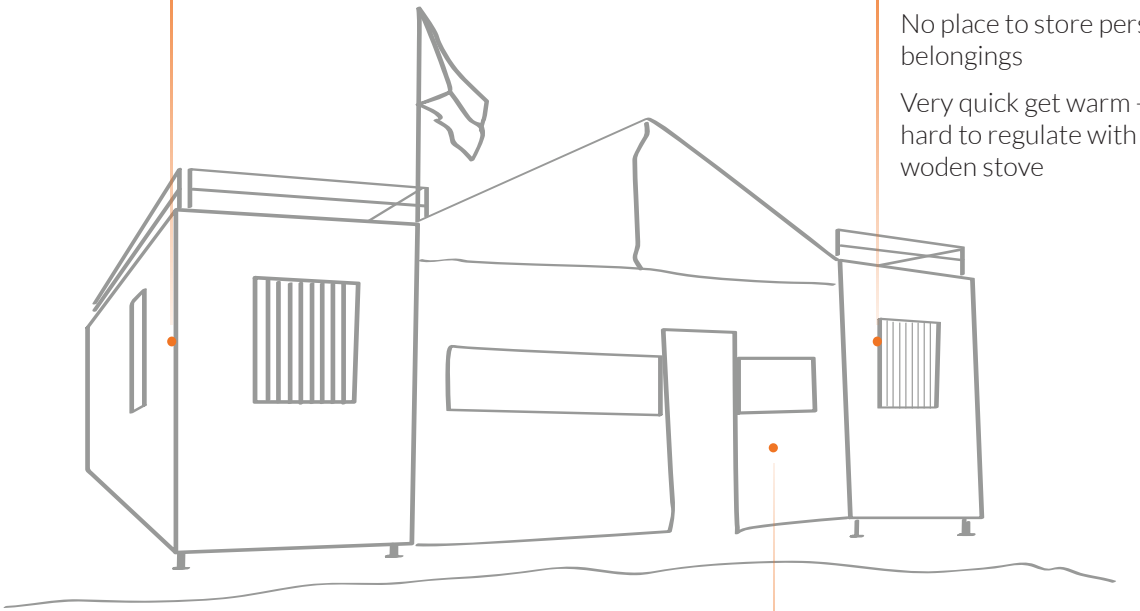
Has to be used by Logistic personal to sleep due to space issues.

BEDROOM

Need more working stations/ tables

No place to store personal belongings

Very quick get warm - hard to regulate with woden stove



WATER TREATMENT & HUMAN EXCREMENTS

The used water is directly flushed to the sea or ground without any black / grey water treatment. Although, researchers try to use 'eco-friendly' detergents.

Toilet paper is burned
The toiled is emtied to the sea, when the activity increases this can pose a problem

EXTREME ENVIRONMENT

Need to heat permanently so researchers dont freeze.

Due to nature preservation restriction it cannot be substituded with any permanent structure, which is a big issue from Sustainable point of view.

5.4. General research practices

The practice is a beneficial way to analyse the link between human activities and the environment.

The illustration below Movement in space and time [see: Figure 29] shows the practice of Researchers conducting research and using their stations. This scheme is based on several interviews with researchers affiliated with the Czech Arctic Research Infrastructure, nearby Polish station, building company Archeva, and Tove Landing from DTU. All interviews can be found in appendix interview.

While considering the sustainability, we as the designers and researchers as the users have mapped out the Practices as entities, which helped to identify several points which can be understood as issues influencing Sustainable Research & Development - marked as red icons or green icons.

A taste of practice complexity and hard researchers life...

The field station - Nostoc station, is made from 4 units connected by a tent [Appendix |Interview Martin# 0307, 2019]. The units were built by Archeva company, and they, not containers but custom build wooden units [Appendix | Interview Pavel Vána].

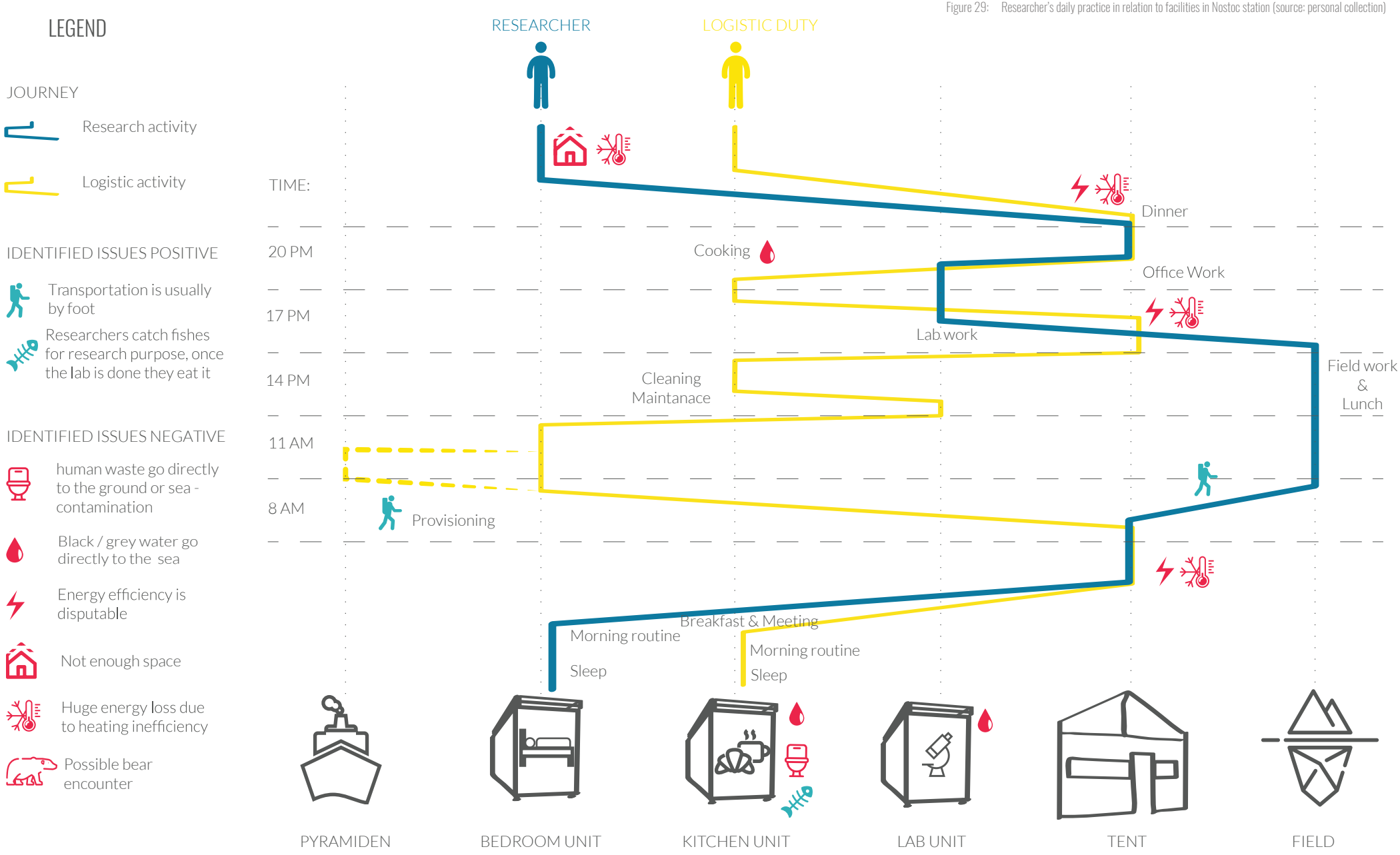
"One of the initial requests was that they would be modular respectively easy to assemble and disassemble without any hard equipment. Also, the modules should be from another company and Archeva should only assemble them, but then it was not possible to have these modules because they needed a crane to be moved. Therefore due to the time pressure of the Government and EU funding deadline, we took over the whole project and manufactured the units."

Archeva owner Pavel was the one creating the design together with scientists. Researchers told him how the conditions are what they want, and he developed a design and his company the structure. He had to think about the structure that it can be put together under different conditions. He has not been on the site before, so everything needed to be thought through and adjustable only with basic equipment. He did not even know if it would be possible to put the units levelled, so he created a design with moveable stands, which would level the baseplate for the structure.

MOVEMENT IN TIME AND SPACE

77.8750° N, 20.9752° E

Figure 29: Researcher's daily practice in relation to facilities in Nostoc station (source: personal collection)



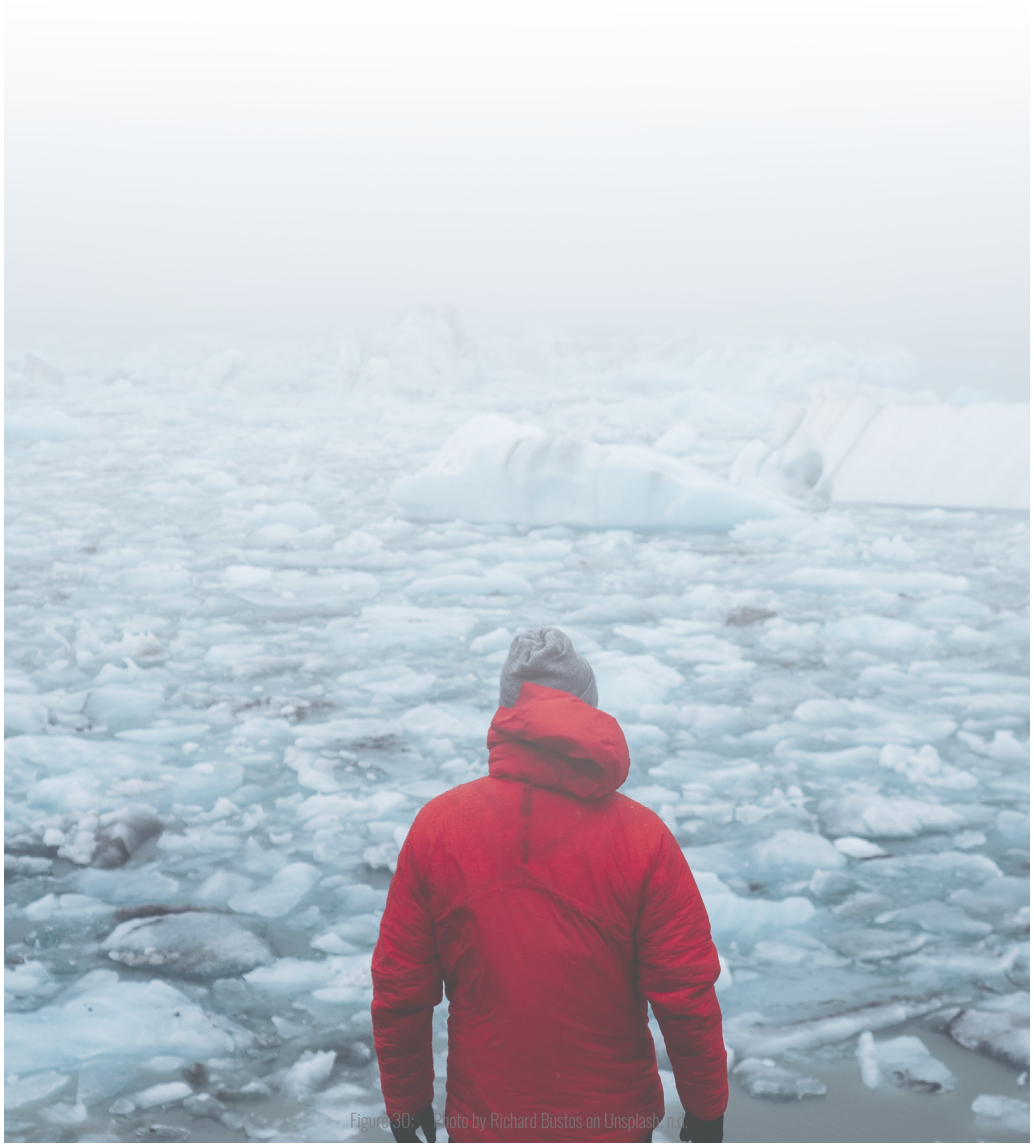


Figure 30: Photo by Richard Bustos on Unsplash [n.d.]

6. Analysis

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This chapter will present two significant outcomes in our findings. Firstly we will present our understanding of sustainability, which has emerged from literature combined with our findings based on Empirical work. Secondly, we provide an overview of three tools used to analyse collected data. Where the first one walks through the established Environmental Footprint method and adaptation in Polar context. The next one introduces Research Practices as entities and Work Environment as the analysis of the later will derive on findings hereof. The last section is devoted to Material flow analysis.

6.1. Our Perspective of Sustainably conducted Research in Svalbard

Thich section derives from previous analysis and provides an explanation for the first part of the problem formulation: HOW CAN BE SUSTAINABILITY FRAMED IN RELATION TO RESEARCH STATIONS IN SVALBARD CONTEXT?

Our perspective on Sustainability, regarding research infrastructure and research activities is conceived in terms of smaller environmental footprint. In agreement with this perspective, we developed the idea to be more action-guiding. Since, there is no documented knowledge of local research activities contribute and to what extend to the environmental impacts, therefore the knowledge of the link between environment impact and research activities still missing. Responding to the gap, we are presenting a possible way of understand sustainability in research activities - developing a more sustainable research practice and serving the same research purpose with a smaller environmental footprint.

To answer, why we have chosen the environmental footprint, it is important to state: It is not the only way of understanding the link between research activities and also a way of measuring the level of sustainability. But it is the most emergent factor identified by Svalbard Science Forum and easiest to implement on researchers activities (footprint can be measured on different variables).

Guided by the comprehension of sustainability presented in State-of-the-art : Sustainability in Arctic context and its identification of 'limited connectivity between the conceptual work and action to take. We have focused in defining it in order to enhance the connection of action based on regional-specific information issues for researchers social groups . When, in Svalbard, the majority of population is non-indigenous and the climatic conditions are extreme we also take as an important part for successful framing of this notion the Uniqueness of Svalbard which restrain some of the general sustainable ideas and suggestions. For example, the general awareness in terms of food is the use of local resources, however that cannot be even considered in Svalbard's context.

Sustainability in Our Perspective of Sustainably conducted Research in Svalbard is understood as: "as research activities that contribute to the world knowledge are executed without compromising the environment and therefore able to continue for a long time" Sustainability involves taking long term decisions equally taking action now to enable a future where lowering the footprints (recycling, water management, pollution prevention, utilized design and construction, maintenance and operations, research planning, ect.) are common research practices.

6.1.1 How do we work with it

The process of using our perspective on Sustainably conducted Research in Svalbard, previously presented material flow analysis and explanation of research practices allows us to tackle the second part of our problem HOW CAN WE EXPLORE RELATED ISSUES?

The sustainable issues could be seen as questionable practices of researchers that need to replace the materials, change the meanings and equip researchers with required skills and knowledge. Since researchers are mainly responsible for the issues, and they are the one who will conduct the possible changes. The practice point of view is a user-focused approach. It will be easier to implement changes when taking the 'users' point of view into consideration in the whole design process. Plus it provides a closer look at where the problem arises and suggesting a potential improvement.

A proper way of analyzing materials is to map out material flow with a connection of researchers' daily practice. Impact assessment and sustainable strategies at Svalbard are usually focusing on strictly new projects and only a few on the impacts of prior activities. However, based on the uniqueness of Svalbard research infrastructure development and the development restrictions, most of the activities and practices are already established.

Therefore in our perspective of sustainability, we would like to highlight the

importance of considering the impact of already established systems. So that is also why we have analyzed already existing structures and proposing an agenda to changing small parts of practices instead of creating new ones. The work environment needs to be also understood in order to understand what can be changed and cannot.

Sustainably conducted Research in Svalbard perspective deriving from Environmental Footprint combined with Practice theory used as a tool to understand how the problem can be approached. Accordingly, lowering the environmental footprint is the purpose of the strategy presented in the next chapter.

6.2. Environmental footprints

The origin of Environmental Footprint (equally called Ecological Footprint) lies to conceptualize a method to analyze the correlation between people and nature. In Scholars work we can find many different accounting concepts which are looking at energy, food or other human activities. However, the concept needs to be aligned with the complexity of human lifestyle, if it aims to describe the human impact intangible way. Therefore, Ecological Footprint is in general understood as methodology concerned with the entire resource flow. “The simplest way to define ecological footprint would be to call it the impact of human activities measured in terms of the area of biologically productive land and water required to produce the goods consumed and to assimilate the wastes generated.More simply, it is the amount of the environment necessary to produce the goods and services necessary to support a particular lifestyle.” [WWF | Ecological Footprint, n.d.]

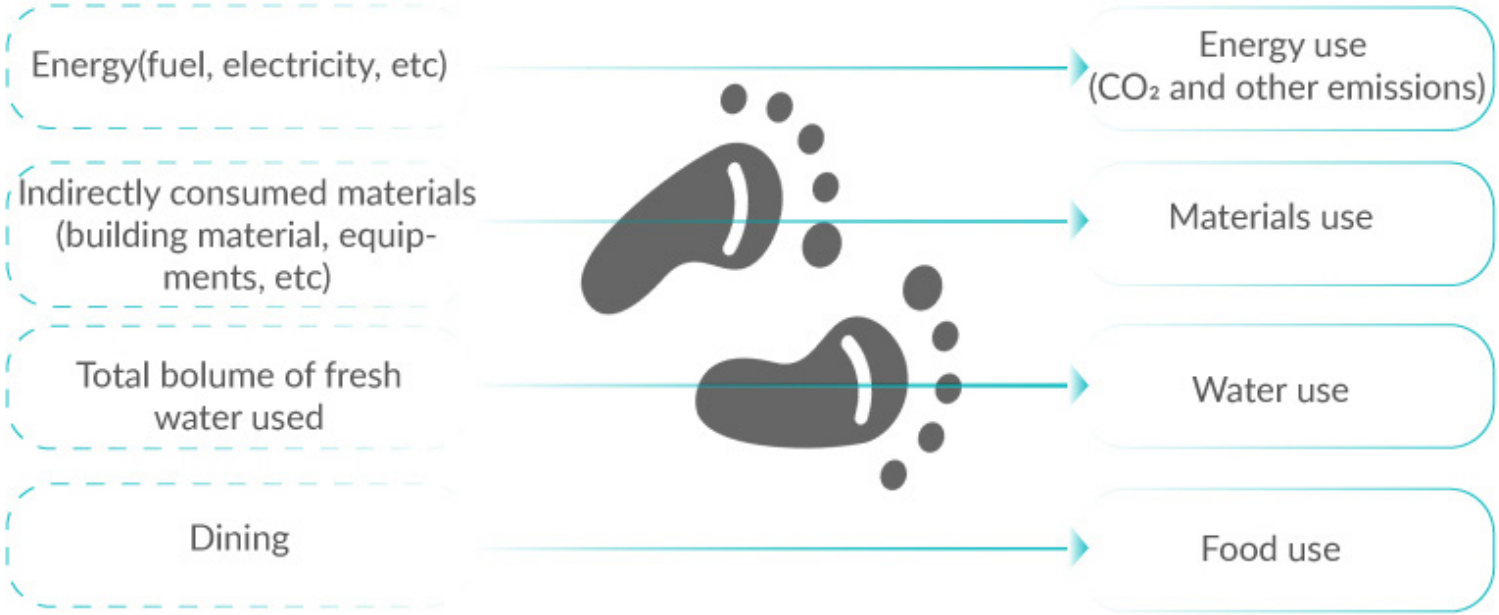

Figure 31: Ecological Footprint of CPE by Halatova & Geng, 2019

Such indicator of human activities can be, therefore, used for describing a local state of the environment while allowing comparison on macro-level and provide global evaluations.

By no means does Footprint analysis specify exact steps what needs to be done. In our case, Footprinting has been used to explore the issues relating to Research Stations and Research Activities themselves in Svalbard and to create a model for further sustainable development.

Generally, Footprinting can be defined as "an integrated tool that '...measures how much nature, expressed in the common unit of "productive space with average world productivity", is used exclusively for producing all the resources a given population consumes and absorb the waste they produce, using prevailing technology.' … This tool was developed to measure whether a given country or region was using resources at a rate faster than nature can regenerate them." [Lyndhurst, 2003, p. 8]

Different approaches to Footprinting provide in rigorous categories of calculations, hardly approximate measurements. Moreover, Research stations and Research are unique subjects to Footprinting, when located in Arctic conditions, especially in Svalbard's non-traditional context. S. T. Brooks from the University of Tasmania developed a standardized approach to Footprinting in an Antarctic context which can be suitably used also in Svalbard's conditions. Footprint indicator per researcher per research days.

According to the interview with Karoline, Svalbard Science Forum is aiming to reduce the footprint of research activities. They are aware of the environmental impact. However, they do not know how the research activities affect the environment and how to deal with it - " It is tough to measure the impact. We are not researchers, we are just trying to make them cooperate. " [Appendix |Interview Karoline #0414, 2019]. Therefore, in this project, we try to suggest a possible approach to the footprints of research activities and identify problematic activities in order to support greener research practices. As the "Ecological sustainability is achieved when the ecological footprint equals carrying capacity." [Lyndhurst, 2003, p.8]

The key environmental indicators in our study include energy use (CO2 and other emissions), material use, water and food use. When Research Communities notice and observe their consumptions of these indicators, they could use this knowledge to better planning of their next research projects.

Provided, there is no continuous data on CO2 footprint, water usage or other emissions, related to Remote Research Stations nor Research Huts or independent research stations in Longyearbyen. We could not do the analysis solely on Environmental Footprints. Therefore we departed from the Environmental Footprint and combined it with our observation of practices which all together help us to create material flow map.

Figure 32: work routine before field work (Source: Facebook - Centre for Polar Ecology)

6.3. Work environment

To be able fully to understand all activities researchers are performing, we have to look at them from several points of view. Besides the already presented perspective, it is also good to understand the work environment that poses opportunities but also challenges to the researchers. One possibility is to look at the work environment from Sustainable Development Goals defined by UN perspective. Taking, all of 17 goals are meant to interact. The 11 goals are devoted to Sustainable Communities "Make human settlements inclusive, safe, resilient and sustainable" [SDGs,2015] If we take in consideration the common understanding of work environment anchored in SDGs we also need to consider the unique aspects of working in Svalbard namely: Security, Pollution and Cooperation. The most developed work environment regarding research activities is in Ny-Ålesund. Therefore following aspects are based mainly on data and interviews from Norwegian Polar Institute residing there; however, they are supplemented with any information from other interviewed researchers. Although we could present all the aspects of the researchers work environment, we choose to describe only the unique ones.

6.3.1 Security

Wildlife

Polar bear encounters should be considered a real possibility anywhere in Svalbard.

Consequently, anyone travelling outside the settlements shall be equipped with appropriate means of protection against polar bears (rifle, and flare pistol). A group should additionally have another person with this equipment, as well as a dedicated group leader with satellite phone/radio. It is needed to note that holding of a rifle comes with proof of clear criminal-record file which needs to be obtained in the resident country.

Transport

Ny-Ålesund is relatively easily accessible, with an airport and a harbour, and it has a well-developed infrastructure (laboratories and observatories) available to researchers. The same as Longyearbyen and Horsund settlements. However, field transportation poses the main challenges. Many of the research stations are

surrounded by research fields which usually need to allow contaminated as possible. Secondly, scientific equipment is sensitive. Accordingly, all personnel is encouraged to use a bicycle, kick sledge, or take a stroll instead of engine powered vehicles. The primary transportation means is a walk.

Medical service

There is no medical service available outside Longyearbyen where the hospital is, except in the summer season when Kings Bay AS usually employs an on-site nurse; however, any medical equipment is present. When something shall happen, the one in medical need is transported by helicopter. The Svalbard Science Forum also identifies helicopter rescues as possibly problematic to Svalbard environment protection. [Appendix |Interview Karoline #0414, 2019]

6.3.2 Pollution

Radio Silence

A unique condition to work practices presents electromagnetic radiation activity, which should be kept at an absolute minimum. Due to the sensitivity of several scientific instruments in Ny-Ålesund. This restriction includes not only radio but also Wi-Fi and Bluetooth. For example, smartwatches or mobile phones can be only used in flight modes. Which puts some thoughts on if the researchers should already arrive at Svalbard with analogue watches to sustain the radio waves silence as low as possible and other preparation like this

Biodiversity

A rising number of visitors and researchers represent a significant threat to native biodiversity and ecosystems are the Invasive alien species. These can be infiltrated to the Arctic simply on any equipment, or personal belongings. The practical measure to lower the possibility is to brush, hoover and wash all bags, clothes, shoes and equipment. However, this knowledge is currently embedded in practices of researchers familiar with the Norwegian Polar Institute webpage. [A Researchers Guide, 2019].

Waste management

At Ny-Ålesund, they have a rigorous system, there are 28 or 32 different categories, where they do sorting. The station is open for everyone. “So, you have to recycle in your hotel room. And you have to bring it into a common centre for recycling, which is also operated by a kings bay. “ [Appendix |Interview Helge # 0429, 2019]

All garbage from Svalbard is gathered, and if not repurposed in Longyearbyen, it is sent to the mainland.

6.3.3 Cooperation

According to Helge Tore Markussen, Station manager Sverdrup research station: “All acting managers or senior representatives from the research institutions present in Ny-Ålesund, together with representatives from NPI and KB meet weekly. … And having a good process, so that researchers can use as little time as possible from the arrive until they are available for ready to go into the field. They should have all the logistics ready here. I think for sharing data, that is overarching policies.” [Appendix |Interview Helge # 0429, 2019]

A purpose of this weekly meeting is to ensure the flow of information about research activities and the organisation of a new group of researchers coming.

However, we have identified that Station managers and therefore, also researchers are missing also another type of knowledge sharing - experiences and situational awareness regarding fieldwork specific to Svalbard. For example:

“... the people going to glaciers in October, they go with satellite photos and all this. However, that could be challenging. So we normally spend August and September trying to get to know the water channels and all this. So that we know the situation before the snow comes and have a good understanding where we can drive and should not drive and so on” [Appendix |Interview Helge # 0429, 2019]

Until now, there is no systematic way to record and share this experience and situational awareness among researchers other than verbally. Which means that every new coming person needs to gain their own experience from the beginning and once they leave their knowledge is gone with them. Since all personnel has placement on Svalbard based on 2 to a 3-year long contract, it is hard to imagine that all needed knowledge is properly transferred.

6.4. Research Practices

6.4.1 Research practice as an entity

The practice, which is being explored in this project regards research activities happening in Svalbard. These research activities consist of numerous groups of practices, such as daily practice, office working, commuting, etc. with different degree of environmental influence. Since the objective is to analyse the environmental impact of research activities, the practice framework includes daily practices of researchers, which we have mapped out in the previous chapter See chapter 5.4: Practice-general research practices]. This analysis is based on the information gathered from interviews and data from research stations reports.

It is a struggle to account for change due to the mutually constitutive relationship between practices and broader social systems, which are difficult to separate and analyse independently. While grounding in practice theory, the three elements perspective helped us to analysis research activities and thus to improve the practices' environmental impact.

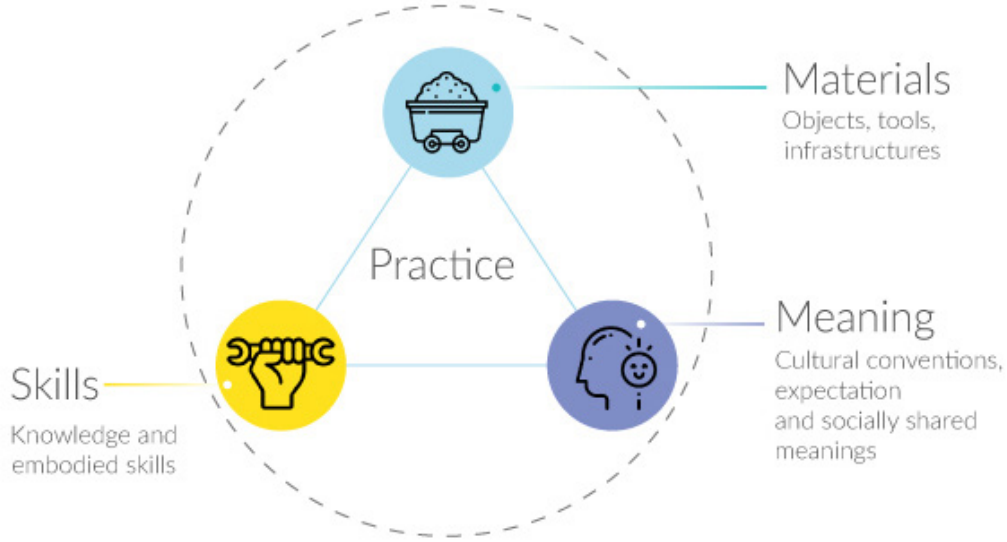

Figure 33: The three elements of a practice based on Practice Theory (Shove et al., 2012) by Halatova & Geng, 2019

The following part explains how we look at research practice as an entity [Shove et al., 2012]. It is important to note, that entity refers to the interrelated elements of practice. Elements seek to identify specific aspects of the practice the materials, competencies and meanings that compose it. By identification of these elements, we can understand the exact approach to changing at least one of them. Important to note, Each time practice is performed, these different elements are brought together, and it is not possible to perform a practice unless all the elements are available. However, for clarity, we are structuring further analysis according to these elements.

Material (objective, tools and infrastructures)

The term Material, includes all material related to researchers, from the research station building materials, equipment to a gas bottle for cooking. The material element in practice clearly shows the interaction of research practice with the local environment. Therefore in our project, mapping out the material is essential for analyzing the environmental impact. Materials in this context have been considered in two different categories:

Indirectly consumed material (such as equipment or buildings, are not directly consume/transformed into emissions, but as they are transported and used in Svalbard for research activities they affect the environment indirectly)

Directly consumed material (these materials are utilized and transformed into another type of materials when serving research practices. For example, gasoline is used to transport researchers to the field station and emit CO2 and other exhaust gases)

Skills(knowledge and embodied skills)

Whether the needed change of practice is feasible is highly depends on if the conductor knows how to do it and if they have necessary tools for it. Through, there are basic rules in Svalbard that researchers need to follow, there is a lack of knowledge and skills to do research in a sustainable way. Their current skills and knowledge regarding conducting research in Svalbard are mostly learned from familiar experienced researchers or from life experience to survive. Even, some researchers are willing to contribute to sustainability. However, they have not equipped with the knowledge of how to practice it.

Meaning (cultural conventions, expectations and socially shared meanings)

A proper research approach needs a shared value for being sustainable among researchers.

During initial interviews with all the researchers, the ending question always related to the understanding of sustainability. Some of the researchers not familiar with the concept of sustainability but they do agree with there is a need for environmental protection. However, the general idea about sustainability in researchers' mind is that it is the government's responsibility.

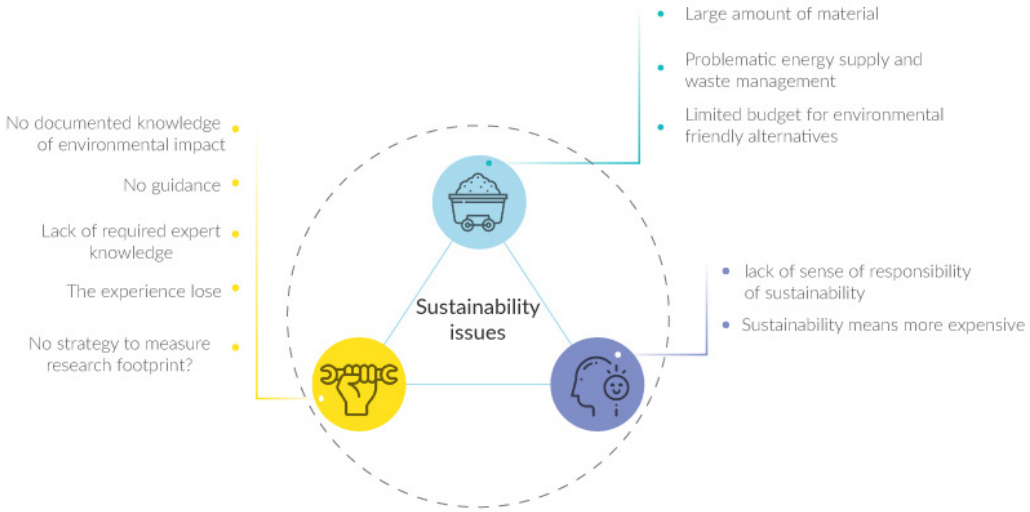

Figure 34: Problem clusters by Halatova & Geng, 2019

6.4.2 Material Flow Analysis

Material exchange and material flows are basic premises for the maintenance and development of human society at the material level. Moreover, as the material is an essential element for practice, the environmental impacts produced by research activities depend primarily on the quantity and quality of the materials which go in and out of the research communities. The requests research systems have from the environment cause resource depletion and environmental degradation.

The essences of material flow analysis are:

- Through the measure of the material input and output, to understand the pathway and flux of each material flow in the whole system, reveal the composition and changes of the materials, reflect both wealth and the pressure caused by research activities.
- Illustrate the dynamic link between research practices and the natural environment, find the potential of material use and environmental improvement.
- Then to effectively regulate and control the flow directions and quantities in accordance with the analysis results.

Therefore it is an crucial way which support policy decision making with a focus of a resource-saving and environment-friendly research community and achieve the goals of keeping the local environment as much intact as possible. [Bao al et. 2010; Hendriks al et. 2000]

Material Flow Model

There are many different models to make the flow for a different purpose. In this project, we combined a tracking model, which takes into account the process of the material life cycle and a total amount model, which analysis of the total input, the total consumption and the circulation in Svalbard. By mapping the total amount of material, it is visualized that what materials are consumed by researchers and by tracking these materials' flow, it is shown where it comes from, where it goes out.

System Description:

The analysis purpose is to understand the environmental impact related to research activities. Therefore, the researcher's practices are highlighted on the map. And the scale of the material flow is within Svalbard, due to 1)the emphasis of analyzing the influence caused by research activities in Svalbard 2) difficulties of data collection of individual material's whole life cycle process. The map is based on the summer season, for the reason that most research activities are conducted in the summer season, and few researchers have experience of doing researches in winter.

The selection of the processes involves identifying those key process which most efficiently represents and describe the complex system under investigation. All directly consumed material is mapped out separately, and they are actually also mainly have directly affect on the environment, such as gasoline, diesel, water, etc. Indirectly consumed materials also illustrated to help to identify what go in and go out

regarding research activities, but not detailed to raw material. Emissions and waste are divided into different types according to where they go.

Data acquisition:

The data mostly collected and summarized from five interviews of experienced researchers who did researches in Svalbard and logistics who have working experience in research stations.

The overall Material Flow Analysis map [see: Figure 35] generally mapping out two layers of materials consumed in Svalbard regarding research activities.

First, directly consumed materials presented as a diamond are diesel, gas, gasoline, auto battery, wood, food, water. They are posted individually due to they are consumed in different ways also because they are transformed into another kind of waste materials, which would influence the environment directly. In order to make it clear of the link between the material and research practices, each line of the material flow are shown.

Second, indirectly consumed material is mapped in groups, for example, building material, equipment, boat material, furniture, electronics, kitchen machine, daily necessities, and personal stuff. All of them are transported elsewhere to Svalbard. We would not map out all the raw material they made from, but we are trying to show how many kinds of thing are going Svalbard for research purpose, as they always negated. Since they do not directly produce waste and emissions, we did not map them individually. The point of making the grouped material is to show the total amount of material go in and go out.

As is shown in the map, problem areas are clearly illustrated, emissions and waste management. Looking backwards, the source of the problems can be easily found. Regarding practice, we could accordingly identify the most consuming practice, stay in the tent, travel by boat, stay in the building, cooking and cleaning and travel by boat. It does not necessarily mean that another practice has no problem, but here we pointed out the most problematic one. Moreover, this suggested where has the potential to improve, for example:

Stay in the building

Just stay in the container, without doing anything else, there is much energy consumed and emissions delivered to the air for maintaining the comfortable environment in the room. Also, indirectly consumed materials, such as building, furniture, together with directly consumed material of wood (to heat up the container), and electricity demands a lot. So wisely use the space inside the building would a potential way to reduce space waste, and improve the building itself is also a way to promoting the better environmental performance of the building.

Cooking and cleaning are energy-intensive practice. Based on the use of kitchen machine, and washing machine, water, food, electricity, gas are consumed. They are also the biggest waste producer. There is a potential for a better way to deal with materials and the way of energies consumed.

Stay in the tent and travel by boat, These two practices are more responsible for emissions. Renewable energy is needed for solving these problems

It needs to point out that this material flow analysis is not based on precise data of the amount of material and emission. Therefore for future improvement, quantity and quality data will definitely contribute to a higher quality Material Flow Analysis that helps calculate the environmental footprint. However, in this project, since the knowledge area, we are contributing to is still in a very early stage, raising awareness and contributing to the understanding of interactions between research practice and the environment is more important currently. And this map [see: Figure 35] benefits explaining the idea and accordingly raising awareness of the need for sustainably conducted approach. Moreover, it suggested where has the potential for a better research practice (highlighted as an issue).

Material Flow Analysis

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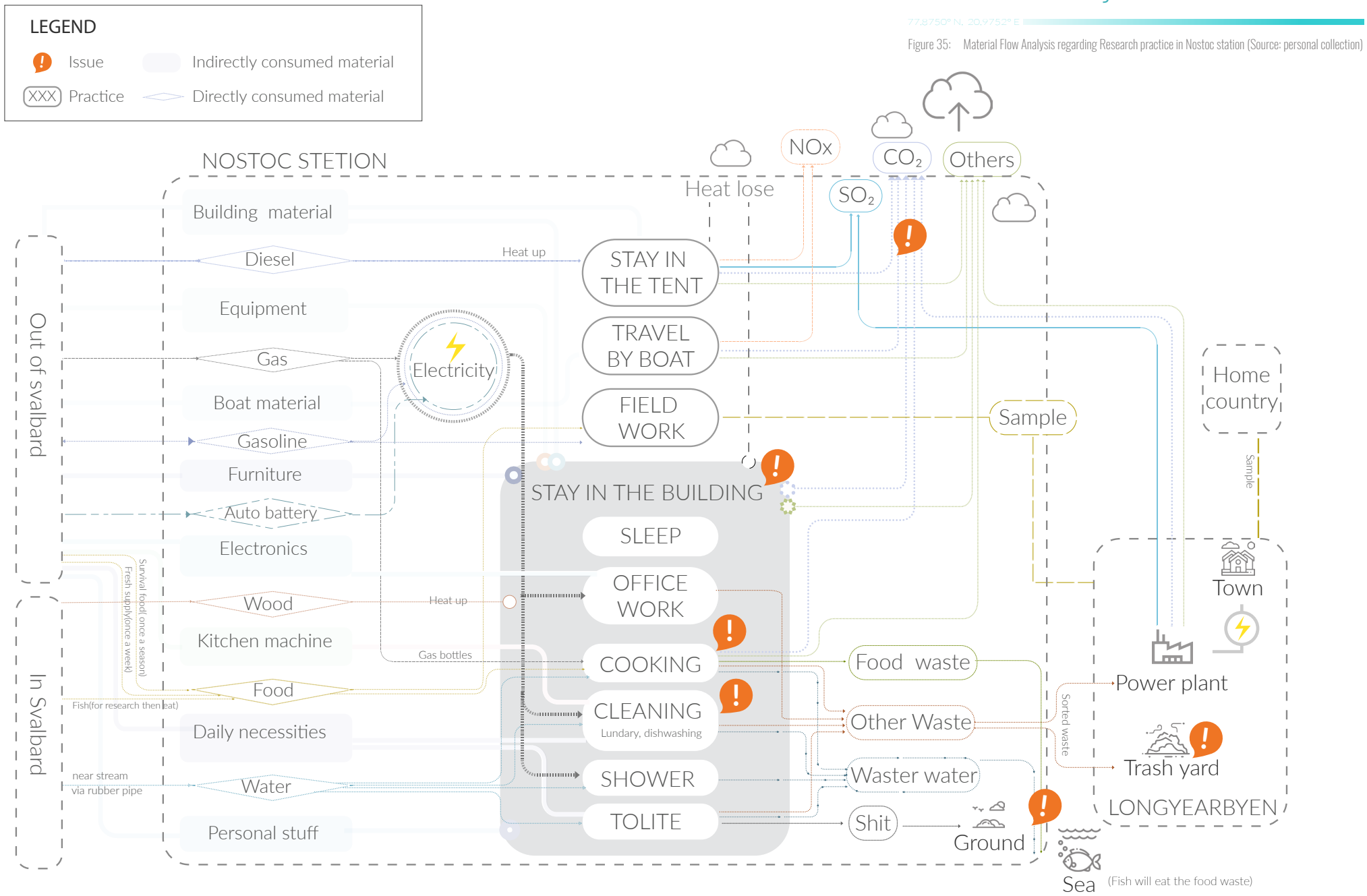
Figure 35: Material Flow Analysis regarding Research practice in Nostoc station (Source: personal collection)



6.5. PROBLEMS DISCUSSION

As the former mentioned [chapter 2.1: Dada collection], we interviewed several researchers. According to what they presented, they are facing several problems, categorized as safety issues (polar bears threatening), problematic facilities (for example the tent heating problems, the space problem in the containers), not enough budget(as they understood, most of their problem derived from no enough funding), reputation [Appendix |Interview Oleg #0228, 2019]. We could conclude that the problems identified by researchers are mainly about the not-well-built building and experience sharing.

However, there are more pressing problems that researchers unable to recognize by themselves. We as sustainable designers can look at the current situation from a systematic view and therefore providing solutions that not only solving the current problems the researchers facing, also contributing to sustainable transition in terms of a sustainable manner of conducting researches in Svalbard.

Solution for solving the problem that researchers are struggling with is not necessarily the right solution for achieving the goal of researching in a sustainable manner. For example, the biggest problem that the researchers are facing is to heat the tent. As presented above [see chapter 5.3: Facilities] the tent connecting the containers is higher, and it is not insulated. So it takes time and energy to heat it. A possible solution would be adding insulation layers inside the tent, which will enable researchers to do activities inside and their problem thus fixed easily, While lowering the gas heater costs. However, in the long-term run, it is a wrong solution for the sake of sustainability since the tent is not designed to heat up and not allowed to do activities. As sustainable designers, we are not just solving the superficial problems. Instead, we dig the problems and providing a solution that serves the long-term interests for society and environment.

Since we analyzing the current research activities from a practice perspective, therefore we identified sustainable issues based on the three elements of practice. (And discussed the problem with considering the important actor SSF, who is facilitating better communication and cooperation between researchers and stations to reduce the environmental footprint)

To clearly explain which element of practice should be tackled in a first place to achieve a change, we refer to them as Practice with a prevailing “X” element. This simplification will help the researchers to be aware of their routines, as they start recognizing these elements in their practices. Important to note, Each time practice is performed, these different elements are brought together, and it is not possible to perform a practice unless all the elements are available.

Practice with a prevailing Material element

The amount and type of material that mapped out in the Material Flow Analysis have the potential to be more sustainable. The problems we identified relating to materials are:

- A large amount of material come to Svalbard for research: the environmental cost of building and maintaining a station not always been noticed according to the interviews with researchers and Svalbard Science Forum. From literature, there is no such document put forward the issue of how much environment is affected by the imported materials. However, this factor is a primary influencer to the surroundings not only by the materials itself also by the way they transported to Svalbard
- Problematic energy supply and waste management: The energy supply in remote areas is the leading direct polluter by CO2 emissions and other exhausts. Regarding waste management, so far, the strategy is based on the waste management system in Longyearbyen, which is classifying waste to plastic, metal, paper, food, battery, etc.
- No enough funding for replacing current equipment setting by environmental-friendly alternatives: Some of the issues the researcher already realized, but due to a limited budget, they can not making the improvements. For example, replacing the diesel generator with a solar generator would definitely improve environmental performance.

Practice with a prevailing Skills/ Knowledge element:

Based on the analysis and research, a lot of sustainable issues raise from the lack of proper knowledge. Issues identified regarding skills/knowledge as follows:

- No documented knowledge of the link between research activities and the local environment and to what extent they are affecting the environment
  - Svalbard Science Forum working for reducing environment footprints regarding research activities, yet they do not do any research, so they do not know know-what and know-how. For example, the case station is struggling with the space problem. As a solution, they tried to heat the tent, which is made for storage only, enabling to do activities inside. Also " the dish leftovers it goes to the sea, but there is no good solution to it" [Appendix | Interview Krzysztof #0320, 2019]
  - There are rules about the colour of the building in Svalbard, but the painting material not necessarily eco-friendly.
- No guidance for researchers on how to act sustainably:
  - So far the food waste and wastewater go to the sea directly. Nevertheless, they recognized there is maybe more proper way, but they do not have the knowledge and skills of how to do that.
  - The cooking, cleaning practice seems typical for the coming researchers to conduct in a current way, however, has the potential to be less energy consumed, at the same time improving the experience
- Lack of required expert knowledge due to no funding for hiring professionals. According to the interviews we did, the researchers have to do some architect and design work on their own [Appendix |Interview Krzysztof #0320, 2019], when no experts are facilitating them. As a result, some problems arise due to the building not maintained in a proper way.
  - For example, the leaking roof is affecting the living quality and induce heat loss of the building. The reason for that is the researcher who assembled and rebuilt the containers do not equip architecture knowledge. They should not do the job.
- The experience lose
  - knowledge about how to effectively conduct research there according to the local environment (weather, traffic route, etc.) will not be available when the experienced person does not present there.

Practice with the prevailing meaning element:

The shared 'meaning' is also significant for making a possible change in research practice. The conductors' view of the concept is fundamental in leading their performance. Identified issues regarding the meaning of research practice are explained below:

- Sense of responsibility for Sustainability missing: some of the researchers already heard about Sustainability or environment protection. The concept based on their understanding is highly related to public infrastructures, such as waste management, or energy supply [Appendix |Interview Marek#0228, 2019]. "It is vital for the government," said Oleg [Appendix |Interview Oleg #0228, 2019]. However, no researchers realized that it is related to their daily practice.
- To conduct research, sustainably mostly means more money for it: interviewed researchers shown willingness to be sustainable and be aware of some potential improvements. However, their capability of making changes is limited by fundings. For instance, the station we contacted is using a cheapest and easiest, unfortunately, most polluting generator (diesel generator). They know it is better to have a solar generator. However, they do not have a budget for it. [Appendix |Interview Martin# 0307, 2019]

Figure 36: Photo by Jay Ruzesky on Unsplash, n.d.

7. The Strategy

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Strategy to lower the Environmental Footprint of research activities, moreover, to support Sustainably conducted Research in Svalbard

In the previous chapters, we have explored issues emerging in research activities and articulated possible framing of Sustainability concerning research activities in Svalbard context. With this knowledge, we are about to suggest a possible strategy helping to address these issues following Sustainability and lowering Environmental Footprint in Research.

Most of the strategic papers regarding any system level change are thought about with a very long timeline ahead. No such change happens overnight, we are very aware of this as much as we believe that it is the right way of thinking through things 20 years ahead and it is highly essential for our future to do so.

Based on our desk research, which several interviews also validated we also believe that some of the changes need to happen now and be envisioned as the future in terms of rapid climatic changes approached us sooner than we expected (or hoped). Therefore, later presented strategy is a short range strategy standing on shoulders the long ones (AACA, HIGHER EDU). However, the awareness, nothing is solid as stone, is projected in the openness of the strategy to new ideas and what is more in flexibility to be adapted to each specific research station/programme.

7.1. Our vision

The vision of the Strategy to lower Environmental Footprint of research activities is that Svalbard will be the leading symbol of Sustainably conducted Research in the international research society, Which hopefully will help the Svalbard Science Forum and researchers operating in Svalbard to achieve not only collaboration but also promoted lowering Environmental Footprint of Research activities.

Firstly we will describe the objectives of the Strategy deriving from Practice Theory, Environmental footprints and lastly work environment. We have analyzed it based on the discussions with the Czech Arctic Research Station researchers. These objectives helped us to formulate the Strategic Plan to achieve envisioned change. If this project continued further on, we would intend to translate all the possibilities from the strategic plan into Action to take. Nonetheless, this is not a part of the current paper.

7.2. The objective of the Strategy

During our research, we concluded that a substantive part of changing researchers' practices to more sustainable ones (in terms of lowering the environmental footprint) is their realization of their daily routines and more importantly what shapes them. Therefore the part of our Strategy is focused on bringing the researchers practices back into the light. As suggested by Shove, there are several ways to change practice as a whole: replace the material, change the meanings, equip the skills/knowledge and break their links. Implies, even though one tip of the practice "triangle" change, the whole system changes because they are interconnected and one cannot exist without another.

Correspondingly, based on the analysis and problem discussion, we tried to frame a Sustainably conducted research practice from three elements in practice. We have used the Design Specification table to categorize the needed improvements relating to the three aspects of practice as an entity. We have identified demands and assigned to each proposed demand criteria which need to be met in order to compensate the gaps between current practice and suggested a sustainable way of conducting research and a wish which would be nice to have as it enhances the positive impact

Category	Demand	Criteria	Wishes
Practice with a prevailing Material element	Material needs to be minimized and updated	Smaller amount of material	Has little or no environmental impact
		Substitutes for better environmental performance	
Practice with a prevailing Skills/ Knowledge element:	Every researcher should know how to act in a sustainable way	Equip researchers with proper knowledge of other researchers experiences	Every researcher, even newcomer, will know well about what they should do when conducting research and why they need to do so
		Equip researchers with proper tools for researching a sustainable way	
		Experience and situational awareness	
Practice with a prevailing Meaning Element:	Researchers share the meaning of research should be done in a sustainable way	Researchers and research managers understand the need for being sustainable	Researchers want to and proud of researching in a sustainable manner
		A shared understanding of sustainability lies in everyone's mindset and daily practice.	

of shaping the practice. The objective can be divided into three aspects, provided one of them is changed; it will lead to the performance change of particular practice, due to the interconnection of these aspects. Accordingly, we have devoted to all three categories equally to support the flow of change. The ideal future research practice, which we proposed as sustainability inspired, would be the one achieving all the wishes, but it will be up to Svalbard Science Forum or the Czech Arctic Research Station as well as other scientists to follow the best appropriate strategic steps.

7.3. Concept development

In the chapter Research infrastructure in Svalbard and also chapter the Main case, we have explained the difficulties each researcher are facing, whether it is their international background or the focus of their research. Accordingly, we are providing as many ways as our project timeframe allowed us to cover the problems that have been identified as issues discouraging sustainable practice regarding research and to provide suggestions of ways to sustainably conduct research, which aims at achieving the overall goal of reducing the environmental footprints.

Concept purpose	Suggestions to achieve the purpose
The same amount of material serving more people	1. Sharing cooking facilities 2. Sharing Cleaning facilities 3. Sharing transportation/logistics facilities
The same space serving more functionality	1. Flexible space design
Eco-friendly alternatives	1. Clean energy supply for heating 2. Clean energy for electricity 3. Clean energy for transportation 4. Use Environmentally friendly detergents
Less emission and better waste management	1. water recycle system
Equip knowledge and tools of how research activities affecting the environment	1. Visual tool which illustrates how and how much research activities affecting the environment. • Material flow analysis • Environment footprint relating to research activities
Provide guidance for how to act in a sustainable way	1. Action guidance for how to conduct the suggestions
Knowledge and experience sharing	1. Networking for sharing research plans 2. Experience and situational awareness sharing (document valuable experience of how to conduct research in Svalbard effectively(less energy and labour consuming) 3. sharing research data
Happy and proud of researching in a sustainable manner	1. Award sustainable stations and researchers

Figure 37: Objectives of the strategy (source: personal collection)

7.4. STRATEGY DEVELOPMENT

In this section, we presented further development of the strategy ideas for changing research practice generated from the last phase. The ideas are evaluated and discussed in the group according to their feasibility, funding demanding, etc.

7.4.1 Evaluation Table

Purpose: the table was designed, serving to evaluate the strategy ideas. In the table, it highlighted the features of the ideas, the time frame, feasibility, and objective fulfilment, which contributes to visualizing the strategy plan. Apart from that, it also helps the decision making for further work on an action plan for this project. For this purpose, the criteria of 'possibility' and ' funding demanding' is highly valued. The actionable plan has to be allowed within the project timeframe. Additionally, It should have low funding requirement since funding has been a big obstruct for researchers to take actions. Description of the table

Objectives fulfilment:

- Low environmental footprint: if the solution directly fulfils the purpose of reducing environmental footprint (green: directly, Yellow: indirectly)

Feasibility:

- The time required for implementation:
  - Short-term: can be done as soon as possible
  - Mid-term: can be done within one season
  - Long-term: need more than one season
- Actors involved: the actors involved in the implementation phase if it needs international cooperations, or individual sations, or can be done in both levels
- Knowledge and tools demanding for designers and for researchers: if it needs a cross-disciplinary approach, and how much it needs to equip researchers knowledge and tools if low, middle or hig
- Funding demanding - If it is highly based on fundings.

Possibility - can we developed the solution into an actionable plan within the project timeframe.

Evaluation Table

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Figure 38: Suggested ideas (sources: personal collection)

Ideas	Lower environmental footprint fulfilment	Feasibility			Funding demanding	Possibility
		The time required for implementation	Actors involved	Knowledge and tools demanding		
1.Sharing cooking /cleaning facilities	Directly	Mid-term	International	Low	Low	Yes
2.Sharing transportation/logistics facilities	Directly	Mid-term	International	Low/Middle	Low	Yes
3.Flexible space design	Directly	Mid-term	Individual station	High	Middle/High	No
4.Clean energy supply for heating/electricity	Directly	Short-term	Individual station / Svalbard	Low	High	No
5.Clean energy for transportation	Directly	Short-term	Individual station	Low	High	Yes
6. Use Environmental friendly detergents	Directly	Short-term	Individual station	Low	Low	Yes
7. Water recycle system/ Human experimentation management system	Directly	Mid-term	National / international	High	High	No
8. A visual tool which illustrates how much research activities affecting the environment	Indirectly	Short-term	National / international	Low/Middle	Low	Yes

Strategic plan

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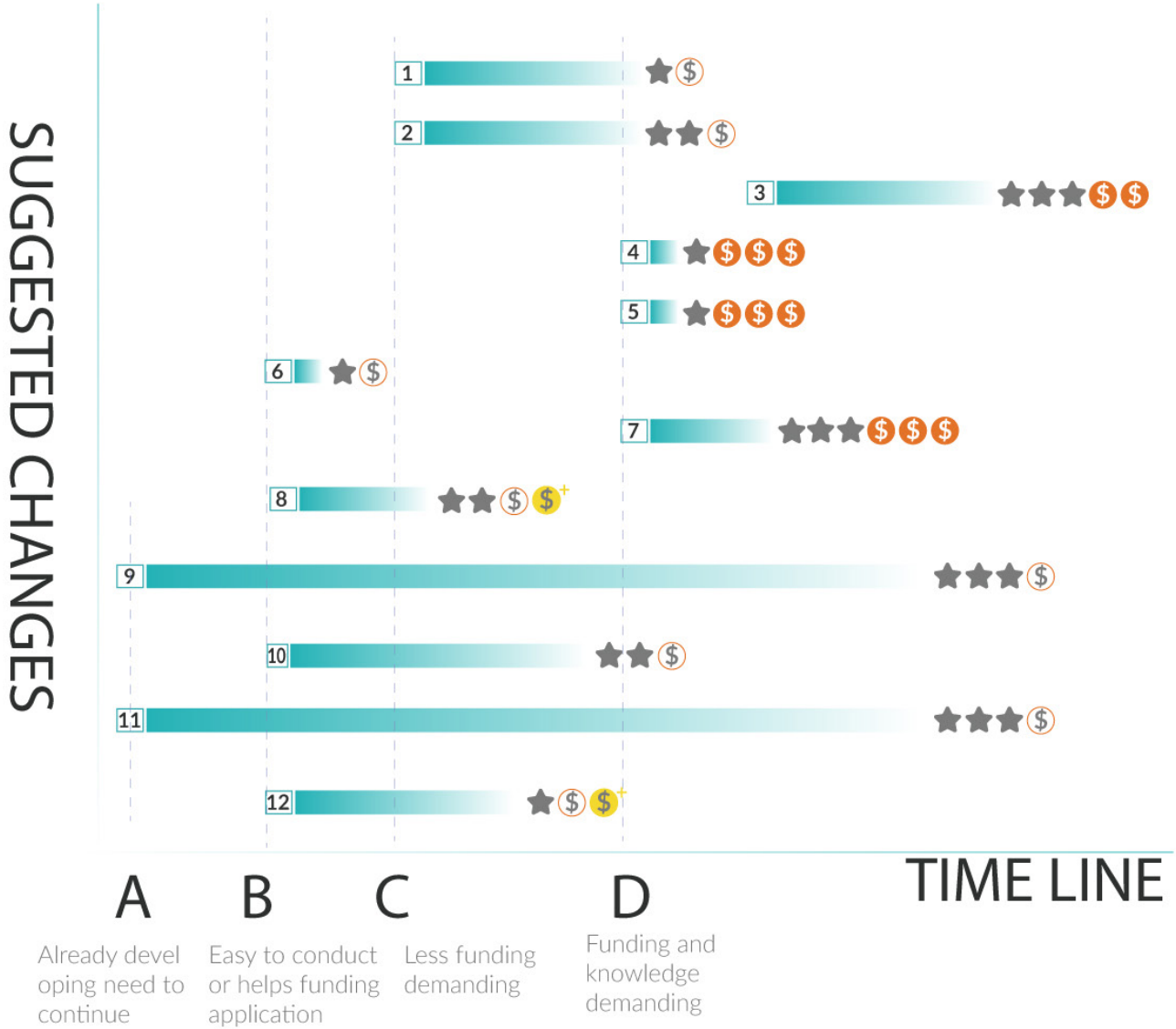
Figure 39: Suggested plan (sources: personal collection)



LEGEND

- 1 — Number for ideas
- ★ — Easy(High feasibility)
- ★★ — Not easy(Mid feasibility)
- ★★★ — Hard(Low feasibility)
- $+ — Helps funding application
- $ — Low funding demanding
- $$ — Mid funding demanding
- $$$ — High funding demanding

The length refer to how long it could be done

7.4.2 Strategic plan

Based on the evaluation table we developed it to a strategic plan [see: Figure 39] to give an overview or plan of when the suggested ideas suggested to be done and in what situation it is feasible to conduct them.

Group A(9 and 11): Networking for sharing research plans and sharing research data is already under planning and developing and need to improve continuously in the future.

Group B(6,8,10,12): are those who need less funding, and easy to conduct, more importantly. No. 6 - Use Environmental friendly detergents, is natural to be done and not high funding demand. No. 8 - A visual tool which illustrates how and how much research activities affecting the environment and No. 12 - Award sustainable stations and researchers are suggested to conduct in an early stage because they are not funding demanding, by contrast, they actually could help funding application. No. 10 - experience sharing, also should be done as soon as possible. Because it not depends on funding and also will benefit researchers in researching a strange place.

Group C(1, 2): sharing facilities and logistics depends on international cooperation and agreement. Therefore it is harder than Group B, for example, use environmentally friendly detergents. However, it will benefit lowering environment footprint. Therefore we would suggest them to be done even there is not enough funding.

Group D(3,4,5,7): changing to renewable energy supply are an essential step to achieving the goal. Therefore as long as there is funding for that, ideas in group D should be improved.

This strategic plan is for actors in Svalbard, particularly: researchers, research secretariat (SSF), research managers, and design engineers to get inspired for their program towards a sustainable research approach. To achieve the strategic goal presented in our vision, actors need to show far more efforts in developing individual ideas into an action plan. Moreover, this paper should be able to empower them, mainly Svalbard Science Forum, when applying for funding and in discussions with policymakers to push for more support regarding low Environmental Footprint projects.

7.5. Actions to take

The evaluation table and strategy plan illustration explain why we choose the specific strategy to develop an actionable plan in this project. We choose to work further on those with low funding requirement since Funding has been a big obstruct of taking actions for researchers and at the same time, it is allowed in this project timeline to develop. Therefore the choice for a further actionable only those in green (Yes) for Possibility and Green(Low) for Funding demanding. Group A and B would be possible for us to work further. We probably will further work on one of the followings:

No.10 - Experience and situational awareness sharing

No. 8 - Visual tool (Material Flow Analysis and Environmental Footprints). Because it helps funding application and has high feasibility.

No.12 - Awarding sustainable researchers and stations. Not Funding, knowledge and tools demanding and helps build a reputation.

Moreover, Suggest a process oriented to organize a course or workshop for researchers. The detailed, actionable plan will be developed after the hand in. There we describe what kind of action plan or the purpose of the action plan.

Figure 40: Iceberg by Annie Spratton, Unsplash, n.d.

8. Discussion

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In this chapter we would like to discuss our approach to the project. What competences Sustainable Desing Engineer has in order to work with such complex topic. What is the contribution to the fiels of Sustainability and values for Researchers, Svalbard Science Forum and Svalbard itself. We were also facing several challenges which shaped the scope of our project.

8.1. Our contribution and competences as sustainable designers

Our contribution 1: a more context-dependent sustainability framing

In Svalbard context, we have conceived Sustainability regarding research practice:

As research activities that contribute to the world knowledge are executed without compromising the environment and therefore are able to continue for a long time.

It is important to signal that we are aware that Sustainability is not something definitive. However, we believe that it is worth the effort to support or improve understanding of Sustainability in a specific context - in our case research activities. Equally, making a strategy to do so.

Our contribution 2: a perspective of dealing with sustainability issues

The goal of the Svalbard Science Forum - encouraging a smaller environmental footprint regarding research activities draws our attention. In agreement with the idea, we developed it to be more action-guiding, which contributes to a 'sustainable' research future. As a way in which we tackle sustainability issues in this project, it is essential to state that it is not the only way of understanding it. However, as the Svalbard Science Forum introduced, they do not have the knowledge of how research activities affect the environment, so in fact,they could not provide a convincing sustainable suggestion for researchers. Taking advantage of the perspective of Environmental Footprint, it helps to explain the interaction between research activities and the environment, which is missing in the current knowledge. Also, it has been identified in contemporary literature as the most important feature of sustainable development in the Arctic.

Besides, Environmental Footprint has the potential to be a measuring tool of Sustainability, if supported by quantity data. It has always been a tricky question of how to measure Sustainability. Therefore, this project suggested a possible way. However, we are afraid to say that Sustainability should be measured only by Environmental Footprint. Since we did not consider the economic sector due to the urgent need maintaining of the local environment. However, it is proving a perspective and supporting to measure sustainable development in terms of social-environmental concerns.

Contribution 3: sustainable development regarding international scientific research

Even though we have argued that the purpose of the strategic plan is to lower down the environmental footprint regarding research activities, we do aware that the overall environmental changes happening in Svalbard and the Arctic can only be tackled with global actions. The environmental effect is expected to be localized in Svalbard and has a limited effect of the mainstream of climate changing. However, as an important international research destination, and a named 'sustainable destination', keep its pristine condition of this archipelago is essential for Svalbard sustainable development and therefore benefits sustainable development regarding international scientific research. Additionally, minimizing the environmental footprint regarding research practice, and accordingly developing a more sustainable research practice serving the same research purpose with a smaller environmental footprint has a symbolic meaning of seeking Sustainability.

Our competence:

In this project, we as sustainable design engineers, can provide a different perspective of analyzing current practical problems researchers are struggling with and identified theoretical gaps. Also, as Svalbard Science Forum is not entirely successful in articulating the strategy on the level which the researchers could understand and more importantly implement. We have the opportunity to help design actionable strategy enabling research affiliated actors to work with the sustainable development of their facilities and moreover practices by helping them understand what Sustainability is.

However, throughout the project, we also have been presented some challenges, which limited our capability. First of all, the project case located far away from Denmark, where the project was conducted. As a result, the whole project research and analysis are done remotely from Svalbard. Needed data are collected by half-structured interviews, emails and desk research.

Given the fact that what people say not necessarily in line with what they will do, and also, something may easily be taken for granted that not problematic in temperate

climate zones but could be a problem in polar climate zones. It would be a great add on, if we could gather first-hand data by presenting in the local surroundings and comply methods, such as follow-the-actor and observation. To minimize the limitation, we have managed to interview as many researchers as possible and map out the main features of the local environment to remind us of the unique local environment.

Another consequence of conducting project remotely is the lack of direct interaction with actors been studied. It was planned to have workshops or design games with researchers who had experience in Svalbard during the solution development phase. Unfortunately, when it is needed for a workshop, summer season already started. Researchers already went to Svalbard so that there is no chance for researchers to participate in workshop-like activities. Therefore there might be a gap between the expected results of our solution and its implementation in the real world. To minimize the gap, we intend to have a discussion with researchers and the staff from Svalbard Science Forum if it is possible or get feedback by email as the next step to develop an action plan.

8.2. What we have intentionally left out of our scope

As the growing interests to Svalbard not only among researchers, academics but also tourists, the increasing yearly number of visitors are inevitably affecting the increase of emissions in terms of transportation.[see chapter 8: Discussion] The most common way to travel to Svalbard is by plane, to the administrative centre and largest settlement of the islands, Longyearbyen, secondly a big cruise-boats. Aeroplanes emit particles and gases such as carbon dioxide (CO2), hydrocarbons, carbon monoxide, nitrogen oxides, sulfur oxides, lead, and black carbon which interact among themselves and with the atmosphere[Easa.europa.eu, 2019]. As a big polluter, we consider this as an inevitable part of Svalbard sustainable development. In regards to research practice, it does play an important part in the environmental impact of research practice, but we did not focus on this mainly because we assume it is more relevant to tourism. Since researchers usually fly in and out in the time range of at least 3 weeks, sometimes counted to months, whereas a regular tourist turnover is counted to days. However, as a primary source of pollution, this could be analysed as an individual project.

Figure 41: Equipment transport to the research site by Centre for Polar Ecology, Svalbard, n.d

9. Conclusion

Growing activity in conducting Research in the extreme environment of the Arctic circle presents a long-term problem resulting in damaging the local environment if not aware of sustainability regarding research activities. The elaborated research area in this paper is not only for the sake of the local environment but also for the symbolic meaning for steering sustainable scientific Research in a sustainable manner.

The paper aimed to fit in the identified gaps in present literature research:

1. the lack of the conceptual knowledge and action research
2. the lack of localized knowledge with a focus on indigenous social groups in the Arctic. At the same time, supporting sustainable development of local research communities by equipping the main actors in Svalbard, particularly: researchers, research secretariat (SSF), research managers, and design engineers, with a different perspective and concrete tools of tackling sustainability issues.

Further on to answer presented research question:

How can sustainability be framed in relation to research activities in svalbard context and how can we explore related issues and what strategy can help to address them? Which we devided into three sections.

Perspective on sustainable Research Activity

Therefore we offered a perspective based on local focus on Research with a thorough understanding of aspect specific to Extreme weather, Vulnerable environment, Arctic Circle seasons, Climate Change, Social Worlds and local Settlements. For example, focusing on already established settlements, infrastructures and projects is the critical point to see the challenges and possibilities for successful promotion and moreover for reshaping of activities to lower the Environmental Footprint.

As a highly valued scientific destination, the local environment has to keep the wilderness as much as possible. Considering the increasing interest in conducting Research in Svalbard, our perspective on sustainably conducted research activities, specifically, is to improve the current situation of research practice towards a future sustainable scenario where research activities contributing to the world knowledge are executed without compromising the environment and therefore are able to continue for a long time.

Take on Investigated issues

Accordingly, to support this development, practice theory was used to develop a more action-guiding context: a substantive part of changing researchers practices to more sustainable ones (in terms of lowering the environmental footprint) is their realization of their daily routines and more importantly what shapes them. Therefore, we analyzed the interaction between Environmental Footprints and research practice to raise awareness of sustainability which actually relies on everyone's every day activities and equip knowledge of how to improve them. We have done this by making Material flow analysis based on the Environmental Footprint method. By doing so, potential improvement regarding research activities is presented, which would give already busy scientists an image of the need for a change. Additionally, it contributes to further guidance for how to conduct Research in a sustainable manner, for example, sharing experience, research data and research plan, applying renewable energy supply, and so on.

If this project continued further on, we would intend to translate all the possibilities from the strategic plan into Action to take a guide. Nonetheless, this is not a part of the current paper.

A platform for actions to take

The strategy which we are proposing solves the problem only to the extent of providing a grounding for Researchers, researchers, research secretariat (SSF), research managers and design engineers to take Action in identified areas. Also, the Strategy needs to stay in the context previously provides an understanding of Our Perspective - Sustainably conducted Research in Svalbard.

The core of this strategy is the strategic plan providing an overview of improved areas, lately developed in concrete actions to take. To achieve the strategic goal presented in our vision, actors need to show far more efforts in developing individual ideas into an action plan. The awareness, that nothing is as solid as stone, is projected in the openness of the strategy to new ideas and moreover in flexibility to be adapted to each specific research station/programme. Implementation of our strategy to researchers' routines could result in Svalbard being the leading symbol of Sustainably conducted Research in the international research society.

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Figure 42: Just don't die (source: Unsplash)

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