NTNU
Norwegian University of
Science and Technology

The Communication Relationship Between the Scientific Community at the Industrial Ecology Program and Society

Julie Schwabe Strand

Master in Industrial Ecology
Submission date: June 2016
Supervisor: Francesca Verones, EPT

Norwegian University of Science and Technology
Department of Energy and Process Engineering

NTNU

Norwegian University
of Science and Technology

Department of Energy
and Process Engineering

EPT-M-2016-132

MASTER THESIS

for

Student
Julie Schwabe Strand

Spring 2016

The communication relationship between the scientific community at the Industrial Ecology programme and society

Kommunikasjonsforholdet mellom forskningsmiljøet ved program for Industriell Økologi og samfunnet

Background and objective

Changes in the climate, impacts on biodiversity, and other environmental issues have gained increasing attention over the past years. Although the scientific community provides research results and data for drivers and consequences of these changes and impacts, the progress in society to adapt to and mitigate the changing environment is rather slow. Changes are skeptically looked at and miscommunication leads to a lack of understanding. A general understanding of research on environmental issues is necessary for society to be able to change. However, if the science does not reach the public directly the societal perception of environmental issues may be distorted and underestimated. The aim of this master work is therefore to investigate how the communication between environmental research and society (including politicians and NGOs) functions today and how it can be improved. For that purpose, a quantitative analysis of two surveys shall be performed with a focus on the communication between Industrial Ecology and society, and the societal perception of environmental issues.

The following tasks are to be considered:

1. Provide an overview of useful channels for (scientific) communication and an overview of remedies to improve communication.

2. Investigate channels of communication of the Industrial Ecology Programme at NTNU.

3. Investigate how society perceives basic environmental issues. Are they concerned? About what?

4. Investigate how society acquires information about environmental issues. Drawing on information from task 1, what are concrete measures to improve this information flow?

5. In addition, perform a quantitative analysis of two surveys sent out to researchers of the Industrial Ecology Programme at NTNU and society.

6. If possible (i.e. if the results are available), compare the results with a survey from forskningsrådet sent out in late 2015.

-- " --

Within 14 days of receiving the written text on the master thesis, the candidate shall submit a research plan for his project to the department.

When the thesis is evaluated, emphasis is put on processing of the results, and that they are presented in tabular and/or graphic form in a clear manner, and that they are analyzed carefully.

The thesis should be formulated as a research report with summary both in English and Norwegian, conclusion, literature references, table of contents etc. During the preparation of the text, the candidate should make an effort to produce a well-structured and easily readable report. In order to ease the evaluation of the thesis, it is important that the cross-references are correct. In the making of the report, strong emphasis should be placed on both a thorough discussion of the results and an orderly presentation.

The candidate is requested to initiate and keep close contact with his/her academic supervisor(s) throughout the working period. The candidate must follow the rules and regulations of NTNU as well as passive directions given by the Department of Energy and Process Engineering.

Risk assessment of the candidate's work shall be carried out according to the department's procedures. The risk assessment must be documented and included as part of the final report. Events related to the candidate's work adversely affecting the health, safety or security, must be documented and included as part of the final report. If the documentation on risk assessment represents a large number of pages, the full version is to be submitted electronically to the supervisor and an excerpt is included in the report.

Pursuant to "Regulations concerning the supplementary provisions to the technology study program/Master of Science" at NTNU §20, the Department reserves the permission to utilize all the results and data for teaching and research purposes as well as in future publications.

The final report is to be submitted digitally in DAIM. An executive summary of the thesis including title, student's name, supervisor's name, year, department name, and NTNU's logo and name, shall be submitted to the department as a separate pdf file. Based on an agreement with the supervisor, the final report and other material and documents may be given to the supervisor in digital format.

☐ Work to be done in lab (Water power lab, Fluids engineering lab, Thermal engineering lab)
☐ Field work

Department of Energy and Process Engineering, 13. January 2016

Olav Bolland
Department Head

F. Verones
Francesca Verones
Academic Supervisor

Research Advisor:

Preface

This master thesis is written to conclude my master's degree at the program of Industrial Ecology at the Department of Energy and Process Engineering at the Norwegian University of Science and Technology. The master thesis was conducted during the spring of 2016, and is a continuation of the project thesis undertaken in the fall of 2015.

Working with the master thesis this semester has been a journey. First and foremost, I want to thank my academic supervisor Dr. Francesca Verones. She has supported me this whole semester and encouraged me to see things in a new light. I am grateful for her availability throughout the semester, and her quick feedback on my work. I also want thank my friends and classmates for academic discussions and our shared interest in environmental affairs. It has been reassuring and helpful to know that everyone has shared the same frustrations I have encountered with this work. Lastly, I want to thank my patient boyfriend and my supporting family. I would not have made it this far without them.

Julie Schwabe Strand
June 2016
Trondheim

Abstract

This thesis maps the communication of environmental science at the program of Industrial Ecology at the Norwegian University of Science and Technology and in the Norwegian society, with the intention to come up with suggestions for an improved dissemination practice. To understand how science dissemination affects social perception of environmental issues, I investigated used channels for communication and experienced barriers with information. This was explored through descriptive statistics from two surveys created in relation to my project thesis in the fall of 2015. In addition, a hierarchical multiple regression was used to test the ability channels and experienced barriers had in predicting environmental literacy. My results indicate that the channels through which environmental science is disseminated do not conform to the channels used by society for information acquisition. While scientists mainly conduct research oriented dissemination through channels such as journal articles and conferences, society uses traditional media to consume environmental information. This communication gap affects the development of environmental literacy in the public. Although society's most used channels did not yield significant results on environmental literacy, popular science media did. In addition, experienced issues with opinionated science turned out to significantly affect environmental literacy. I suggest that the program of Industrial Ecology should take more use of traditional media (regular and online) and further explore the internet in their dissemination work. In addition, the scientists should undergo formal education to make sure they possess the right skillset for communication with a lay audience, as well as making their research easier and more entertaining to consume. I further suggest that the university implements better recognition for science dissemination, and facilitates this practice.

Sammendrag

Denne masteroppgaven kartlegger kommunikasjon av miljøvitenskap ved program for industriell økologi ved Norges teknisk-naturvitenskapelige universitet og i det norske samfunnet, med intensjon om å komme med forslag til en forbedret formidlings praksis. For å forstå hvordan vitenskapsformidling påvirker samfunnets oppfatning av miljøspørsmål, undersøkte jeg kanaler brukt i kommunikasjon og opplevde barrierer med informasjon. Dette ble utforsket gjennom beskrivende statistikk fra to spørreundersøkelser som ble opprettet i forbindelse med master prosjektet mitt høsten 2015. I tillegg ble en hierarkisk multippel regresjon brukt for å teste evnen kanalbruk og erfarte barrierer hadde til å predikere miljøkunnskap. Mine resultater viser at kanalene miljøvitenskap spres gjennom ikke svarer til de kanalene som brukes av samfunnet for informasjons tilegnelse. Mens forskere hovedsakelig driver med forskerrettet formidling gjennom kanaler som tidsskriftartikler og konferanser, bruker samfunnet tradisjonelle medier til å konsumere miljøinformasjon. Dette kommunikasjonen gapet påvirker utviklingen av miljøkompetanse i befolkningen. Selv om samfunnets mest brukte kanaler ikke ga signifikante prediksjoner på miljøkompetanse, gjorde populærvitenskapelige media det. I tillegg viste det seg at opplevde problemer med personlige meninger i vitenskap påvirket miljøkompetanse signifikant. Jeg foreslår at program for industriell økologi tar mer bruk av tradisjonelle medier (vanlig og online) og ytterligere utforsker internett i formidlingsarbeid. I tillegg bør forskerne ta en formell utdannelse for å sørge for at de har rett kompetanse for kommunikasjon med lekfolk, samt gjøre sin forskning enklere og mer underholdende å konsumere. Jeg foreslår videre at universitetet implementerer bedre anerkjennelse for forskningsformidling, og tilrettelegger for denne praksisen.

Abbreviations

ANOVA — The analysis of variance

ISSP — International Social Survey Programme

NSD — Norsk Senter for Forskningdata

NTNU — Norwegian University of Science and Technology

SVT — Faculty of Social Science and Technology Management

SYSMIS — System missing/A respondent did not answer the question

Table of contents

List of tables

List of figures

1 Introduction

1.1 Environmental science and communication

We are all part of the natural system that is planet Earth. The environment we live in provides us with all our necessities such as resources, weather control, disease regulation, and recreation, that are essential for our survival and development (1, 2). A sustainable, healthy environment is something we must all strive for in order to ensure enough resources for future generations (2, 3). The only way we can transform into a more sustainable society is if we know about the occurring changes and solutions to environmental problems. Dissemination of environmental research is therefore key to enable societal change.

Communicating environmental science is important to create a shared understanding about issues regarding the environment (4, 5). This information has usually been mediated by media professionals or trained educators (4, 6). However, the importance of a scientific voice is greater today than ever before as the media landscape has changed considerably (5). Today, environmental information is communicated through a vast set of platforms, such as journal articles, TV, newspapers, social media, blogs, films, public presentations, and more (5). The audience is in need of trustworthy voices and reliable facts to sort through the massive amounts of information available in today's media landscape (5). Cantrill and Oravec (7) claim that the *"environment that we experience and affect is largely a product of how we have come to talk about the world"*. Considering this, the dissemination of environmental science in an understandable matter, and who communicates it, affects how society chooses to deal with environmental issues.

Over the past couple of decades, greater emphasis has been placed on dissemination of environmental science and research to the lay public (4, 8-11). Norwegian universities are even required by national laws to disseminate science and spread knowledge to society (12). Carlsen et al. (13) argue that in order for society to consider social processes and understand the world, knowledge must be communicated to everyone (13). Secondly, Carlsen et al. (13) claim that science dissemination is related to our use of knowledge. Societal development relies on stakeholders having access to vital information that affect them and are relevant for their businesses (13). The science dissemination practice in Norway has been highly debated by media professionals, universities, politicians, and scientists (14-16). Although many consider the practice to be adequate, most people argue that scientists need to open up more about their research and improve their communication skills (17).

A lot of work has been undertaken to investigate why people act environmentally (e.g., (18-20)), how environmental literacy and pro-environmental behavior are linked (e.g., (18, 21)), and how different media effects influence pro-environmental behavior (e.g. (22, 23). In addition, multiple studies have looked at how to communicate science (e.g., (4, 24, 25)), and research on barriers that complicates understanding of science has grown (8, 26-28). In Norway, a few studies on science dissemination at universities have been undertaken (e.g., (9) and (29)), however, research on how different channels and obstacles can affect scientific literacy is lacking. In this work, I aim at investigating at this relationship. I am going to look at how environmental science and research is disseminated today at the program of Industrial Ecology at the Norwegian University of Science and Technology (NTNU), and how society perceives environmental information. Further, I will link this to channel use and experienced barriers. My research question is:

> *How is environmental information communicated to society, and what measures can be taken to increase society's literacy on environmental issues?*

Information about communication practices and perception of environmental issues will be obtained through two surveys I created in relation to my project thesis in the fall of 2015 with the intended use for this master thesis. By mapping the communication practices, my intention is to come up with suggestions on the best ways to disseminate environmental science and research at the program of Industrial Ecology to increase understanding in society.

In the following, a clarification of the concepts used in this work will be presented. After that, chapter 2 presents a short literature review of environmental communication and public perception of environmental science. In chapter 3, I illustrate the methodological choices made in the study and show how the work can be replicated. Chapter 4 deals with the results, and in chapter 5 I discuss the findings and implications of these. Finally, concluding remarks and suggestions for further research are made in chapter 6.

1.2 Key concepts

The Norwegian society

The term "society" is often understood synonymously with the word "nation" (30). However, a society is more than just the national borders in which inhabitants reside. A more fitting definition of "society" for this purpose would be that of the social sciences where society is defined as a "social system" (30). A social system describes relations and interactions that are more firm than other social patterns, but not as constant as some natural systems (31). This entails considering society as a set of social actors, which interact with each other – both with their own community and nation, but also the rest of the world. The Norwegian society then, is a specific society that encompasses the Norwegian population, beliefs, and social interactions (32). For the purpose of this work, I will use the term as described here when I refer to the Norwegian society.

Environmental science and Industrial Ecology

Environmental science is an overarching term for sciences that are related to the environment in some way. The environmental sciences help us understand more about natural systems and interactions, and how we as humans affect it (33). It encompasses scientific fields such as biology, chemistry, physics, energy, ecology, and more (34). The field of industrial ecology is a branch of environmental science that focuses on systems thinking within the environmental system (35). It investigates how human systems and lifestyles interact with the natural environment, and how they impact the surroundings. Industrial ecology is focused on material and resource use, and tries to find ways to quantify and lessen the impact humans have on the environment (35).

Science communication and dissemination about the environment

Communication can be defined as interaction between two or more entities, be it humans, organisms, ecosystems, computer technology, or other (4, 36). In this context, it is limited to human interaction. [Human] communication can take various forms and be verbal or non-verbal, or any combination of these (37, 38). In addition, we differentiate between one- and two-way communication (37). The former refers to communication where the recipient (i.e. reader, listener etc.) has no possibility to respond to the sender of the message (37). Two-way communication entails an interaction where both parties can send and receive messages (37). Communication is a big part of what makes humans interactive beings (37, 39), and enables us to learn, develop, and participate in public life (40, 41). The overarching goal of intended communication, what we call *successful* communication, is for both the sender and receiver of a message to fully understand the content of said message (4).

Communication seeks a shared understanding of something. Although we experience communication (or rather, interaction) where shared understanding is not necessarily the goal (38), this type of unintended communication will not be dealt with here.

The Norwegian Research Council (Forskningsrådet) defines science dissemination as communication of science and research (42). In their strategy report from 1997, they point out that science dissemination can be split into three different types, based on the stakeholder group the disseminator addresses. These are *researcher oriented-*, *user oriented-*, and *public oriented* *dissemination* (42). While researcher oriented dissemination consists of communication with other professionals, user oriented- and public oriented dissemination includes a lay audience. The user oriented dissemination involves communication with specific groups, institutions, or other stakeholders that rely on the researchers' science in their business (42). Public oriented-dissemination involves communication to the lay public audience – the society (42). When I speak of communication or dissemination, I refer to the type of communication where a sender wants to convey a specific message with a goal of shared understanding. The two terms, communication and dissemination, will be used synonymously.

Environmental communication is a broad term that encompasses all types of communication about the environment (4). Klöckner (38) defines environmental communication as *"[…] a process by which meaning about the environment and environmental problems is exchanged between individuals through a system of common symbols, signs, and behavior".* For the purpose of this work, I limit the term to include only communication between environmental scientists and the lay public about environmental information. With environmental information, I refer to all types of messages exchanged about the science and research of environmental issues. This can be information about climate change, ecosystem services, biodiversity, local pollution, or more.

Environmental literacy

Miller (43, 44) argues that being scientifically literate means to have a general understanding of science, and to possess a basic vocabulary of scientific terms. Environmental literacy, or knowledge, refers here to the level of information a person holds about certain types of environmental affairs; issues that are often frequented in the news media. It also considers how people understand environmental controversies debated in the public. Essentially, it means how well informed people are about the environment. An example is how people perceive blame or liability of climate change. While some people may agree that China can be blamed for the climate changes we see today, research indicates that we cannot simply blame one country (45-47). Although China is responsible for a large amount of the world's emissions and is the biggest emitter today (46, 47), when we consider per capita emissions and emissions embodied in trade, the blame is harder to place. Perceiving this one way or the other gives an indication of how well informed (or literate) a person is on environmental research and science.

2 Theoretical framework

2.1 Public interest in and understanding of environmental science

How interested people are in environmental issues can affect how much information they acquire about the topic, how they act, and how much knowledge they take with them (48). Extensive research has been conducted globally to uncover public interest in and perception of science (49, 50). Concerning general science, these studies have shown that people generally have a high interest in science and technology (11, 49-51). In Norway, similar studies have been conducted. In a study of the population's relation to research, science, and technology from 1999, Ramberg et al. (52) asked two questions about personal interest in and societal importance of different disciplines[1]. They found that *"environmental science"* was ranked third on personal interest, but was considered the most important discipline for society by the majority (52). Five years later, however, Ramberg (53) discovered that not only had the personal interest for *"environmental science"* declined with 5.5%, but it was now only considered to be the second most important area of study. The European Commission also conducts surveys on a regular basis to measure attitudes, interest, and opinions in Europe through the Eurobarometer (54). In the 2005 Eurobarometer (55), a high interest in environmental issues was found in Norway. According to the survey, the topic of *"environmental pollution"* was considered the most interesting topic to read about in the news (55). This interest was also evident in the 2007 Verdiundersøkelsen (56) where *"environmental pollution"* was considered the most important issue to deal with when asked about the United Nation's Millennium Development Goals[2] (56).

More recent surveys, like The International Social Survey Programme (ISSP) environment survey from 2010 (57), or Forskningsrådet's (58) survey in 2014, have found similar results. ISSP (57) saw that 15.3% of the Norwegian population considered the environment to be the most important issue in Norway, while 15.6% deemed it second most important. Forskningsrådet (58) found that 12% of the population were *"very interested"* and 35% *"pretty interested"* in science and technology. In the 2015 Klimabarometer, TNS Gallup (59) found an increased interest and concern for the environment compared to previous years. They saw that not only was *"climate change"* considered to be the second most important challenge Norway faced (second to *"immigration"*), but two thirds of the population were concerned with how they themselves could reduce their impact on the environment.

---

[1] The two questions asked were *«Which two disciplines interest you the most?»* and *«Which of the same disciplines do you think are the most important for society?»*

[2] The options were *«That people live in poverty and need»*, *«That girls and women are discriminated against»*, *«Bad hygienic conditions and infectious diseases»*, *«Insufficient education»*, and *«Environmental pollution»*.

Interest in environmental science is an important factor to consider when communicating science to increase public awareness and knowledge. Although it has been shown that people generally have a high interest in science and environmental issues, studies have discovered that people tend to have a medium to low understanding of it (11, 49, 57, 60). The 2010 ISSP (57) survey showed that only about half of the population (48.3%) was concerned about environmental issues in general. However, people were concerned about environmental threats facing Norway (Figure 1). The 2010 ISSP (57) asked the respondents to select the environmental issue they considered most important for Norway. The results showed that climate change, resource depletion, and air pollution was thought of as most important (Figure 1).

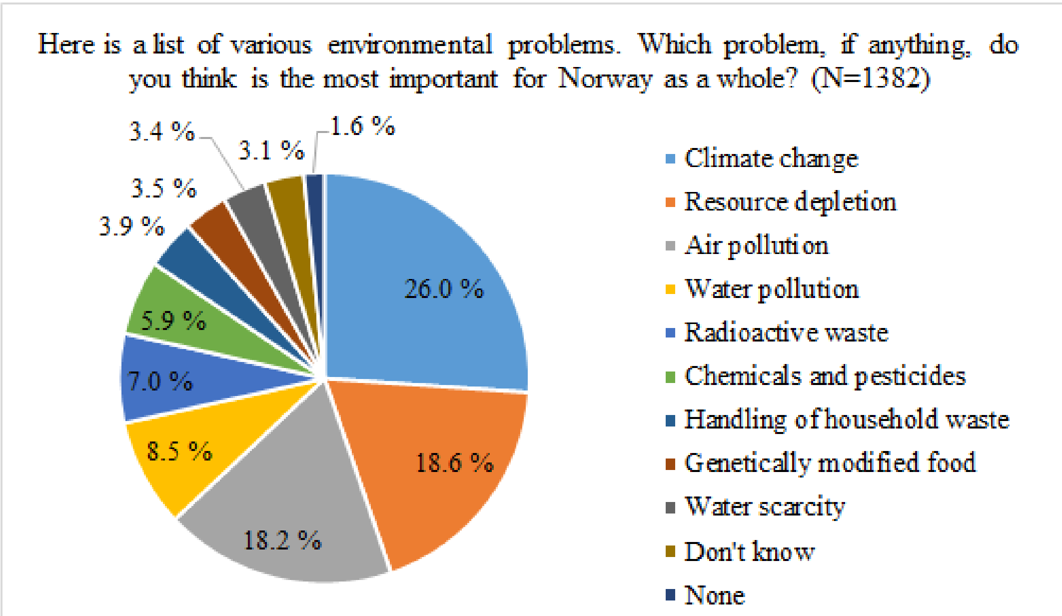

Figure 1 Percentage of population who think different environmental problems are important

When it comes to scientific literacy on environmental issues, 50% reported they knew a lot[3] about the causes for the listed environmental problems, but only 31 % said they knew a lot about solutions to these problems. However, despite a relatively high self-reported literacy, the 2010 ISSP (57) discovered that a minority of Norwegian people considered air pollution from cars, temperature increase due to global warming, and pollution to rivers and lakes as *"extremely dangerous"* or *"very dangerous"* to the environment (29%, 39%, and 35%, respectively). This may imply that people tend to overestimate their own scientific literacy.

Why are society less informed or have less actual knowledge about the environment than their interest and self-declared environmental literacy imply? The actual access to research and

[3] On a Likert scale: 1=«*Do not know anything at all*»; 2; 3; 4; 5=«*Know a great deal*», replies of 4 and 5 on the scale make up 50 % of the respondents.

information can explain some of the variance in environmental knowledge (4, 28, 52, 61). Falk and Storksdieck (48) claim that it matters where research and information is published as people are selective of how they appropriate knowledge. Accessibility is therefore an important factor to consider. However, according to Hayes (62) the complexity in how environmental science is presented by many scientists may explain more. Since terminology and jargon is not consistent between disciplines and different scientific literature (62-64), it is also inconsistent between scientific literature and "the common tongue". Unknown and complex terminology and language in scientific writing prohibits people from creating meaning from what they have read, and thus people misunderstand the key messages (27, 50, 62). Trust in sources that provide environmental information is also something that should be considered. According to Lorenzoni et al. (27), people tend to disregard information if the sources are not considered reliable by the audience, or if the sources are unknown. They also found that a low understanding of science could be explained by confusion or uncertainty about conflicting opinions and facts in the media. Ryghaug et al. (28) also discovered this to be a barrier to understanding environmental science. They saw that not being able to differentiate between opinions and facts, and the conflicting public debate about environmental issues, furthered confusion about what to believe.

2.2 Environmental communication in practice

There has always been a debate in the scientific community about neutrality and objectivity of the scientist (5). Should scientists only restrict themselves to publish research in journals and disseminate science to peers? Or do they have a moral obligation to communicate results further to society and to advocate for solutions? Soulé (65) insisted that some disciplines, like conservation biology, demanded that the scientists could not remain silent about their research as it could have tremendous impacts on society. He argued that certain disciplines have an ethical duty to address issues in the public and offer recommendations to society in order to face environmental problems. Although many natural scientists agree to advocating certain responses to environmental issues (4, 5, 66, 67), others recommend restraint (68-70). Wiens (69) argues that taking a stand or sharing opinions in an environmental issue in the public can affect the scientific procedure itself. He agrees that environmental research - when valuable to society - should be presented objectively to the public in order to inform the citizens. However, he warns scientists about getting emotionally involved and advocating specific responses or solutions to problems as this goes beyond the objective science (69).

In Norway, the attitudes of natural scientists seem to be in line with Soulé's opinion. In Forskningsrådet's (71) survey on science communication from 2015, it was discovered that 83% of natural scientists considered *"spreading knowledge to society"* an important motivation for science communication. They also found that 52% felt it was important to find time to communicate science, and 61% claimed they wanted to spend more time on it. However, their attitudes were not reflected in their practice. Only 26% spent more than 5 hours a month communicating science to the public (71). In addition, when asked about the importance of communicating with different groups, *"Most people"* was considered least important (71)[4].

The concern to remain neutral and objective is also manifested in the expectations of universities, research facilities, and peers (72). There is – and has always been – a pressure from these institutions on scientists to publish their work in scientific journals (13, 72). The fear of losing neutrality and objectivity, coupled with a pressure to publish in "respected journals" or other "scientific channels", affect the channel choice of scientists when they disseminate their work (5, 73). Today, scientific articles are the main channel environmental scientists use for communicating research and possible effects of certain actions (4, 72, 73). When environmental science is mainly available through scientific articles, public access to the information becomes limited. This is due to limited availability to the general public, and frequent use of technical language (62). Although some of these journals are open access, most people get their latest information on research and environmental issues from internet channels and news media (55, 61, 74) (see section 2.3). The amount of published articles in journals about environmental issues compared to broadcast media is enormous. A search with Web of Science for the word *"environment*"* including either *"issue*"* or *"problem*"* in published work turned out approximately 8200 pieces (75). This was even while restricting the search to only include articles, published in English and in 2015, and within the research area *"environmental sciences and ecology"*. Searching in Retriever's ATEKST[5] for "miljøproblem*" in Norwegian news media in 2015 turned out 1946 pieces of information, where many were letters to the editor and replicas. Although a superficial examination, this illustrates a picture of the small piece of information the news media publishes compared to published research. The limited scientific content in the news media then prohibits society to gain increased knowledge about environmental research.

[4] 1. *«Students»* (90%), 2. *«Pupils, teachers and schools»* (74%), 3. *«Politicians and government»* (72%), 4. *«Journalists/media»* (68%), 5. *«NGOs»* (54%), 6. *«Employees in public sector»* (52%), 6. *«Employees in private sector»* (52%), 7. *«Most people»* (50%).

[5] Retriever's ATEKST is an online search tool to look up Norwegian media pieces.

Although scientific articles are the main channel environmental scientists worldwide use to disseminate science, the situation in Norway seems to be different. Forskningsrådet (71) found that *"popular science presentation"* and *"arranged/co-hosted seminar, conference, network gathering, event"*[6] were the two forms of dissemination activities natural scientists in Norway[7] use the most (Figure 2), although only slightly more than articles. *"Academic article"* was the third most used communication activity (Figure 2).

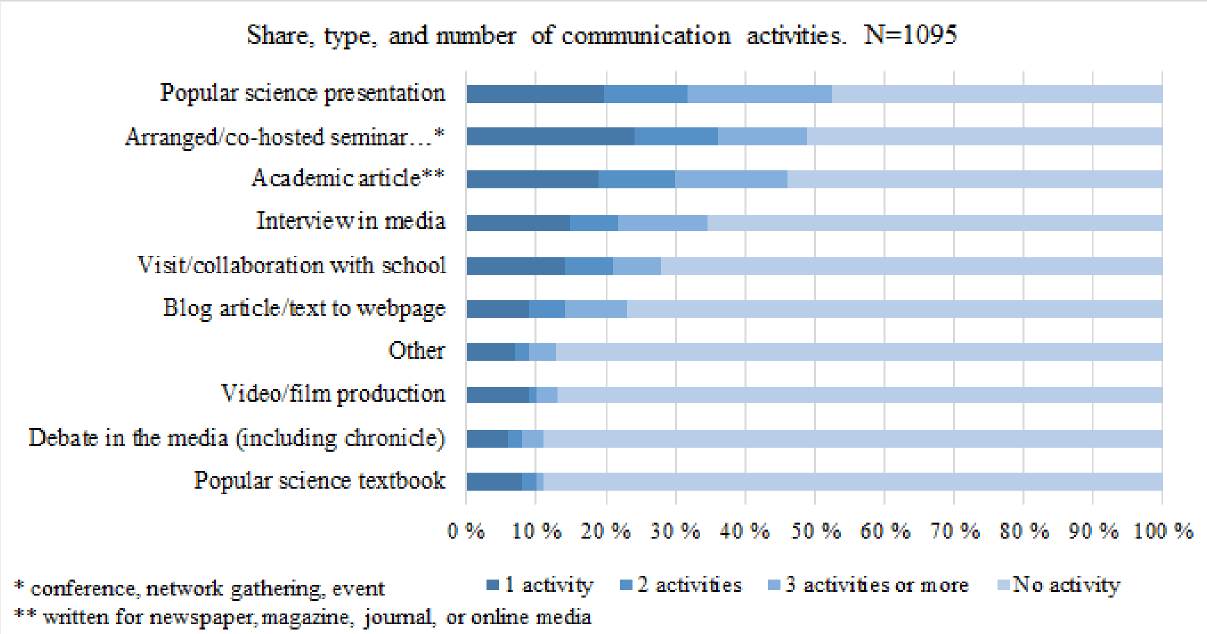

Figure 2 Communication activities over the past year amongst natural scientists in Norway (71)

However, considering only written science dissemination and differentiating between journal articles and popular science, the difference between the two is worrisome. In 2005, Kyvik (9) published a study on science dissemination at Norwegian Universities between 1998 and 2000. He found that only 44% of natural scientists had published a popular science article, and only 23% had contributed with an article to the public debate. On average, this amounted to 1.4 and 0.8 articles per natural scientist over the three years (9). Comparing this to the number of published academic articles, which was 10.1 on average, the difference between the two is enormous. In the years between 2005 and 2007, similar tendencies were found for all scientists in Norway. Bentley and Kyvik (29) saw that while scientists within all fields published 8.2 academic articles on average over the three years, only 2.0 popular science articles were published within the same timespan.

[6] Translated from Norwegian *«populærvitenskapelig foredrag»* and *«arrangert/vært medarrangør for seminar, konferanser, nettverkssamling, arrangement»*.
[7] Not necessarily scientists with a Norwegian citizenship, but scientists based in Norway.

2.3 Society's channel choices

People gain knowledge about the world around them either by personal experience, or some type of communication through a medium (4, 76). Which channels they use depend on a number of factors; convenience and availability (76), content (36), the degree to which the channel satisfies personal needs (77), speed of updates (78), and ability to be anonymous (78), among others. Statistisk sentralbyrå investigates the Norwegian population's media habits through Norsk mediebarometer every year (79). The survey looks at people's mass media habits, time spent on media consumption, and the access to different media. It also looks at differences regarding which platform the medium takes place (i.e. regular versus online media). The differences in share of people who use different channels were quite big for the Norwegian population in 2015 (Figure 3).

In 2015, internet was the most used channel with 87% of the population using it on average daily (Figure 3). Included in the internet-use was also the use of social media (79). 70% of internet users frequented Facebook, 11% read blogs, and 44% used it for other types of social media. Reading newspapers was the second most used medium. 72% of the population reported to read newspapers on a daily basis in 2015 (Figure 3). TV was the third most used medium with 67% of the population using it daily (63% regular and 11% online), and 59% of the population listened to the radio (Figure 3). Journals were also listed as an option in the survey. In 2015, 8% of the population read print journals and 10% read online journals on average daily, totaling up to 16% unique users in the population (Figure 3).

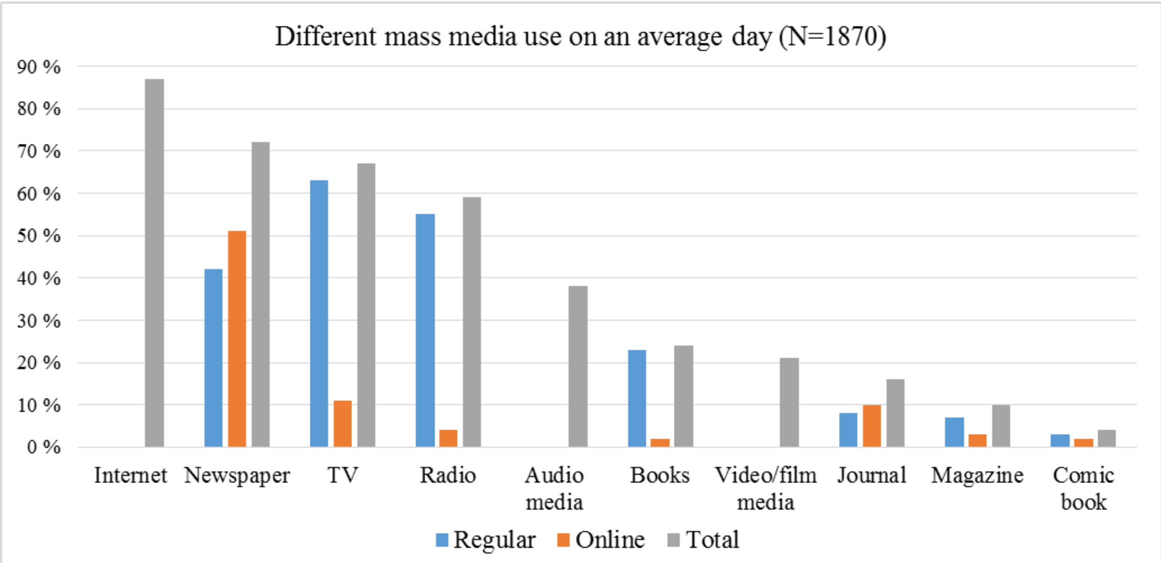

Figure 3 Share of users for different media. Regular, online, and total users displayed (79)

Comparing the results from the 2015 Mediebarometer with previous years, certain media trends become clear. Less and less people read newspapers (print), magazines (print and online) and journals (print and online), and they generally watch less TV (79). The amount of people who listen to radio, however, has been relatively stable over the past 20 years (79). Internet users on the other hand, have grown rapidly in recent years. In 2004, "only" 44% used internet daily, and in four years, this percentage grew to 71% of the population (79).

When it comes to deliberately seeking out information about science and nature, the media picture is quite similar. Forskningsrådet (74) reported that in 2014, internet was the most used medium to acquire information about research with 48% stating it was their main source. TV came in second with 15% of the respondents, and newspapers followed at 14% (74). Some people also used social media to acquire information about research. 1% reported social media to be their biggest source of information on science and research (74). However, journals or other specifically academic sources (such as debates, presentations or the like) were not among the options respondents could choose from[8]. The 2015 Mediebarometer (79) found that 50% of internet users used the internet for factual and background information. They further discovered that TV and radio were mostly used for news (46% and 45%, respectively) however, a small percentage of the population also used TV for debates (6%) and programs about nature (4%) (79). People who read journals mostly read professional and union leafs (49%), but 17% of the population read journals about science, politics or culture (79).

2.4 Channel groupings

There are numerous different types of media to use in science dissemination and information acquisition, and no list will ever be exhausted (4, 80). However, these can be split into groups depending on what types of medium they are, what genres they cover, to whom the message is intended, or other groupings (9, 25, 36, 81). For this work, I differentiate between *traditional media in their original form; traditional media found online; new media; scientific media;* and *popular science media.* Traditional media (online and printed) are understood here as broadcasting mass media (76), and new media indicates the use of internet for social media and webpages other than broadcasting media (78). Scientific media refers to channels (online and printed) where the information is produced by scientists and is mainly for other scientists or science students (9). The last category is labelled popular science media, and includes media (online and printed) that are often used to popularize science for the lay audience (4, 25).

[8] The source options were: *«internet», «TV», «newspapers», «magazines», «social media», «books», «radio», «other»,* and *«don't know».*

2.5 Research question and hypotheses

As introduced in section 1.1, my research question is *How is environmental information communicated to society, and what measures can be taken to increase society's literacy on environmental issues?* To answer the first part of the question, I investigate the communication practices at the program of Industrial Ecology through descriptive statistics from a survey sent to researchers at the program (see section 3.1). The second part of the question will be answered through descriptive statistics from this survey, as well as a survey sent out to the public (see section 3.2). Also, a set of hypotheses derived from the theory will be tested. In addition, I will describe what environmental issues society is concerned about.

There seems to be a discrepancy between where environmental science is published, and from where people acquire it. To investigate how society's channel choice affect environmental literacy, hypotheses *H1 - H5* will be tested:

H1: Traditional media (old platform) have a positive effect on environmental knowledge.

H2: Traditional media (new platform, i.e. online) have a positive effect on environmental knowledge.

> *H2.1: Traditional media (new platform) have the biggest effect of all channel groups.*

H3: New media have a positive effect on environmental knowledge.

H4: Scientific media have a positive effect on environmental knowledge.

H5: Popular science channels have a positive on environmental knowledge.

> *H5.1: Popular science media have a bigger effect than scientific media.*

Hypotheses *H6 – H8* cover difficulties with acquired environmental information. Scientific language is more difficult than the lay audience has experience in, and people struggle with differentiating between scientific facts and opinions. In addition, trust in the sources of information can create some of the variance in people's perception of environmental information. These three issues will be investigated by the following:

H6: Experienced difficulties with languages have a negative effect on environmental knowledge.

> *H6.1: Difficulties with language have the biggest negative effect of the three barriers (language source, and science vs. opinions).*

H7: Experienced difficulties with sources have a negative effect on environmental knowledge.

H8: Experienced difficulties with science and opinions have a negative effect on environmental knowledge.

To see which is more important in predicting environmental knowledge, a comparison between channel choices and barriers will be undertaken. To explore this, *H9* will be tested:

H9: Barriers in understanding science are more influential than channel choice.

3 Materials and methods

I use data from two surveys I created in relation to my project thesis in the fall of 2015 with the goal of exploring them in the master thesis. The first survey, *"Communicating environmental science"* (Appendix A), was created to uncover practices and attitudes at the program of Industrial Ecology at NTNU towards disseminating environmental science to the public. This survey is referred to as "survey 1" in the continuation of the work. The second survey *"Klima og miljø: kunnskap og interesse"* (Appendix B), was developed to understand the Norwegian society's knowledge about environmental issues, problems with environmental science, and media they have used to acquire environmental information. This survey is referred to as "survey 2" in the continuation of the work.

All the statistical analyses and coding were performed using IBM SPSS Statistics version 21 with a license provided to me by NTNU.

3.1 Survey 1: "Communicating environmental science"

The first survey was based on questions from Forskningsrådet's (82) own survey on science dissemination, as well as my inquiries from interviews with employees at the program of Industrial Ecology. It was made in Word since it was not necessary to use a survey tool as it was only distributed on paper. Three people reviewed and tested the survey before it was distributed. Since anonymity was assured by excluding sensitive questions (such as age, political preference, nationality etc.) and the survey was distributed by paper, it did not need approval from the Norwegian data protection office for research, *Norsk Senter for Forskningdata* (NSD), before distribution.

Survey 1 contained a short introduction to the thesis and 23 questions. The questions were about time spent on communicational activities, channels for disseminating science, topics communicated, and a set of statements about disseminating environmental science (Appendix A). The majority of questions were closed questions with categories. I also used a 5-point Likert scale, but there were also a few open-ended questions in order to capture the scientists' personal motivation for science dissemination (Appendix A).

The target respondents were scientists working at the program of Industrial Ecology at NTNU. This included PhD students, junior and senior researchers, as well as professors. The survey was distributed on the 04.04.2016. Out of 30 surveys handed out, 21 were completed (70% response rate).

3.2 Survey 2: "Klima og miljø: kunnskap og interesse"

The second survey was largely based on international and national surveys (see e.g. (57, 59, 83, 84)) with questions about attitudes towards the environment, as well as the literature review and interviews from the project thesis. I used NTNU's internal survey system *SelectSurvey* to set it up, with aid from the IT-service at the Faculty of Social Science and Technology Management (SVT).

The survey consisted of a thorough introduction to the survey and thesis, and 27 questions (Appendix B). It was split into six sections: *background information*; *interest and concern*; *environmental knowledge*; *a set of statements*; *information acquisition*; and *trust in various actors*. Most of the questions were closed questions where respondents chose different options (categories) or degrees on a 5-point Likert scale. Some of the questions had an additional option of open-ended answers (Appendix B). I had five people test the survey before releasing it. The questionnaire also underwent quality control from SVT's IT-service before launch. These gave feedback about changes that should be made, and an estimated time to complete the survey was established to about seven minutes.

Preliminary to the launch, I had to consider the sample size I was aiming for. The sample size had to be of such proportion that it was big enough to draw conclusions from. There are no definitive rules about size, however the bigger is always the better (85, 86). Field (85) says the sample size *"depends on the size of the effect (i.e. how well our predictors predict the outcome) and how much statistical power we want to detect with these effects"* (85). He provides an overview of sample sizes based on Miles and Shevlin's (87) graph that can be used to find suitable sample sizes. I expected a medium effect with my model of 15 predictors (see section 3.2.2), and the sample had to be at least 170 cases based on this graph.

Green (88) suggests estimating the required sample size by looking at two measures. Firstly, if you want to test the model overall, a minimum sample size of 50+8(k), where k is the number of predictors in the model, is a good measure (88). Secondly, if you want to test individual predictors, he suggests a sample size of at least 104+k. When both values are calculated, the biggest sample size should be the minimum goal (88). For my model, these measures gave minimum sample sizes of 170 and 119 cases. Therefore, my sample had to be at least 170 cases, conforming with the suggestion by Miles and Shevlin (87).

Before launching the survey, a standard application was sent to NSD, in line with national regulations. After the project was approved, the survey was launched. It was available as a selfadministrated online survey to reach as many respondents as possible. The sampling method was based on random selection through personal network distribution, as well as random respondents from an open forum. Although random people took the survey, this sampling method is not considered a true random sampling (85, 89). The implications of this will be discussed in section 5.5.

The survey was first sent out to the people outside the program of Industrial Ecology that took part in the interview process last fall, in addition to 10 key actors in my personal network. The selected respondents consisted of politicians, employees in large corporations and non-governmental organizations, and family and friends with large networks. Each recipient was asked to forward it to other people. Three days before the survey closed, it had generated 367 responses. In order to get some additional responses, the survey was made available at reddit[9] for two days. 11 people answered the survey within these days. The survey was available between 25.02.2016 and 01.04.2016, and 378 people completed the survey within this timeframe. Of all the replies, 147 respondents did not check of "Finished" at the last page of the survey. I therefore had to exclude these cases, as their consent to use their response was not given by this completion step. In addition, two cases had only finished one third of the survey, and were excluded from further analysis. The final sample size was 229 respondents.

3.2.1 The dependent variable: environmental literacy

The dependent variable, or outcome, measures environmental knowledge within the Norwegian society. It shows a person's environmental literacy on an index ranging from 0 (no knowledge) to 16 (high knowledge). To measure this, beliefs and opinions about environmental issues and the environment as a whole were asked in Survey 2 (Table 1). Answers on statements essentially detect a person's opinion, and not necessarily their knowledge. However, considering that environmental literacy is defined here as how well people are informed about environmental science and problems, such opinions still apply. Although it would be wrong to say that one opinion is more correct than another is, how much people disagree or agree with these statements indicate how well informed they are. People whose replies on statements were in line with present research were given points on the index (Table 1). The three fact questions gave points based on how close to the truth respondents answered. The question about anthropogenic climate change and economic sector only had one point-giving answer. Tons of CO_2-equivalents emitted per year had three. Respondents answering *"10 million tons"* and

[9] https://www.reddit.com/r/norge/. Reddit is a forum for discussion and sharing, and consists of multiple small communities, such as the subreddit «*Norge*». The users can also vote the content up or down depending on how interesting they find it.

"more than 70 million tons" received a point because the respondents knew the amount was in the millions although *"50 million tons"* was the correct answer (Table 1).

Table 1 Variables in the environmental knowledge index. Bold indicates answers that gave points

Variable	Text	Answers	Coding procedure
PrivateCO2	*Private people's emissions play a big role*	1=Strongly disagree; 2=Disagree; 3=Neither; **4=Agree; 5=Strongly agree**	Recoded: 1, 2, 3=0; 4=1; 5=2. SYSMIS=0
BlameChina	*It is mainly China's fault that we have environmental problems today*	**1=Strongly disagree; 2=Disagree;** 3=Neither; 4=Agree; 5=Strongly agree	Recoded: 1=1; 2=2; 3, 4, 5=0. SYSMIS=0. Reversed to fit index
NothingCC	*There is nothing we can do to prevent climate change*	**1=Strongly disagree; 2=Disagree;** 3=Neither; 4=Agree; 5=Strongly agree	Recoded: 1=1; 2=2; 3, 4, 5=0. SYSMIS=0. Reversed to fit index
NorwayCO2	*Norway emits so little compared to the rest of the world that it does not matter what we do here at home*	**1=Strongly disagree; 2=Disagree;** 3=Neither; 4=Agree; 5=Strongly agree	Recoded: 1=1; 2=2; 3, 4, 5=0. SYSMIS=0. Reversed to fit index
Research	*Climate- and environmental science cannot make a difference in the challenges we face today*	**1=Strongly disagree; 2=Disagree**; 3=Neither; 4=Agree; 5=Strongly agree	Recoded: 1=1; 2=2; 3, 4, 5=0. SYSMIS=0. Reversed to fit index
AnthrCC	*Do you believe in anthropogenic climate change?*	**1=Yes;** 2=No	Recoded: 1=2; 2=0. SYSMIS=0
TonsCO2	*Approximately, how many tons CO2-equivalents do you think Norway emits annually?*	1=Less than 300 tons; 2=500 tons; 3=4000 tons; 4=35000 tons; **5=10 million tons; 6=50 million tons; 7=More than 70 million tons**	Recoded: 1, 2, 3, 4=0; 5=1; 7=1; 6=2. SYSMIS=0
Sector	*Which economic sector do you think is the biggest source of greenhouse gases on a global basis?*	1=Transport; **2=Energy;** 3=AFOLU; 4=Industry; 5=Building	Recoded: 1, 3, 4, 5=0; 2=2. SYSMIS=0

Three of the variables had a few respondents who did not answer the question (SYSMIS). *BlameChina* had eight SYSMIS, *NorwayCO2* had three, and *NothingCC* had two. To include these respondents, SYSMIS' on the index were coded to 0. The coding (Table 1) shows that informed answers received a score of either 2 (completely in line with the truth) or 1 (partly in line with the truth). For the computation of the variables, each respondents score on each variable was added. This is what makes up the index ranging from 0 to 16.

3.2.2 The independent variables

Background variables

I included *gender*, *age*, and *education* as background variables to control for demographic differences. Research indicates that males tend to have higher knowledge about nature, environment, and science than females (21, 52). Age was included because multiple studies have shown that younger people tend to have higher environmental knowledge than older generations (52, 53, 90). Education was included as studies have shown that higher educated people tend to be more environmentally informed (21, 52). All three variables were dummycoded (i.e. turned into dichotomous variables with values of 0 and 1). Female, older age (>40), and lower education (up to completed high school) were used as reference categories.

Control variables

To make sure the model was not influenced by other significant variables, two control variables were included: *interest in climate- and environmental news* and *party preference*. These were included because previous work has found that both have an effect on people's awareness and knowledge on environmental issues (56, 91). Interest was dummycoded to differentiate between those who reported to have an interest and those who reported not to have an interest in environmental information. Party preference was dummycoded to compare the difference between affiliation with green parties and other parties. This division was based on two analyses from the NGOs Framtiden i våre hender (92) and World Wide Fund for Nature (93) carried out during the last election (2013). No interest and non-green parties were used as references.

Predictors: channel choice and barriers

I focused on two sets of predictor variables that explain some of the variance in environmental literacy (28). The first set of variables was related to channel choice when acquiring knowledge about environmental science and information. There were 19 channels to choose from (multiple-choice), and 1 option of no engagement with environmental information seeking. To understand the effect channel choice has on environmental knowledge, the different media were grouped according to type of channel (see section 2.4). The groups were: Traditional channels (*newspaper, TV, radio*); Online traditional channels (*newspapers, TV, radio*); New media (*social media, other webpages*); Scientific media (*journal article, scientific report, scientific summary, book*); Popular science channels (*magazine, research center, museum, festival, debate, public presentation*); Other channels; and No channels. If a respondent had used at least one channel within a group, they received the score of "1".

The second set of variables were related to barriers between environmental research and information, and understanding of this. These were grouped based on the nature of the obstacle: Language *("Difficult language", "Unknown jargon", "Unclear messages")*; Source (*"Don't know if the source is reliable", "Sources are not given");* and SCvsOP (*"Too little "science" in the information", "Too many opinions in the information", "Hard to differentiate between science and opinions")*. If a respondent experienced at least one barrier within a group, they received the score of "1".

A full overview of the all the coding can be found in Appendix C.

3.2.3 Hierarchical multiple regression

Multiple regression is a statistical method used to predict an outcome (Y) from a set of independent variables, or predictors (X_1, X_2, X_i) (85). A linear predictive model is fitted to the data by the method of least squares and used to predict values on the dependent variable (Y) (85). The goal is to find the line that has the least distance between the predictive model and the observed data (85). The smaller the distance is, the smaller the residual in the model is. This indicates a good model to predict Y. The predictive model is chosen by selecting the line that has the lowest sum of squared differences (85).

In a hierarchical multiple regression, the independent variables are entered in blocks (86). Using this technique allows us to explore the differences between the blocks, and to control for influence by other predictors (86). The important effect sizes are R^2 and ΔR^2; the *unstandardized coefficients (B)* and associated *standard errors;* the *standardized coefficients (Beta);* and the *t-test* and *the significance* of the t-test. The R^2 tells us about the total variance in the outcome (Y) the model is able to explain (85). The ΔR^2 value illustrates the change between blocks in a model. The unstandardized coefficient (B) denotes the gradient on the regression line (85). The value illustrates the change in Y from one unit change in the independent variable (X_i) when all other variables are stable. The standard error tells us about the variance in B-values for similar samples (85). The standardized coefficients (beta) can be used to compare the contribution of the different independent variables because they are converted to the same scale (86). The beta-values refer to the number of standard deviation changes in the outcome (Y) for a one standard deviation change in the predictor (X_i). The t-statistics test the null hypothesis that B or beta are 0, and if it is significant then the alternative hypothesis is accepted (85).

I conducted four preliminary regressions to investigate the data. Assumptions for hierarchical regressions were checked after running the final model (see section 4.1.2). In the final regression, three blocks were entered (background variables, control measures, and channel choices and barriers). Listwise exclusion of missing values was used to exclude SYSMIS on any of the variables, leaving the final sample size for the regression at N=227. All coefficients presented are from model 3. The full regression output can be found in Appendix D.

3.3 Data reliability and validity

Reliability is a measure of the quality of the data (89). It is about if repeated measurements with the same instrument yield the same results as your own (89). There are different ways to assess the data’s reliability. I have used common source critique of the data and sampling, and a reliability-test of the index created from survey 2. Validity means if we actually measure what we want to measure (89). We differentiate between many types of validity. In this context, face validity and content validity were the most important ones. To assess the face validity means to check whether or not the variables capture what it asks about (89). For example, if questions about trust actually measures trust in various actors. Content validity refers to if the selection of indicators give a reasonable coverage of the theoretical concept that is measured, and is a subjective assessment based on how a concept is defined (89).

3.3.1 Survey 1

The reliability of survey 1 was tested through general source critique and sampling method. The face validity was checked trough testing of the survey before it was handed out. Assessing the validity was not considered necessary for survey 1 as it was only used to illustrate actual practices, and none of the variables were used to measure theoretical concepts.

3.3.2 Survey 2

To assess the reliability of the data from survey 2, I considered the sources the survey was based on and the sampling method, and the internal consistency of the index. I performed a reliability analysis using Cronbach's alpha to check the internal reliability of the index. The coefficient vary between 0 and 1 and the reliability is considered good if the value is high, preferably above 0.70 (86, 89). However, lower scores does not necessarily indicate low reliability as the coefficient is sensitive to the number of indicators included (86). If less than 10 indicators make up the index, and the alpha is lower than 0.70, the mean inter-item value should also be reported (86). A value between 0.2 and 0.4 on this measurement is considered acceptable (86). The face validity was checked trough the five people who tested survey 2 before it was launched. Regarding content validity, only the index was assessed as this was used to measure the theoretical concept of environmental literacy. The assessment was based on the definition of environmental literacy used in this work.

4 Results

4.1 Reliability, validity and assumptions

4.1.1 Survey 1

The survey was largely based on Forskningsrådet's (82) own survey on science dissemination, in addition to replies on the interviews with employees at the program of Industrial Ecology from last fall. Forskningsrådet is a respected institution, and is considered a reliable source. The replies from the interviews provided me with insight to what types of questions could be useful and relevant for the survey. Since three people who work at the program were interviewed, their answers were considered reliable. Surveys usually indicate a high reliability since they are highly standardized, however, errors may occur when entering data by hand (89). To ensure no errors had occurred when entering the data, all responses were checked twice after completion. Three people (one professor and two master candidates at the program of Industrial Ecology) reviewed, tested and provided feedback for survey 1. This ensured high face validity in that the survey asked the correct questions to obtain measures of actual practices.

4.1.2 Survey 2

Many of the questions from survey 2 were based on existing surveys from TNS Gallup (57, 59), World Values Survey [WVS] (83), and European Social Survey [ESS] (84). Because these are respected and highly reliable sources of information, the reliability of the data from the questions that are the same or similar can be deemed high. The sampling method was through an online survey which generated a complete SPSS-file, and reliability is generally high when using surveys due to its highly standardized nature (89). The reliability test of the index yielded a too low score on both the alpha and the mean inter-item correlation with values of $\alpha < 0.643$ and 0.189, respectively. However, the values were very close to acceptable levels, so the internal reliability of the index was considered acceptable for this work.

The face validity was tested through the five people and SVT's IT-service who reviewed the survey. The feedback indicated that most questions were understood correctly and measured what they aimed to measure. Some questions were changed based on feedback to ask more precisely and use other words. The content validity of the index was considered good since the questions that make it up are very different and measure various aspects of environmental knowledge. In addition, the index was based on level of literacy on issues and facts that have been frequented in the news media.

The normality was checked using a Normal Probability Plot of the Regression Standardized Residuals. The line conformed to what we expect in order to meet the assumption of normality.

Outliers were investigated through a scatterplot, and as some seemed to be outside the boundaries, casewise diagnostics and residual statistics were run. These showed that nine cases (3.96%) had standardized residuals beyond ± 1.96, and one case (0.44%) outside ± 2.58. This is within the boundaries of an accepted level as we would expect 5% to have standardized residuals outside ± 1.96 and 1% outside ± 2.58 (85). The Mahalanobis distances showed that one case exceeded the critical value (86) of 37.697[10] with a value of 42.139. This case, alongside the cases with standardized residuals outside the boundaries, were inspected further to see if they had undue influence on the model. Trough Cook's distance, centered leverage value, and standardized DFFit and DFBeta values (statistics from SPSS to show whether any case has large influence on the regression parameters) it was discovered that none had any undue influence. Homoscedasticity (a random and evenly dispersed spread of residuals around the regression line) and linearity was checked using a scatterplot of the standardized residuals (*ZRESID) against the standardized predicted values (*ZPRED). The graph was evenly distributed along the center with no funneling out or any curve, which meant both assumptions were met. The predictors were also checked for multicollinearity. VIF and tolerance values indicate whether a predictor has a strong relationship with other independent variables in the model, and should be below 10 and above 0.10, respectively (85). All VIF values were well below the cut-off point (the highest VIF was 1.447), and the lowest tolerance value was 0.691. The assumption of no multicollinearity was therefore also met.

4.2 Communicational practices and channel use

4.2.1 Communicational practices at the program of Industrial Ecology

In survey 1, the scientists at the program of Industrial Ecology were first asked about their interest in science communication, and whether or not they thought their interest was higher or lower than that of their colleagues. The majority (85.7%) reported a high interest in science dissemination, and only 9.5% claimed to have little interest. The majority (61.9%) of respondents also thought their interest was the same, or less than that of their colleagues. Only 14.3% thought their own interest was higher than other people at the program.

The scientists were also asked to list all the different means of communication used in the past year (Figure 4). Looking at groupings of channels based on their platform and audience, there is a clear favoring of scientific media among the scientists. For traditional channels (TV, newspaper (online and regular) and radio), newspapers were the most used medium. 33.3% of

[10] The critical value was the chi-square value based on the number of independent variables as degrees of freedom, using an alpha level of 0.001.

all the scientists at the program had been featured in an online news article, and 23.8% had experience in the paper version. 19% of the total had been on radio in relation to disseminating their work, while TV was the least used medium (4.8%) of the four traditional channels. Regarding new media, social media was popular, as 52.4% of the scientists had used it on at least one occasion during the past year. Other webpages were less used (28.6%), however, it was still more used than many other channels. Among the popular science channels, a majority of the sample used public presentations. Other medium such as debates or magazines were less used, and only 19% and 14.3% had used them, respectively.

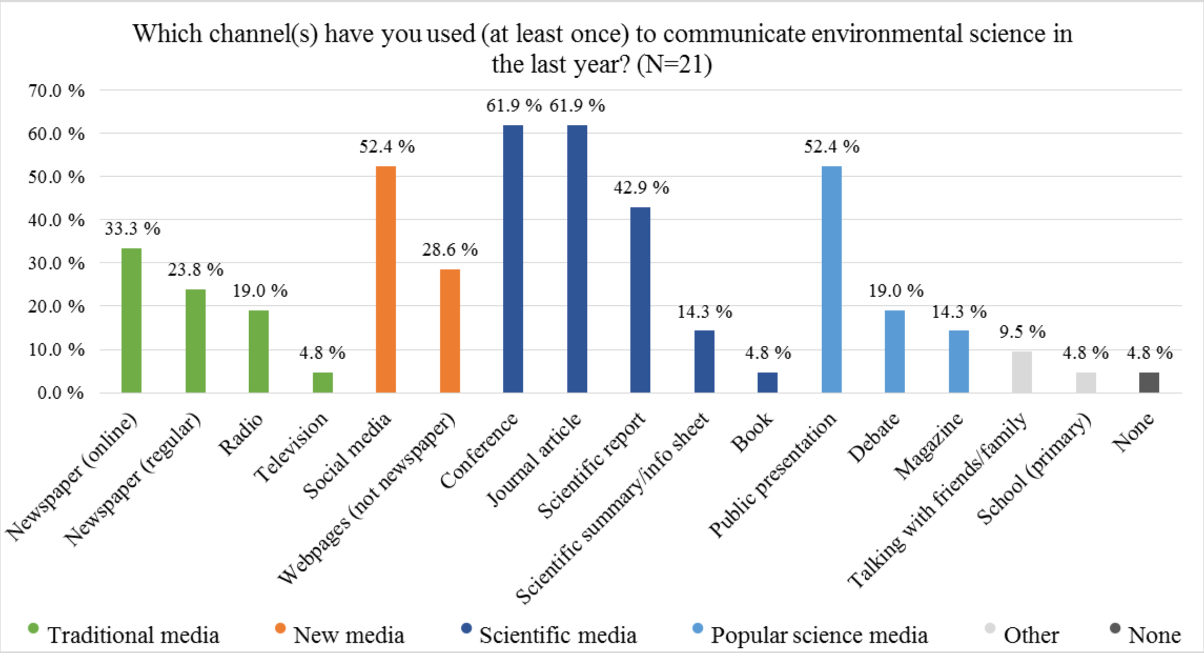

Figure 4 Overview of scientists who have used different channels to communicate environmental science in percentages. Grouped by type of medium

Considering unique users of different media groupings, popular science media was almost as much used as scientific media with only 4.8% less users (Figure 5). New media as a whole was the third most use type of medium with 57.1% reporting to have used at least one of the two channels over the past year. 33.3% of the scientists had used a type of traditional media, which means that the scientists who published in online newspapers were the only ones who also used other types of traditional media.

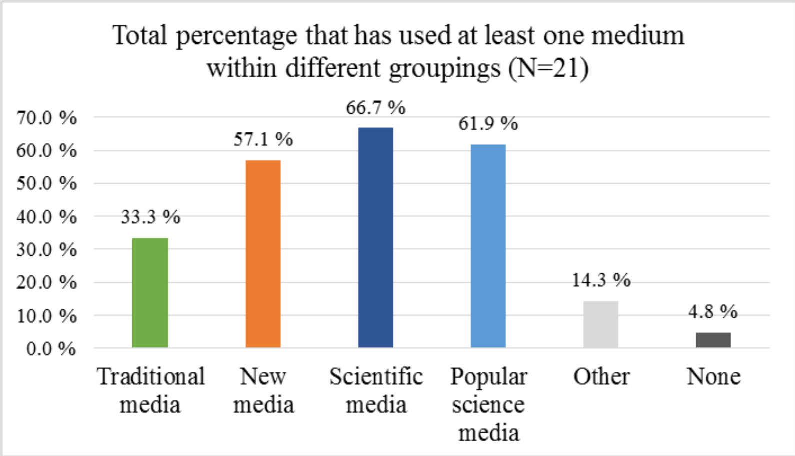

Figure 5 Total percentage of unique scientists per media group

The survey also asked about the importance of finding time to communicate environmental science, and how much time they spent on communication each month. Although 81% stated it was very important and 9.5% a little important to find time, this attitude was not reflected in their actual practice. Half of the scientists spent less than 3 hours a month communicating science, and the majority (70%) spent less than 5 hours (Figure 6). However, 20% of the respondents reported spending more than 10 hours a month communicating environmental science (Figure 6). The mean answer given was 4.25, which equals a little over 3-4 hours spent on science communication. The average time spent was 4.074 hours per month.

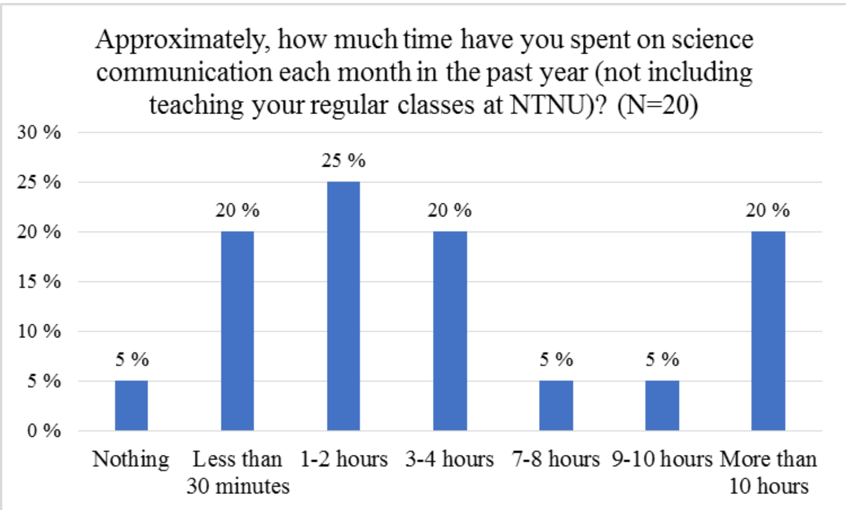

Figure 6 Time spent on science communication per month. Percentage of total sample

4.2.2 Channels used in society

In survey 2, the respondents were asked to select all the channels they had used to acquire environmental information with over the past year (Figure 7). Comparing the traditional channels between regular and online platforms, there are clear differences. Only 45.4% reported to have used regular newspapers compared to 79.9% who used online newspapers. Online newspapers were also the most used channel overall in the sample. In the use of TV to acquire environmental information, the respondents favored the regular platform. 66.8% reported to watch regular TV to gain environmental knowledge, while only 34.5% used online TV-services. Regarding radio, the regular kind was also preferred over online radio as 35.8% used regular and 16.2% had used online versions. New media were quite popular among the respondents to learn about environmental science. 51.5% had used various webpages and 49.8% had specifically used social media. The use of social media was slightly higher than reading articles (journal or similar). Only a minority of the respondents had used scientific summaries or reports to read about environmental information. Using popular science media such as debates or magazines seemed to be less popular than other media. Although 40.6% reported to have watched debates about environmental science, only 5.2% had ever attended a museum or a festival to learn more about the environment.

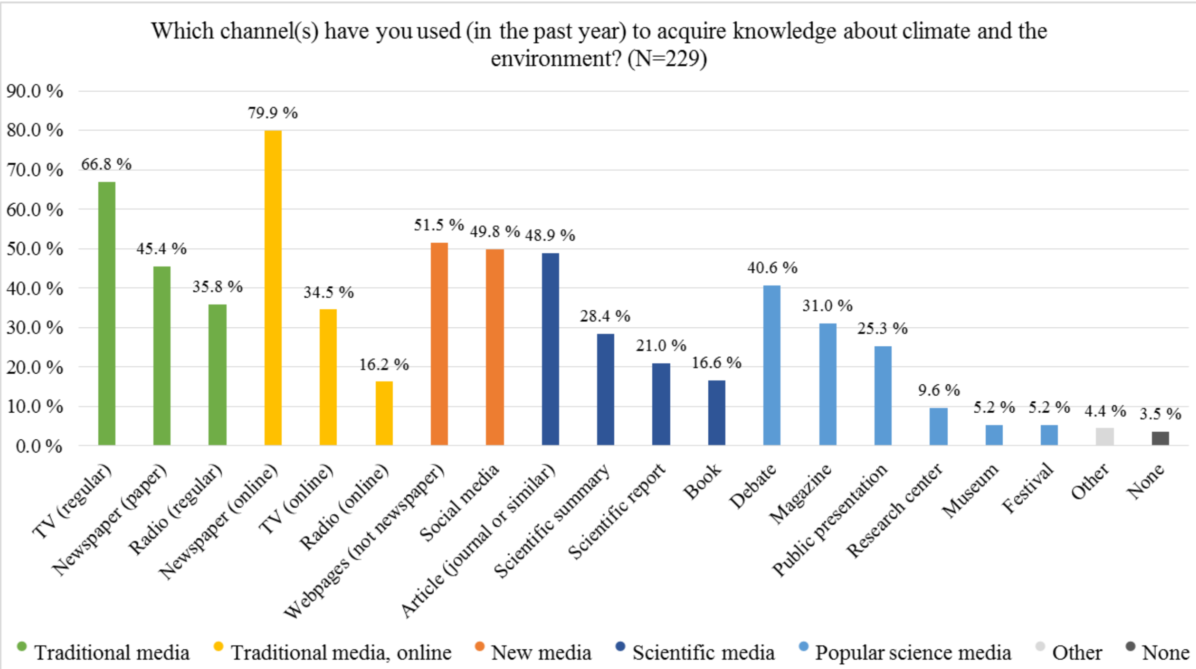

Figure 7 Overview of percentages in society that have used different channels to acquire environmental information. Grouped by type of medium

Looking at total percentages of the unique respondents' use of any channel within a group, the picture changes a little (Figure 8). Traditional media found online were still the most used channel type with 81.2% unique users, and traditional media on regular platforms came in second (76.9%). However, more people used a type of popular science medium (61.6%) than scientific media (57.6%), which was not apparent in Figure 7. This indicates that the same people who read journal articles or similar also use other types of scientific media to acquire knowledge about the environment.

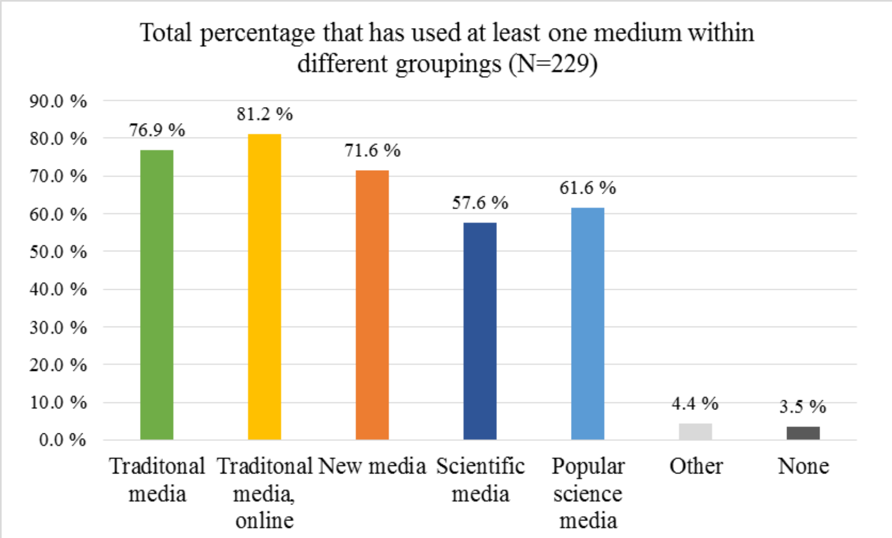

Figure 8 Total percentage of unique users in society per media group

4.2.3 Channels as predictors

In model 1, demographic variables (*Male, Young, HiEd*) were entered as a block, while the control measures (*Interested, Green*) were included in the second model (Table 2). Together, they explained 19 per cent (0.190*100) of the variance in environmental knowledge. In model 3, channels used for acquiring information and experienced barriers were entered. These variables explained an additional 9.5% of the variance in environmental knowledge, after the control of other variables (Table 2). The Sig. F change showed that this was a statistically significant contribution (F (12, 227) = 2.789, p < 0.01) to the model.

Table 2 Model summary of hierarchical multiple regression of environmental knowledge index.N=227

Model	R	R^2	Std. Error of the Estimate	Change Statistics		
				ΔR^2	F Change	Sig. F Change
1	0.320a	0.102	2.903	0.102	8.458	0.000
2	0.435b	0.190	2.771	0.087	11.922	0.000
3	0.533c	0.284	2.665	0.095	2.789	0.003

a. Predictors: (Constant), Young, HiEd, Male
b. Predictors: (Constant), Young, HiEd, Male, Green, Interested
c. Predictors: (Constant), Young, HiEd, Male, Green, Interested, CHnone, CHother, CHtraditional, CHnewmedia, CHscientific, CHtradnewplat, Chpopscience, SCvsOP, Language, Source

The analysis of variance (ANOVA) tests if the model as a whole is better at predicting environmental knowledge than using the mean (85). The F-ratio represents the ratio of improvement in prediction, and is greater than 1 when the improvement is much greater than the inaccuracy in the model. The F-ratio for model 3 from ANOVA was F (12, 227) = 5.585, p < 0.001. This means that the model as a whole significantly improved my ability to predict environmental literacy with these three blocks.

To find out how much each predictor contributed, we look at the B-values (unstandardized) and respective significance values from Model 3 when all variables have been entered (Table 3). Only higher education turned out to have a statistically significant contribution to environmental knowledge of the background demographics. Both control measures, interest in environmental science and party affiliation, were significant as well (*ps* < 0.01). Of the seven group channel choices, traditional channels (old platform) had a B-value of 0.559 ($p = 0.255$), and traditional channels (new platform) had a value of B = 0.311 ($p = 0.561$). However, neither were statistically significant on a $p < 0.05$ level, which means that hypotheses *H1* and *H2* were rejected. New media and scientific media both had positive B-values, but these were also not significant. Hypotheses *H3* and *H4* were therefore also not supported by the model. Only popular science media was statistical significant in model 3. Hypothesis *H5* stated that popular science media have a positive effect on environmental knowledge. The B-value of *CHpopscience* showed that using any type of popular science to acquire information about environmental science increased the level of knowledge with a 1.055 increase on the environmental literacy index ($p < 0.05$). The analysis thus yielded support for hypothesis *H5*. *CHother* and *CHnone* both yielded positive effects, but neither were statistically significant.

Table 3 Coefficients from hierarchical multiple regression of channel use and environmental knowledge index. Model 3. N=227

Model	Variable	B	Std. Error	β	t	Sig.	*p* <
3	(Constant)	5.025	0.830		6.055	0.000	0.001
	Male	-0.504	0.371	-0.083	-1.360	0.175	ns
	HiEd	1.240	0.406	0.185	3.057	0.003	0.01
	Young	0.474	0.427	0.074	1.109	0.269	ns
	Interested	1.291	0.456	0.171	2.830	0.005	0.01
	Green	1.394	0.422	0.202	3.306	0.001	0.01
	CHtraditional	0.559	0.490	0.078	1.141	0.255	ns
	CHtradnewplat	0.311	0.534	0.040	0.582	0.561	ns
	CHnewmedia	0.764	0.435	0.114	1.757	0.080	ns
	CHscientific	0.064	0.421	0.010	0.153	0.879	ns
	CHpopscience	1.055	0.419	0.169	2.520	0.012	0.05
	CHother	0.181	0.932	0.012	0.194	0.846	ns
	CHnone	1.174	1.154	0.071	1.017	0.310	ns

Note $R^2 = 0.284$ for **Model 3** ($p < 0.01$)

As for hypotheses *H2.1* and *H5.1*, the standardized beta-values and associated significance levels are used (Table 3). *H2.1* stated that traditional media on a new platform had the biggest effect on environmental knowledge of all the different channel groups. *CHtradnewplat* actually had one of the smallest beta-value of the channels (β = 0.040) meaning that it did not have the largest effect had it been significant ($p = 0.561$). The model showed that *H2.1* was not supported by the results. Hypothesis *H5.1* claimed that popular science media had a bigger effect than scientific media. The beta-value of popular science was the highest of all channel groups with $\beta = 0.169$, and was significant at $p < 0.05$. However, scientific media ($\beta = 0.10$) was not significant ($p = 0.879$), which means that *H5.1* was neither rejected nor supported, and instead inconclusive.

4.3 Experienced barriers

4.3.1 Scientific dissemination barriers

Survey 1 revealed that time was an issue when scientists prioritized science dissemination. 71.4% stated they would communicate their research and environmental science more if they had more time to do so. However, time was not the only thing that constrained science dissemination. Recognition of communication was also an important factor for many (Figure 9). 47.6% of the scientists said they would disseminate more work if it were better recognized by the university. Receiving recognition from peers and the Industrial Ecology society as a whole was also a motivational factor for 42.9% of the respondents. The most important institution to receive recognition from, however, was society in general. The majority of scientists (57.1%) said they would communicate more if it were better recognized by society.

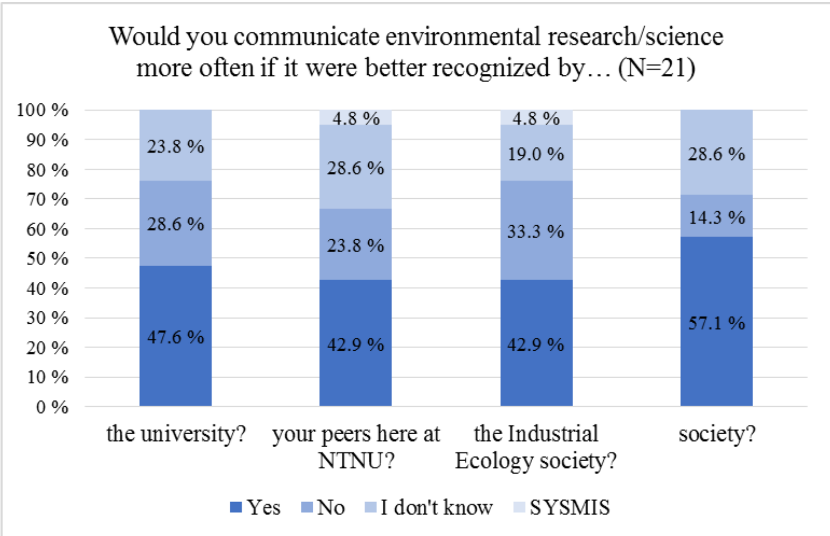

Figure 9 Shares of responses by recognition from different institutions

Survey 1 also listed two statements about attitudes towards environmental communication which the scientists had to consider (Figure 10). The majority disagreed that scientists frequented in the public debate were frowned upon, but 14.3% stated they agreed with this. The use of unconventional channels was also brought up in relation to this type of disapproval. Less people disagreed with this claim (9.5% less) and 4.8% strongly agreed that this was true.

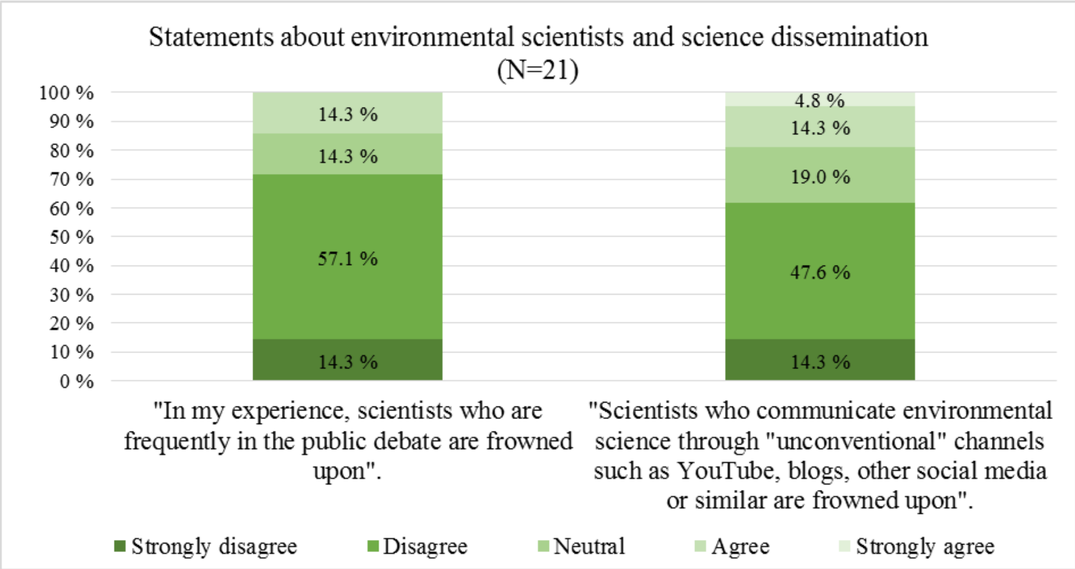

Figure 10 Shares of agreement to statement about environmental scientists

4.3.2 Experienced barriers in society

Survey 2 asked the respondents to report any difficulties they had experienced with understanding environmental information (Figure 11). The single biggest issue was that the audience often felt there were too many opinions in environmental information. The second most important issue was related to difficulties differentiating between science and opinions in environmental information. In addition, 32.8% did not always know if the source of information was reliable, and 32.2% reported difficulties understanding jargon.

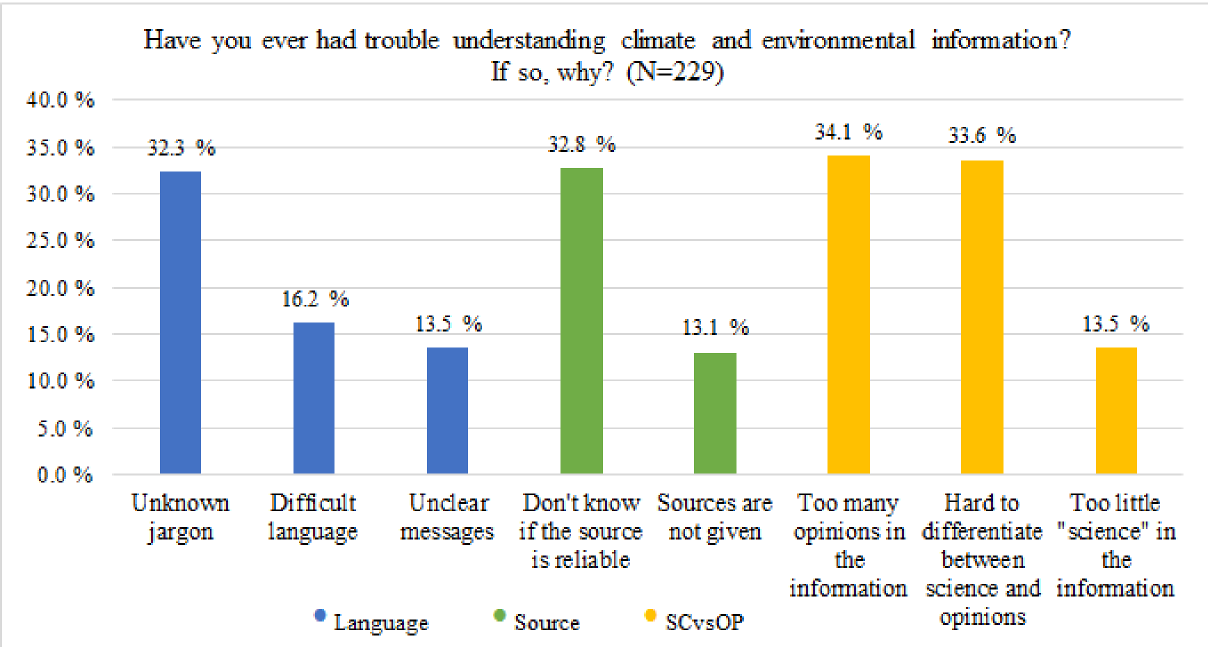

Figure 11 Percentage that has experienced difficulties when consuming environmental information. Grouped by barrier. Total unique respondents displayed

Looking at unique responses of grouped experienced barriers (Figure 12), 37.1% reported to have had issues related to sources of the information. 41.9% of the sample had come across at least one linguistic issue, and 52% had experienced trouble with facts and beliefs.

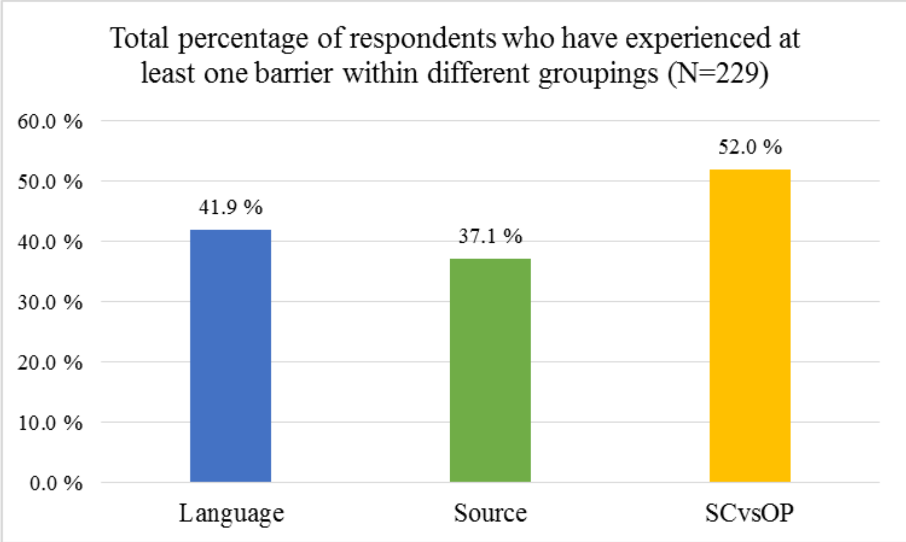

Figure 12 Unique respondents that have experienced at least one issue within different groupings

4.3.3 Barriers as predictors

Model 1 contains the demographic variables, while the control measures were included in the second model (Table 4). They explained 19% of the variance in environmental knowledge. Model 3 was the entry with the main predictors: channel choice and barriers. They accounted for an additional 9.5% of the variance, and Sig. F change indicates that this was a statistically significant contribution (F (15, 227) = 2.789, $p < 0.01$) (Table 4).

In brief, the background variables, control measures, channel choice and barriers were moderately associated with environmental literacy as model 3 explained 28.4% of the variance ($p < 0.01$). The F-ratio for model 3 from ANOVA was F (15, 227) = 5.585, $p < 0.001$. This means that model 3 significantly improved my ability to predict environmental literacy.

Table 4 Model summary of hierarchical multiple regression of environmental knowledge index.N=227

Model	R	R^2	Std. Error of the Estimate	Change Statistics		
				ΔR^2	F Change	Sig. F Change
1	0.320a	0.102	2.903	0.102	8.458	0.000
2	0.435b	0.190	2.771	0.087	11.922	0.000
3	0.533c	0.284	2.665	0.095	2.789	0.003

a. Predictors: (Constant), Young, HiEd, Male
b. Predictors: (Constant), Young, HiEd, Male, Green, Interested
c. Predictors: (Constant), Young, HiEd, Male, Green, Interested, CHnone, CHother, CHtraditional, CHnewmedia, CHscientific, CHtradnewplat, Chpopscience, SCvsOP, Language, Source

Only one of the three barriers made a statistically significant contribution (Table 5). Hypothesis *H6* stated that difficulties with language negatively affected environmental literacy. Its B-value indicates that if linguistic problems are experienced, environmental literacy decreases with 0.582 points on the index. However, as it was not statistically significant, *H6* was not supported. *H7* claimed that experienced trouble with the information related to sources negatively affected environmental literacy. The B-value of *Source* however was positive (0.500), which means that trouble with sources actually increases environmental literacy. However, the result was not significant (p = 0.217), and *H7* was rejected. The last predictor, *SCvsOP*, concerned hypothesis *H8*, which stated that difficulties with understanding information because of mixing of science and opinions had a negative effect on environmental literacy. The model yielded a negative B-value for *SCvsOP* (-1.272) that was significant ($p < 0.01$). *H8* was therefore supported.

Table 5 Coefficients from hierarchical multiple regression of barriers and environmental knowledge index. Model 3. N=227

Model	Variable	B	Std. Error	β	t	Sig.	*p* <
4	(Constant)	5.025	0.830		6.055	0.000	0.001
	Male	-0.504	0.371	-0.083	-1.360	0.175	ns
	HiEd	1.240	0.406	0.185	3.057	0.003	0.01
	Young	0.474	0.427	0.074	1.109	0.269	ns
	Interested	1.291	0.456	0.171	2.830	0.005	0.01
	Green	1.394	0.422	0.202	3.306	0.001	0.01
	Language	-0.582	0.372	-0.095	-1.566	0.119	ns
	Source	0.500	0.404	0.079	1.238	0.217	ns
	SCvsOP	-1.272	0.384	-0.209	-3.310	0.001	0.01

Note R^2 = 0.284 for **Model 3** ($p < 0.01$)

For hypotheses *H6.1* and *H9*, the standardized beta-values and associated significance level were checked (Table 5). *H6.1* said the negative effect of linguistic barriers were bigger than the other two barriers. The beta-value of *Language* was neither the highest nor statistically significant, and *H6.1* was not supported. The final hypothesis, *H9*, stated the effects of barriers were more influential than the effects of channel choices. Since the only significant predictors were *CHpopscience* and *SCvsOP*, these were used in comparison. *SCvsOP* was more influential (β = -0.209, $p < 0.01$) than *CHpopscience* (β = 0.169, $p < 0.05$). Hypothesis *H9* was therefore partly supported as no other channels or barriers could be used to compare.

4.4 Concerns in the population

To gain insight to what society takes with them from environmental information, questions about level of concern and areas of concern were asked in survey 2. 67.3% reported concern about the environmental challenges the world is facing, however, 23.1% claimed to be unconcerned. 9.6% were neither concerned nor unconcerned about environmental issues. The results regarding which environmental challenge the respondents considered the greatest threat facing Norway and the world can be seen in Figure 13 and Figure 14 below. In Norway, increased flooding and extreme weather was seen as the biggest threat (29.7%) (Figure 13). Global warming came in as the second greatest challenge with 17.9% selecting it. 17% of the respondents thought local air pollution was the greatest challenge, and 13.1% recognized loss of ecosystem services as the biggest challenge (Figure 13).

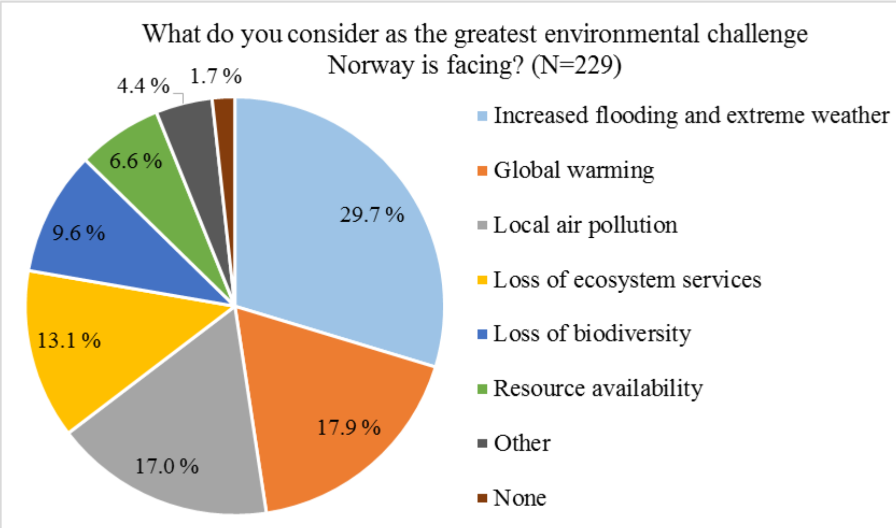

Figure 13 The Norwegian populations' greatest perceived environmental challenge Norway is facing

When asked about the world, 41.5% of the respondents selected global warming as the greatest challenge (Figure 14). Loss of ecosystem services came in second (19.7%), and resource availability was chosen by 14.4%. Local air pollution and increased flooding and extreme weather were only considered as the greatest challenge by 5.2% for both options.

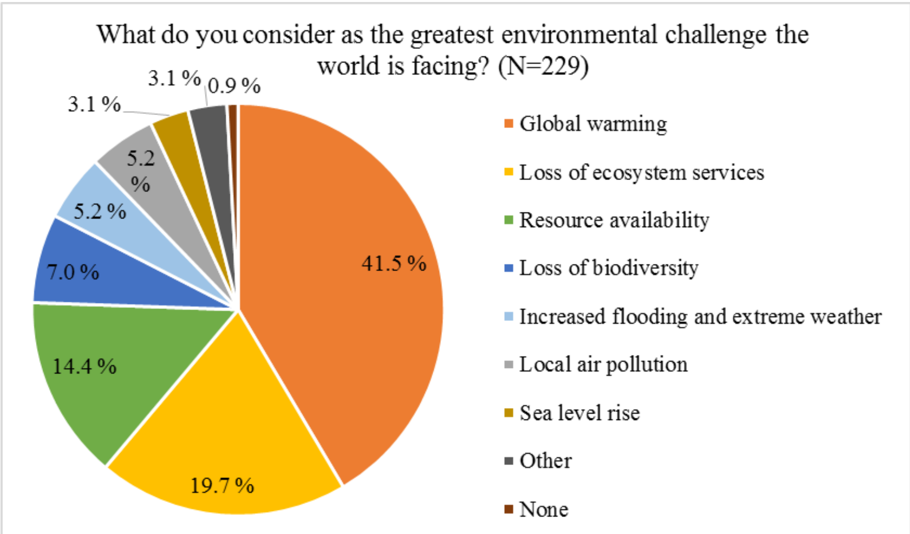

Figure 14 The Norwegian populations' greatest perceived environmental challenge the world is facing

5 Discussion

This chapter summarizes the results and discusses them in light of the proposed research question and literature. The aim of this study has been to map the communicational relationship between environmental scientists at the program of Industrial Ecology and the Norwegian society. The research question is: *How is environmental information communicated to society, and what measures can be taken to increase society's literacy on environmental issues?* I wanted to see how environmental science is disseminated, and how this corresponds to society's acquisition of information and appropriation of environmental scientific literacy. My goal has been to come up with suggestions on communication practices that help increase environmental literacy in society.

5.1 Channel use: key findings

The environmental scientists at the program of Industrial Ecology fail to be present where society is located. The results from survey 1 and survey 2 revealed that there is a great difference between which channels environmental scientists use to disseminate science, and which channels society use to acquire information (Figure 4 and Figure 7). While scientists mainly used conferences for other professionals (61.9%) and journal articles (61.9%), a minority of society reads articles (48.9%). Society acquired information mostly through broadcast media such as online newspapers (79.9%) and TV (66.8%). Scientists, on the other hand, did not use these channels extensively. Only 23.8% had ever published work in online newspapers, and only one scientists had ever been on TV to disseminate science. Public presentation was the second most used channel for scientists alongside social media (52.4%). However, only a quarter of society attended public presentations over the past year, and roughly half used social media to consume environmental information.

Comparing the results from survey 1 with Forskningrådet's (71) findings about natural scientists in Norway, the results are somewhat different. Almost half (49%) of the natural scientists had arranged and participated on a conference, and 46% had written an academic article. A higher percentage of the scientists at Industrial Ecology had engaged in these media. However, considering that Forskningsrådet did not differentiate between fields within natural sciences, it seems reasonable that the respondents in survey 1 were more active as the program belongs to a young discipline and is an international program. In addition, Forskningsrådet's survey and survey 1 did not define the activities exactly the same way, which can cause some of the differences seen. Similarities can, however, be found in the number of scientists who partook in public presentations and contribution to webpages. While 53% of the natural scientists from Forskningsrådet's survey had held at least one popular science presentation in the past year, 52.4% scientists from the program of Industrial Ecology had done so too. In addition, 23% of natural scientists in Norway had contributed with written material on webpages, and this number is only slightly higher within the environmental scientists at the program of Industrial Ecology (28.6%).

When considering unique users of different channels, the picture changes. The unique contributions show that scientists used popular science media in general (61.9%) almost as much as scientific media (66.7%) to communicate science (Figure 5). New media came in third with 57.1% unique users. This is somewhat surprising compared to previous findings in Norway which have found that natural scientists prefer scientific medium over popular science dissemination (9, 29). However, Kyvik (9) and Bentley and Kyvik (29) only looked at written articles, and did not differentiate between popular science media, traditional media, and new media as I do in my work. When considering only written media and including newspaper articles, my results comply with theirs.

Although it is positive that some popularization of environmental science seems to be a trend at the program, it is of little use when society does not engage in these channels. Popular science media was the second least used channel group by society before scientific media (Figure 8). The results do show that a majority of society used popular science to acquire information (61.6%), however, other channel groups were used a lot more. Regular traditional media were used by 76.9% and 81.2% of the respondents used traditional media online. Even society's use of new media (71.6%) exceeded popular science media as a channel group. The results found in survey 2 are in line with general media habits found by the Mediebarometer (79) which show that the internet and traditional media were used excessively more than media such as magazines or journals. Forskningsrådet's (74) results from 2014 also showed that people primarily used the internet and traditional media to acquire information about research and science. The extensive use of broadcast media by the public is not surprising. McQuail (76) claims that people have to use broadcast media to gain knowledge about current events and issues as they often have no possibilities for first-hand knowledge. It is therefore reasonable that people turn to broadcast media when they want to know the latest regarding environmental research. Comparing society's use to the scientists' use of traditional media reveals the biggest gap in the results. Only 33.3% of scientists used a type of traditional media. This difference is extremely worrisome, especially when considering the topic. Environmental changes are something that concerns everyone, regardless of their profession. It should therefore be available where people consume information.

However, it is understandable why scientists used traditional media the least. Broadcast media are characterized by their sensationalism of current issues and events and their simplification of complex phenomena (76, 81). It is not only the scientists' fault that their work is less present on this platform. Not only do many journalists lack sufficient training in science to understand much of the research (10), but the criteria for what is considered newsworthy can be really constricting (36, 61). Broadcast media, especially in a changing media environment like today, depend heavily on producing fast stories that capture the eye of the audience (76). It has to be societally relevant, and preferably connected to something the public can relate to. However, a lot of environmental research does not meet these standards. Research is often complex and has associated uncertainties, and can be hard to relate to everyday issues. Many Norwegian scientists have also expressed that they feel the media simplifies and distorts research and science, and they have little control over the content of the new stories (94). It is therefore not unreasonable for scientists to refrain from having their work trivialized by the news media. However, as Amundsen (94) states it in his chronicle, scientists need to meet people where they are. Unfortunately, people seldom read journal articles.

Journal articles, newspapers, public presentations and social media can all be used to disseminate environmental information; however, the content will often be very different. Still, it is reasonable to assume that consuming environmental information from any channel increases a person's environmental literacy, especially compared to not consuming anything at all. I hypothesized that all channel groups (expect other and none) would have a positive effect on development of environmental literacy. The hierarchical regression, however, showed that only popular science was significant of the seven different options. This is somewhat surprising. Consuming information about a topic generally means appropriating more knowledge (28, 95). These insignificant results may then indicate that how society consumes information actually plays a minor role in development of environmental literacy. Availability of environmental information on such channels is still useful because we want people to consume this type of information. However, it seems as other factors may be more important in increasing public literacy as no other channel groups besides popular science had significant effects. On the other hand, it may also simply be because the sample size of survey 2 and construction of the literacy index were too small and narrow.

Regardless of the disappointing insignificant results, popular science media still had a significant effect on environmental knowledge. The model showed that it had a positive effect on development of literacy with a B-value of 1.055 (p < 0.05). This finding is important in relation to the statistics about dissemination and channel use described above. The scientists were good at using this channel group as it was the second most used of all. However, popular science media were the second least used channel group by society. This is not all that surprising as popular science media in this work consisted of debates, magazines, public presentations, research centers, museums, and festivals. All of these channels, with the exception of magazines, require an active, physical action, such as searching up a debate, signing up for it, driving to the location, and participate within a set timeframe. It may even cost money to partake in some of the popular science activities. Acquiring information at personal expenses like this reduces the likelihood of using such channels (96, 97). Consuming information from traditional channels leaves the consumer with a broader choice of when, where, and how (76), and often comes at a less expense for the consumer.

The findings described above are concerning. Broadly speaking, my results show that the scientists are not where the people are. This has grave implications for development of knowledge. If the science is not available on channels that are used in society, much of the information gets lost. This has multiple downsides. Not only does society miss what may be crucial information about their own contributions to environmental problems, but they are also left in the dark about solutions and future changes. Further, the very existence of research can be questioned. Research' main purpose is to provide society with answers and solutions to current problems (89, 98). It aims at discovering problems that can hurt society, and works towards solutions to prevent this. However, there is little point of conducting environmental science if no one except other professionals hear about it. Unfortunately, this may be the end result if the channel gap continuous to exist. Although historical patterns show that natural scientists generally prefer scientific media even when they know they are less used by society (4, 9, 29), changes in the practice are necessary if the goal is to change society for the better. However, my results also show that the environmental scientists at the program of Industrial Ecology are good at using popular media such as public presentations. The society, on the other hand, did not favor such channels. Considering the positive effect popular science exerts on environmental knowledge in the public, society needs to take use of these media more.

5.2 Experienced barriers: key findings

Different barriers prohibit science dissemination at the program of Industrial Ecology. Survey 1 revealed that 70% of the scientists spend less than 5 hours a month on dissemination. This is extremely little as a normal work month is about 160-170 hours (99). However, these tendencies were also found by Forskningsrådet (71). Although their results showed that only 46% spent less than 5 hours a month, 28% had not replied to the question. Considering only the ones who responded, 64% of the natural scientists in Norway spent less than 5 hours a month on science communication.

To find out which barriers prohibited science communication, scientists were asked to consider a set of statements about science communication. One of these concerned the prevailing belief that scientists frequented in the public debate are frowned upon. My results indicate that this is not a widespread problem at the program. The majority (71.4%) disagreed with this statement, and only 14.3% agreed that this was an issue. The other scientists remained neutral. When asked about the use of "unconventional channels" such as YouTube or other social media for science dissemination, more people agreed that users of these are frowned upon. 19.1% were in agreement, however, the majority (61.9%) still disagreed. These numbers are better than previous results from Norway have shown. Forskningsrådet's (71) study showed that out of the natural scientists who responded to the question, 23% agreed that scientists frequented in the media were frowned upon, while less than half (45%) disagreed with this claim. This indicates that the frowning culture seen in Norway is less prevalent at the program of Industrial Ecology at NTNU. Although it is still present, it does not seem to exert a major problem for the majority of environmental scientists. Nevertheless, if a frowning culture is not the main problem that prohibits science disseminate, what is?

Scientists are under a lot of pressure with regards to their daily tasks and expectations (9, 13). Not only do they have to conduct research, but they also have to teach, do administrative tasks, and apply for funding, to mention a few. Time constraint is therefore always an issue, and when science dissemination comes on top of other tasks, time does not suffice. The results from survey 1 illustrates this picture well. Almost all the environmental scientists (89.5%) stated it was important to find time to communicate science, and the majority (71.4%) claimed they would communicate more if they had more time. Although not as high percentages, this tendency was also present in Forskningsrådet's (71) results. About half of the natural scientists stated it was important to find time for science dissemination, and 61% wanted to spend more time on it (71). This shows that the environmental scientists at the program are more eager and willing to spread knowledge to society, and there is room for improvement if the structural conditions are right. So what does it take to disseminate more science for the lay audience?

The gap between the attitudes and the actual practice comply with previous findings. Carlsen et al. (13) and Pleasant et al. (100) have found that many scientists genuinely want to communicate their work, but other tasks take up too much time, and are more recognized. Receiving recognition seemed to be an important contributor to science dissemination among the surveyed scientists. Most important was recognition from society itself. 57.1% claimed they would communicate environmental science more often if it were better recognized by society. Regarding increased recognitions from their peers at NTNU and the Industrial Ecology society in general, 42.9% said they would communicate more. What types of recognition the scientists miss is unknown, but it is reasonable to assume that verbal recognition is not enough on its own. Science communication have historically received little incentives and this makes it easier to downgrade (13, 94). Although such incentives seem redundant as Norwegian universities are required to disseminate science by law (12), the results indicate that such action may be necessary to increase science dissemination.

Some types of recognition exist for science dissemination on a national basis in Norway. Forsker Grand Prix is a distinguished prize among PhD candidates which rewards outstanding dissemination activities and abilities (101). Morgenbladet has a national ranking of Norway's best lecturer decided by a jury, where students, colleagues and others can nominate and vote (102). Even Forskningsrådet hands out an annual dissemination prize to scientists, institutions, or journalists (103). However, these do not work as incentives for science dissemination, but rather as recognition of previous work. Prioritizing science communication in the daily work of scientists requires more than just a possibility of a future prize. A change in the system is needed, where dissemination is deemed higher and recognized with corresponding incentives.

The issues society experience in relation to environmental information are different from those of the scientists. Naturally, society does not feel the time constraints that scientists experience, nor the lack of recognition or incentives. However, other barriers hinder society from appropriating knowledge from environmental information. In survey 2, the respondents were asked to list any issues they had experienced when consuming environmental information. The single biggest issue was the perception that there were too many opinions about the environment in the media (Figure 11). 34.1% claimed this caused them to misunderstand information. However, almost as many respondents reported trouble with three other issues as well. 33.6% found it hard to differentiate between facts and opinions, and 32.8% did not always know if the sources of the information were reliable. Also, 32.3% reported that unknown jargon had caused them to misunderstand environmental information. Grouped together and distinguished by unique responses, over half had experienced difficulties regarding opinionated information (Figure 12). Linguistic issues were the second most common barrier with 41.9% unique respondents. Finally, 37.1% respondents had experienced a type of source-related issue in the past. These tendencies are in line with presented work on barriers of public understanding of science (see section 2.1). Difficult jargon prohibits people from taking meaning from information as they misunderstand the messages. As Hayes (62) puts it, there is a *"growing inaccessibility of science"* due to the complexity of the language scientists use. Troubles with opinionated science is also nothing new. Ryghaug et al. (28) found evidence of this in their study of public understanding of global warming in Norway. Sources have also been shown to be root for disregarding information. Trust in information is key to believe and understand the implications of environmental research and science (27, 104).

I hypothesized that the three groups of barriers mentioned above would exert a negative effect on people's environmental literacy. However, linguistic issues or trouble with the sources of information did not have a significant effect. Only trouble with opinionated sources yielded a significant result. This is unexpected, as trouble with understanding information seems to be a logical explanation for a decrease of literacy. Nevertheless, considering the size of the sample (N=227) and the construction of the index (eight measures), such a result may indicate that a bigger sample and more complex index is needed to measure literacy. What my analysis did show, however, was that experienced issues with opinionated science predicts a decrease in environmental knowledge of 1.272 ($p < 0.01$) on the index. The beta-value showed that this effect was the strongest of all included variables in the analysis. This means that dealing with this problem can help increase public literacy of environmental issues. However, how easily this can be done, is questionable.

In an ideal world, issues like the ones describe above would be non-existent. However, reality is different, and some of them cannot be avoided. The linguistic barrier is something that can change. Scientists need to recognize that when they address a lay audience, their scientific language will not suffice. Learning how to simplify their language is therefore an important measure to take to increase society's understanding of science. Although complex phenomena often depend upon specialized jargon to make sense, simplifying the information for society can be done without compromising the message itself. There are multiple communication classes available, also at NTNU, where scientists can learn to interact with their audience. Such a small step seems obvious to take if it can help increase society's environmental literacy. Opinionated science and source issues however, are something society has to accept. Environmental information has become a highly political issue (105), and politicians are often frequented in the public debate about problems and solutions. As representatives of political parties, politicians will always front the opinions of the party. In some cases, these may be conflicting with scientific facts, such as some politicians' disregard of climate change (106). There is little that can be done to avoid such problems in the public eye; however, scientists can be the reassuring voices that support the actual facts. Although taking a stand in such issues may come off as subjective opinions, scientist can easily remain neutral if they leave emotions aside. Generally, people tend to place greater trust in researchers and universities than politicians and governmental employees (107). When a scientific voice is heard in regards to environmental topics in the news media, society can be assured that the sources are reliable.

5.3 Concerns in the population

People seem generally concerned about environmental issues. The results from survey 2 revealed that a majority (67.3%) was concerned about the environmental issues the world is facing. 23.1% claimed they were not concerned, and although a frightening high percentage, this complies somewhat with previous studies. The 2010 ISSP (57) found that 15.1% were unconcerned about issues regarding the environment. However, less people reported in the ISSP to be concerned (48.3%). The biggest difference between my results and the ISSP can be seen in the percentage of respondents who did not express a clear opinion. The results from survey 2 only had 9.6% claiming they were neither concerned or unconcerned, while in the ISSP results, this percentage amounted to 36.1%. There are no clear answers to why people choose to remain neutral about issues such as these. If we take into consideration the time gap between the ISSP data collection and the collection of survey 2 responses, then it may make more sense. The past years have seen increased temperature changes and even more focus on environmental problems in the news than the years before 2010. This could have affected people's perception of the seriousness of global environmental changes. However, it is still concerning that almost a quarter of the respondents from survey 2 were not worried about environmental issues. This may reflect a lack of sufficient information in society, as it is my opinion that environmental problems should cause societal concern. However, it may also reflect a genuine belief in the combat of environmental problems. Many people have a strong belief that technological changes may solve global environmental problems, and this can in effect cause a lack of concern about the threats (21).

Regarding specific environmental issues people deemed most important, there are a few similarities and differences between the results from survey 2 and previous studies. My results showed that increased flooding and extreme weather (29.7%), together with global warming (17.9%) and local air pollution (17%) were the top three threats facing Norway (Figure 13). In the 2010 ISSP (57), climate change was considered the most important environmental problem (26%), followed by resource depletion (18.6%), and air pollution (18.2%). Climate change and global warming are often used interchangeably to explain both the major changes in weather and the increased temperature (3, 108). The top concerns from both results are therefore somewhat corresponding. However, the high concern about resource depletion from ISSP was not found in my results. Resource availability was only considered the most important challenge by 6.6% of the respondent from survey 2, as opposed to ISSP's 18.6%. Another similarity can be seen in the percentage who did not consider any of the listed environmental problems as the most important. The results from survey 2 showed that 1.7% were not concerned about anything, while in the ISSP, 1.6% chose none.

It is no surprise that climate change or the direct results of it (global warming, and increased flooding and extreme weather) were considered the most important environmental challenges Norway is facing. Climate change has been heavily frequented in the news media over the past few years. Especially after the release of the latest IPCC report, news media published articles about how climate change would affect us in the near- and long-term future. The concern about these issues may reflect a society that is well-informed about ongoing changes and coming disasters. This can also be seen in the results of greatest concern on a global basis. Global warming (41.5%), loss of ecosystem services (19.7%), and resource availability (14.4%) were the three issues most people were concerned about in survey 2 (Figure 14). Although there are no correct answers to which challenge is the greatest as many of them are connected and results of each other, the tendencies seen in society's concern are interesting. In Norway, people were mostly concerned about flooding and extreme weather. In the relatively cold climate in Norway, rain is not among the welcomed weather events in general, and a high concern for this may actually reflect a preference of nice weather. We can speculate about this also because only 17.9% considered global warming as the biggest threat. However, this is a trivial oversimplification. It is more reasonable to assume that people relate more to local damages that affect them directly than global changes that can be hard to see. Increased flooding and extreme weather in Norway are impacts that people "feel more on their body" than a global temperature increase of 2° C.

Why was global warming considered less threatening to Norway than to the world as a whole? Is it because people know that it affects other places, such as Bangladesh, more severely than Norway? Or is it simply because people here do not mind increased temperatures? Whatever the answer may be, society's general level of concern for overall issues coupled with the issues they were concerned about point to an at least somewhat informed society that is keeping up with the latest news on environmental changes. However, the percentage of people who are unconcerned, and the people who did not consider any environmental challenge as important definitely would benefit from improved science dissemination. Especially since environmental changes are happening now (3, 109), and the world has to take action immediately to cope with a changing environment (110). Increasing society's level of scientific literacy, even if this means only a small percentage of the population in Norway, is something we should aim for. And we need environmental science dissemination that works to be able to do so.

5.4 Overview of suggested remedies and channels

New environmental discoveries are a big part of what the public needs to learn more about to become a more sustainable society. Knowledge is what drives change, and increasing society's environmental literacy has no pitfalls. Accessibility to information, in terms of both physical access and mental comprehension, is therefore key to create environmentally informed citizens. Based on the results and discussion above, I have come up with some suggested remedies and useful channels that can improve science dissemination and public scientific literacy.

5.4.1 Formal education

No simple recipe exists for how to succeed in science dissemination to increase the scientific literacy society exhibits. There are however, numerous suggestions in literature on how to improve communication with a lay audience. A first step, as suggested by Jurin et al. (4) and Miller (11), is for scientists to undergo formal education in science communication. Many scientists struggle with dissemination simply because they lack training in how to connect to a lay audience. Receiving proper training where they learn to understand their audience is an important starting point to increase public scientific literacy. The scientists at the program of Industrial Ecology seem to want to improve their communicational skills to better disseminate environmental science. While almost half of the surveyed scientists had already taken a communication class, 63.6% of the remaining people wanted to take one in the future. This shows a willingness and recognition of the importance of formal training. The scientists seemed to be aware that they might not know everything about communication, and it is very positive to see that so many are willing to make a change. Scientists and the lay public are supposed to have different levels of knowledge about environmental science; however, everyone should understand information that has implications for society as a whole. Scientists can contribute to making this happen.

To make sure the scientists at NTNU hold the skills to disseminate to a large audience, communication classes should become mandatory for all permanent faculty. Today, there exists a number of communication courses PhD students can take, however, they are not mandatory, nor are they aimed at faculty besides PhDs. Making communication classes mandatory for all would ensure that the researchers possess the right skillset to communicate meaningfully to society and could therefore improve how science is disseminated today.

5.4.2 Recognition, incentives, and time for communication

Recognition and incentives for science dissemination is a good start to make communication more desirable and a part of the scientist's daily work routine. When almost 50% of the surveyed scientists say they would communicate more if it were better recognized by the university, there is room for changes. Principal Bovim (111) states that the researchers at NTNU have to communicate their work more and better. However, if NTNU does not facilitate and make this task easier, it can become very hard. Scientists are extremely busy with many tasks that have to be undertaken. Time to communicate has to be taken out from other work by the scientists themselves as long as it is not explicitly included in their job description. This does not seem fair. Many of the surveyed scientists expressed they were both interested in communicating their work and wanted to spend more time on it. However, when time to disseminate is not included in their "regular" work hours and is not merited, it receives a low prioritization. Scientists who then actually take time to do so, "looses" time on other tasks, such as research. Time to communicate science should already be a within their working hours, and not something that comes on top of other tasks. It needs to become a recognized part of scientists' job description if we hope for more science dissemination.

NTNU could, and should, take steps towards better facilitation of dissemination. This would not only be beneficial for the scientists themselves, but also for the university as a whole and society. The university would be more seen in the public through its researchers' dissemination practice, and society would benefit from increased information on recent research. Firstly, time to communicate should become an established part of employees' work description. Secondly, communication should be recognized better, both informally and formally. In addition, incentives can be an important measure. Promises of the possibility of future prizes are just not good enough alone, and the university needs to come up with strategies that encourages more science dissemination.

5.4.3 Visibility in traditional and new media

Another suggestion is to be present at relevant arenas where society engages and is interested. Weigold (10) asserts that this should be obvious, however, it can often be hard to know where that is. Considering the fact that society mainly uses traditional media to learn about the outside world, this would be a good place to begin. The scientists at the program of Industrial Ecology should therefore try to get more involved in the broadcast media. Broadcast media is an important interface between society and scientists. It can contribute to an increased public understanding of environmental issues. New media are also channels that should be considered. Considering the changing media environment today, there is a huge opportunity in these media for the future. More and more information is being shared on social media (112), and it is a good way to connect with different groups. Young people frequent new media more than older generations, and to get them interested in environmental research, social media can be a good place to begin. An overview of suggested useful channels for scientists at the Industrial Ecology program can be found in Table 6 below.

Traditional and new media also open up for debates and discussions. Miller (11) says making sure relevant environmental research is part of the public debate is an important step to take to engage citizens. Although regular traditional media typically do not facilitate public participation, the new media environment lets users go online to partake in discussions about things they have read other places. Online broadcasting media and new media already promote online discussions, and scientists can benefit greatly from this function. This again, creates a more involved audience, and thus can enhance the scientific literacy of the lay audience.

Table 6 Overview of useful channels for scientific communication. Advantages and disadvantages (4, 5, 25, 36, 76, 77, 112, 113).

Channel	Advantage	Disadvantage
Regular newspaper	Mass communication; large and diverse audience; participation in public debate	Impersonal; slow; one-way communication; short longevity
Online newspaper	Advantages above + two-way communication; fast updates; long longevity	Impersonal; can be too fast
Regular TV	Mass communication; large and diverse audience; connectedness with audience through visual display	Restrictive (time and place); short longevity; time consuming to produce; one-way communication
Online TV	Advantages above + not restrictive (time); long longevity; (two-way communication)	Restrictive (place); time consuming to produce
Regular radio	Mass communication; large and diverse audience; short and concise information; easily accessible	Very short longevity; less attentive audience; one-way communication
Online radio	Advantages above + long longevity; (two-way communication)	Less attentive audience
Social media	Large and diverse audience; fast; easy to share information; long longevity; two-way communication	Information overload; audience often have to search and find the "site"/information; trolling*
Other webpages	Large and diverse audience; no limits to store, upload/download, share, or consume information; fast; two-way communication; long longevity	Information overload; audience often have to search and find the "site"/information; trolling

*to provoke for the sake of provocation. The purpose of trolling is not to argue for or against something, but rather to create a negative atmosphere in general.

Visibility in and use of the channels society engage with can also decrease the issues society experience with environmental information. As survey 2 revealed, many of the respondents struggled with trust in sources and differentiating between facts and personal opinions. A "scientific present" in the news media can help solve this. If environmental scientists are a part of the public debate, they can work as reassuring voices. This is important to make people realize the seriousness of much of the environmental information out there, and to "clean up" some of the arguments made in public debates. This in turn can help with trust issues as scientists in the public news exert trustworthiness and authority.

5.4.4 Easier language

However, appropriate platform is not the only thing that is important. The actual content of the information is equally, if not more, important to increase comprehension of science. Hayes (62) claims the growing inaccessibility of science stems from the highly complex language scientists use. He suggests that the language scientists use when disseminating research has to be simpler. Jurin et al. (4) also make a point of this. Comprehensible language is a key factor to interpret information (4). As seen from survey 2, people had experienced multiple problems with the use of complex and unclear language in environmental information. Making sure it is as easy as possible, without losing the complex nature of the phenomenon described, is a fine balance scientists need to become better at. In addition, the content has to capture the consumers. Dahlstrom (114) and Negrete and Lartigue (115) suggest disseminating science through storytelling. Engaging and capturing the audience means more than just sharing interesting and understandable science; it means getting them to want to consume more and for the audience to take messages with them. Barker (73) claims telling good stories when communicating science is the very heart of good science dissemination, and is something scientists should always do. The concept of storytelling was not investigated in the surveys. However, considering how news stories in broadcast media are constructed, I assume that a similar format of environmental information is useful. People mainly read traditional media because it provides them with the latest information, and it is entertaining at the same time. No one wants to spend excessive time on boring information, however relevant or useful it may be.

5.5 Implications of the study

Some remarks about the implications of the chosen method must be made. Regarding survey 1, it is possible that the people who responded did so because they have a higher interest in science dissemination than others at the program. However, based on the replies on interest and perceived level of interest compared to others, this seems unlikely. In addition, since the survey was only handed out on one occasion, people who were not present did not get an opportunity to participate in the study. The survey could have been passed out on multiple occasions to ensure that everyone who wanted to partake had the opportunity. To ensure anonymity, no background variables was asked in survey 1. This makes it difficult to make definitive conclusions based on the results, as it is not possible to see if the respondents correspond to the actual distribution of scientists at the program. The results can therefore not be generalized to the entire program of Industrial Ecology. However, the general trends are still valuable for the program, especially since my suggestions are based on more than just the replies from the 21 respondents.

Regarding survey 2, a few implications of the actual questionnaire should be addressed first. A few of the questions depended on the respondent's previous experience with certain terms. For example, question 12 asks: *"Approximately, how many tons CO_2-equivalents do you think*

Norway emits annually?"[11]. This is a problem because it is not given that everyone has knowledge about what this term means. However, the term was deliberately used for two reasons: media's use of the word and the amount of CO_2 in total greenhouse gases (measured in CO_2-equivalents) in Norway. A search with ATEKST shows that the term "CO_2-ekvivalent*" has been used in 5 277 media pieces since 1992, the majority after 2006 (116). In fact, most articles about *total emissions* use the term CO_2-equivalents. In addition, the Norwegian greenhouse gas emissions in 2014 consisted of 82,5% CO_2, according to Statistisk sentralbyrå (117). So even if a person was not aware of the amount of CO_2-equivalents and instead interpreted it as just CO_2, they would still be able to give the correct response. The second problem occurred because question 12 indicates that there is a correct answer. This was also the case for question 13 and 14 (Appendix B). Although I made precautions and tried to avoid this by adding *[...] do you think [...]*, most people will still perceive this question with correct and incorrect answers. It is therefore possible that some people, instead of answering what they actually thought, looked up the question online to find "the correct" answer.

There was also an issue with the statements. Although it was made clear the survey was anonymous, people might feel pressured to answer what is considered "politically", "socially", or "ethically" correct (89). In addition, the use of statements in an index measuring environmental literacy can be problematic. Statements with Likert-scales are most often used to measure attitudes (89). With the statements in survey 1 I did not only want to measure attitudes, but also how well people were informed. Some of the statements were based on prevailing attitudes in society about environmental issues that are untrue, have a narrow view, and are debated against in research. One example was the statement: *"Private people's emissions plays a big role"*. People can have opinions about this claim, however, research have shown that there is a "correct" answer to whether or not individual emissions play a big role in the entire emission-picture (118-120).

As survey 2 was not based on true random sampling, the results cannot be generalized. This is a downside of using a self-created survey instead of using already collected data from institutions like Statistisk Sentralbyrå or TNS Gallup. However, for a master student it is almost impossible to sample a completely random sample of respondents with a self-made survey due to the cost and time it takes to do so. This essentially means that my results can only be used as a guideline for the tendencies that match what others have found. However, since the main goal

[11] The original question from the survey was in Norwegian and was *«Omtrent hvor mange tonn CO_2-ekvivalenter tror du Norge slipper ut årlig?»*

of the thesis was to come up with suggestions on channels and remedies for the program of Industrial Ecology’s science dissemination, this is considered a minor issue. In addition, the sampling size of N=229 was fairly large and in compliance with suggested sample sizes, so the suggestions made based on the results are still considered valuable for the program.

6 Conclusion and outlook

In this thesis, I explored the communicational practices at the program of Industrial Ecology at NTNU and in society. This has been investigated by looking at the results from two surveys sent out to faculty at the program and to society. The goal was to map the communicational practices at the program and in society, and to come up with suggestions for the faculty at the program on how to improve science dissemination.

The dissemination of environmental science at the program does not take place where society actually finds and consumes environmental information. This affects society's environmental literacy. While the scientists mainly use scientific media such as journal articles to communicate research, society favors traditional media such as newspapers. These findings are in line with previous research on science dissemination and media habits in Norway, and it is not surprising that this gap exists. Time constraints, lack of recognition, and how news media operates are three issues that keep scientists from communication more with the lay public. While the university can make changes such as including dissemination in the researchers' work description and increasing recognition of communication, the ways of the news media are harder to change. However, scientists should still work towards reaching the audience where they can be found. The changing media landscape opens up for other channels, such as social media or other webpages, that scientists can use relatively freely without the restrictions of the news media. In addition, other measures can be taken to enable society's appropriation of environmental literacy. Easier language and making research more entertaining through connecting it to relatable issues are two such steps.

It can be difficult to keep up with a changing media environment, especially for the busy scientist. However, it is necessary to do so if we want society to become more sustainable. This is crucial as the world is changing fast due to anthropogenic pressures. People need to be informed about what goes on, how their lives impact the environment, and what they can do to better it. We need to work closer together to implement changes to secure a healthy environment for our future generations and the planet. Science dissemination is key to this spread of knowledge.

The findings in this work, although not generalizable, can be seen as a contribution to the research in science dissemination in a changing media environment. However, more research is needed to fully understand how environmental science dissemination can affect society. One suggestion for further research is to look at different media effects and environmental literacy. Although numerous work on media effects exist, a comparison of media effects from different channels in connection to environmental literacy is still lacking. This is something that should be explored further to gain increased insight to which channels society are most affected by in regards to environmental information. Further, it could be interesting to see what effects science dissemination has on researchers and scientists. Does extensive dissemination contribute to an increase in funding for the researcher? How is science dissemination for a lay audience linked to scientific publishing for peers? These questions can help uncover new strategies for increased science dissemination towards society.

References

1. MEA. Ecosystems and Human Well-being: Biodiversity Synthesis. Washington, DC.: World Resources Institute, 2005.
2. Miller T, Spoolman S. Sustaining the Earth. 11th ed. Stamford, USA: Cenage Learning; 2015.
3. Houghton J. Global Warming. The Complete Briefing. 4th ed. Cambridge, United Kingdom: Cambridge University Press; 2009.
4. Jurin RR, Roush D, Danter KJ. Environmental Communication - Skills and Principles for Natural Resource Managers, Scientists, and Engineers. 2nd ed. Netherlands: Springer Netherlands; 2010.
5. Cox R. Environmental Communication and the Public Sphere. 3rd ed. California: SAGE Publications, Inc.; 2013.
6. Nadkarni NM. The Moss-in-Prison project: disseminating science beyond academia. Frontiers in Ecology and the Environment. 2006;4(8):442-3.
7. Cantrill JG, Oravec CL. Introduction. In: Cantrill JG, Oravec CL, editors. The Symbolic Earth Discourse and Our Creation of the Environment. Kentucky: The University Press of Kentucky; 1996.
8. Moser SC. Communicating climate change: history, challenges, process and future directions. Wiley Interdisciplinary Reviews: Climate Change. 2010;1(1):31-53.
9. Kyvik S. Popular Science Publishing and Contributions to Public Discourse among University Faculty. Science Communication. 2005;26(3):288-311.
10. Weigold MF. Communicating Science: A Review of the Literature. Science Communication. 2001;23(2):164-93.
11. Miller S. Public understanding of science at the crossroads. Public Understanding of Science. 2001;10(1):115-20.
12. Kunnskapsdepartementet. Tilstandsrapport for høyere utdanning 2014. 2014.
13. Carlsen B, Müftüoglu IB, Riese H. Forskning i media - Forskere om motivasjon og erfaringer fra medieintervjuer. Norsk medietidsskrift. 2014(03).
14. Kristiansen N. Lite nytt om forskningsformidling i Forskningsmeldingen2013 30.05.2016. Available from: http://forskning.no/meninger/leder/2013/03/lite-nytt-om-forskningsformidling-i-forskningsmeldingen.
15. Sverdrup-Thygeson A. Er nøytral forskningsformidling mulig?2015 30.05.2016. Available from: http://forskning.no/meninger/kronikk/2015/03/er-noytral-forskningsformidling-mulig.
16. Redaksjonen Gemini. Kommentar: Har vi bruk for forskning som ikke kommuniseres?2006 30.05.2016. Available from: http://gemini.no/2006/11/kommentar-har-vi-bruk-for-forskning-som-ikke-kommuniserer/.
17. Salomonsen J. Forskningen må åpne seg radikalt2016 30.05.2016. Available from: http://forskning.no/om-forskning-samfunn-kommunikasjon/2016/01/forskningsverdenen-ma-apne-seg-radikalt.
18. Jensen BB. Knowledge, Action and Pro-environmental Behaviour. Environmental Education Research. 2002;8(3):325-34.
19. Whitmarsh L, O'Neill S. Green identity, green living? The role of pro-environmental self-identity in determining consistency across diverse pro-environmental behaviours. Journal of Environmental Psychology. 2010;30(3):305-14.
20. Stritch JM, Christensen RK. Going Green in Public Organizations: Linking Organizational Commitment and Public Service Motives to Public Employees' Workplace Eco-Initiatives. The American Review of Public Administration. 2016;46(3):337-55.

21. Kollmuss A, Agyeman J. Mind the Gap: Why do people act environmentally and what are the barriers to pro-environmental behavior? Environmental Education Research. 2002;8(3):239-60.
22. Holbert RL, Kwak N, Shah DV. Environmental Concern, Patterns of Television Viewing, and Pro-Environmental Behaviors: Integrating Models of Media Consumption and Effects. Journal of Broadcasting & Electronic Media. 2003;47(2):177-96.
23. Shanahan J, Morgan M, Stenbjerre M. Green or brown? Television and the cultivation of environmental concern. Journal of Broadcasting & Electronic Media. 1997;41(3):305-23.
24. Social Issues Research Centre [SIRC], Amsterdam School of Communications Research [ASCoR]. Guidelines for scientists on communicating with the media. sirc.org: SIRC, n.d.
25. Laszlo P. Communicating Science. A Practical Guide. New York: Springer; 2006.
26. Hobbs RJ. Overcoming barriers to effective public communication of ecology. Frontiers in Ecology and the Environment. 2006;4(9):496-7.
27. Lorenzoni I, Nicholson-Cole S, Whitmarsh L. Barriers perceived to engaging with climate change among the UK public and their policy implications. Global Environmental Change. 2007;17(3–4):445-59.
28. Ryghaug M, Holtan Sørensen K, Næss R. Making sense of global warming: Norwegians appropriating knowledge of anthropogenic climate change. Public Understanding of Science. 2011;20(6):778-95.
29. Bentley P, Kyvik S. Academic staff and public communication: a survey of popular science publishing across 13 countries. Public Understanding of Science. 2011;20(1):48-63.
30. Skirbekk S. Samfunn Store norske leksikon2014 [19.12.2015]. Available from: https://snl.no/samfunn.
31. Skirbekk S. Sosiale systemer Store norske leksikon2014 [19.12.2015]. Available from: https://snl.no/sosiale_systemer.
32. Frønes I, Kjølsrød L, (eds.). Det norske samfunn. 6th ed. Oslo: Gyldendal akademisk; 2010.
33. Environmental Science. What is Environmental Science? environmentalscience.orgn.d. [20.05.2016]. Available from: http://www.environmentalscience.org/.
34. Cunningham M. What is Environmental Science? - Definition and Scope of the Field study.comn.d. [20.05.2016]. Available from: http://study.com/academy/lesson/what-is-environmental-science-definition-and-scope-of-the-field.html.
35. NTNU Industrial Ecology. About Industrial Ecology (IndEcol) ntnu.edun.d. [20.05.2016]. Available from: https://www.ntnu.edu/web/indecol/about1.
36. Schwebs TØ, Helge. Media i Samfunnet. Oslo: Samlaget; 2007.
37. Littlejohn SW, Foss KA. Theories of human communication. 10th ed. Long Grove, IL: Waveland Press, Inc.; 2011.
38. Klöckner CA. The Psychology of Pro-Environmental Communication. United Kingdom: Palgrave Macmillan; 2015.
39. Morreale SP, Osborn MM, Pearson JC. Why Communication is Important: A Rationale for the Centrality of the Study of Communication. Journal of the Association for Communication Administration. 2000;29:1-25.
40. Blumer JG. Communication and democracy: The crisis beyond and the ferment within. Journal of Communication. 1983;33:166-73.
41. Stotsky S. The connection between language education and civic education. Bloomington, IN: ERIC Digest; 1992.
42. Norges forskningsråd. Nasjonal strategi for allmennrettet forskningsformidling. Oslo: Norges forskningsråd, 1997.

43. Miller JD. The measurement of civic scientific literacy. Public Understanding of Science. 1998;7(3):203-23.
44. Miller JD. The Development of Civic Scientific Literacy in the United States. In: Kumar DD, Chubin DE, editors. Science, Technology, and Society: A Sourcebook on Research and Practice. Dordrecht: Springer Netherlands; 2000. p. 21-47.
45. Qu J, Zeng J, Li Y, Wang Q, Maraseni T, Zhang L, et al. Household carbon dioxide emissions from peasants and herdsmen in northwestern arid-alpine regions, China. Energy Policy. 2013;57:133-40.
46. Liu J, Diamond J. China's environment in a globalizing world. Nature. 2005;435(7046):1179-86.
47. Weber CL, Peters GP, Guan D, Hubacek K. The contribution of Chinese exports to climate change. Energy Policy. 2008;36(9):3572-7.
48. Falk JH, Storksdieck M, Dierking LD. Investigating public science interest and understanding: evidence for the importance of free-choice learning. Public Understanding of Science. 2007;16(4):455-69.
49. Kim H-S. PEP/IS: A New Model for Communicative Effectiveness of Science. Science Communication. 2007;28(3):287-313.
50. Vogel C, Moser SC, Kasperson RE, Dabelko GD. Linking vulnerability, adaptation, and resilience science to practice: Pathways, players, and partnerships. Global Environmental Change. 2007;17(3–4):349-64.
51. European Commission. Special Eurobarometer 340 / Wave 73.1 - TNS Opinion & Social. European Union: European Commission, 2010.
52. Ramberg I, Kallerud E, Nielsen TH. Befolkningens forhold til forskning, vitenskap og teknologi. Resultater fra en norsk intervjuundersøkelse Oslo: Norsk institutt for studier av forskning og utdanning, 2001 Contract No.: Rapport 1/2001.
53. Ramberg I. Nordmenns forhold til forskning og teknologi 2004. Resultater fra en intervjuundersøkelse. Oslo: Norsk institutt for studier av forskning og utdanning/Senter for innovasjonsforskning, 2004 Contract No.: Skriftserie 21/2004.
54. European Commission. Public Opinion. Home ec.europa.eun.d. [09.05.2016]. Available from: http://ec.europa.eu/COMMFrontOffice/PublicOpinion/index.cfm/General/index.
55. Sjøberg S, Schreiner C. Holdninger til og forestillinger om vitenskap og teknologi i Norge. En framstilling basert på data fra Eurobarometer og ROSE Oslo: Universitetet i Oslo, 2006.
56. Listhaug O, Jakobsen TG. Verdiundersøkelsen 2007: Norske meninger om miljø – lokalt og globalt. Samfunnsspeilet 2008(1):31-40.
57. TNS Gallup. Internasjonal spørreundersøkelse om miljø, 2010, norsk del av ISSP. In: Programme ISS, editor. NSD. Norske spørreundersøkelser2010.
58. Forksningsrådet. Hvor interessert er du i utviklingen innen forskning og teknologi? In: 2014 IM, editor.: Forskningsrådet; 2014.
59. TNS Gallup. TNS Gallups Klimabarometer 2015 [Presentation]: TNS Gallup; 2015.
60. Pew Research Center. Major Gaps Between the Public, Scientists on Key Issues pewinternet.org: Pew Research Center; 2015 [12.05.2016]. Available from: http://www.pewinternet.org/interactives/public-scientists-opinion-gap/.
61. Stamm KR, Clark F, Eblacas PR. Mass communication and public understanding of environmental problems: the case of global warming. Public Understanding of Science. 2000;9(3):219-37.
62. Hayes DP. The Growing Inaccessibility of Science. Nature. 1992;356:739-40.
63. Crotty M. The Foundations of social research: Meaning and perspective in the research process. United Kingdom: Sage Publications Ltd. London; 1998.

64. Likens GE. The role of science in decision making: does evidence-based science drive environmental policy? Frontiers in Ecology and the Environment. 2010;8(6):e1-e9.
65. Soulé ME. What is conservation biology? A new synthetic discipline addresses the dynamics and problems of perturbed species, communities, and ecosystems. BioScience. 1985;35(11):727-34.
66. Barker S. There is no path – the path is made by walking. Frontiers in Ecology and the Environment. 2007;5(10):554-.
67. Bolstad G. Forskere ønsker mer tid til å kommunisere forskningsradet.no: Forskningsrådet; 2015 [28.11.2015]. Available from: http://www.forskningsradet.no/no/Nyheter/Forskerne_onsker_mer_tid_til_a_kommunisere/1254013717103/p1174467583739.
68. Slobodkin LB. Proclaiming a new ecological subdiscipline. Bulletin of the Ecological Society of America. 2000;81(3):223-6.
69. Wiens JA. Scientific responsibility and responsible ecology. Conservation ecology. 1997;1(1):16.
70. Rykiel EJ. Scientific Objectivity, Value Systems, and Policymaking. BioScience. 2001;51(6):433-6.
71. Future Present Group AS. Forskningskommunikasjon 2015. Forskningsrådet; 2015.
72. Grace J. “The best papers are the boldest”. Frontiers in Ecology and the Environment. 2007;5(1):49-50.
73. Barker S. Environmental communication in context. Frontiers in Ecology and the Environment. 2006;4(6):328-9.
74. Forskningsrådet. Hva er din viktigste kilde for informasjon om forskning? In: 2014 IM, editor.: Forskningsrådet; 2014.
75. Web of Science. Results webofknowledge.com: Thomson Reuters; 2016 [12.05.2016]. Available from: https://apps.webofknowledge.com/Search.do?product=UA&SID=P2rWpdq27Yo5EplwjbR&search_mode=GeneralSearch&prID=b2176160-3f9e-4527-ad4a-10d9c1c1b2ad.
76. McQuail D. Mass Communication Theory. London: SAGE Publications Ltd; 2010.
77. Hagen I. Medias publikum. Frå mottakar til brukar? Oslo: Gyldendal; 2000.
78. Aalen I. En kort bok om sosiale medier. Bergen: Fagbokforlaget; 2012.
79. Vaage OF. Norsk mediebarometer 2015. Oslo-Kongsvinger: Statistisk sentralbyrå, 2016.
80. Aalberg TE, E. . Mediesosiologi. 2nd ed. Oslo: Samlaget; 2012.
81. Larsen P. Medievitenskap 2: Tekstteori og tekstanalyse. 2nd ed. Bergen: Fagbokforlaget; 2008.
82. Steen G. Undersøkelse om forskningskommunikasjon: Forskningsrådet; 2016 [10.03.2016]. Available from: http://www.forskningsradet.no/servlet/Satellite?blobcol=urldata&blobheader=application%2Fpdf&blobheadername1=Content-Disposition&blobheadervalue1=+attachment%3B+filename%3D%2220151125FPGGyrdPresentasjonkonferanse9.pdf%22&blobkey=id&blobtable=MungoBlobs&blobwhere=1274507268409&ssbinary=true.
83. World Values Survey. WWS 2010-2012 Wave. worldvaluessurvey.org: WWS; 2010-2012.
84. European Social Survey. Questionnaires NO. europeansocialsurvey.org2002.
85. Field A. Discovering Statistics Using SPSS. 2nd ed. London: SAGE Publications; 2005.
86. Pallant J. SPSS. Survival Manual. 4th ed. Australia: Allen & Unwin Book Publishers; 2010.

87. Miles J, Shevlin M. Applying regression and correlation: a guide for students and researchers. . London: Sage; 2001.
88. Green SB. How many subjects does it take to do a regression analysis? Multivariate Behavioural Research. 1991;26:499-510.
89. Ringdal K. Enhet og mangfold. Samfunnsvitenskapelig forskning og kvantitativ metode. 3rd ed. Bergen: Fagbokforlaget; 2007.
90. Whitmarsh L. What's in a name? Commonalities and differences in public understanding of “climate change” and “global warming”. Public Understanding of Science. 2009;18(4):401-20.
91. Kvaløy B, Finseraas H, Listhaug O. The publics’ concern for global warming: A cross-national study of 47 countries. Journal of Peace Research. 2012;49(1):11-22.
92. Framtiden i våre hender. Her er de beste og verste miljøpartiene framtiden.no2013 [12.04.2016]. Available from: http://www.framtiden.no/201303016043/aktuelt/klima/her-er-de-beste-og-verste-miljopartiene.html.
93. World Wide Fund for Nature. WWF har miljøtestet partiene i valgkampen: store forskjeller mellom partiene wwf.no2013 [12.04.2016]. Available from: http://www.wwf.no/?40166/WWF-har-miljtestet-partiene-i-valgkampen-Store-forskjeller-mellom-partiene.
94. Amundsen T. Holder seg borte fra media med god grunn. forskning no Nettavis om norsk og internasjonal forskning. 2016.
95. Miller JD. Public Understanding of, and Attitudes toward, Scientific Research: What We Know and What We Need to Know. Public Understanding of Science. 2004;13(3):273-94.
96. Griffin RJ, Dunwoody S, Neuwirth K. Proposed Model of the Relationship of Risk Information Seeking and Processing to the Development of Preventive Behaviors. Environmental Research. 1999;80(2):S230-S45.
97. Kahlor LA. An Augmented Risk Information Seeking Model: The Case of Global Warming. Media Psychology. 2007;10(3):414-35.
98. Whitmer A, Ogden L, Lawton J, Sturner P, Groffman PM, Schneider L, et al. The engaged university: providing a platform for research that transforms society. Frontiers in Ecology and the Environment. 2010;8(6):314-21.
99. Arbeidstilsynet. Alminnelig arbeidstid: Arbeidstilsynet - Kontroll og veiledning om arbeidsmiljø; n.d. [06.06.2016]. Available from: http://www.arbeidstilsynet.no/fakta.html?tid=78151/#Alminnelig_arbeidstid.
100. Pleasant A, Good J, Shanahan J, Cohen B. The literature of environmental communication. Public Understanding of Science. 2002;11(2):197-205.
101. Norges teknisk-naturvitenskapelige universitet. Forsker grand prix 2016 n.d. [25.05.2016]. Available from: https://www.ntnu.no/forsker-grand-prix/.
102. Morgenbladet. Kåring: fantastiske formidlere: Morgenbladet; 2016 [25.05.2016]. Available from: https://morgenbladet.no/2016/03/karing-fantastiske-formidlere.
103. Mekjan S. Hvem bør vinne Forskningsrådets priser? : Forskningsrådet; 2016 [25.05.2016]. Available from: http://www.forskningsradet.no/no/Nyheter/Hvem_bor_vinne_Forskningsradets_priser/1254018092007?lang=no.
104. Malka A, Krosnick JA, Langer G. The Association of Knowledge with Concern About Global Warming: Trusted Information Sources Shape Public Thinking. Risk Analysis. 2009;29(5):633-47.
105. McCright AM, Dunlap RE. THE POLITICIZATION OF CLIMATE CHANGE AND POLARIZATION IN THE AMERICAN PUBLIC'S VIEWS OF GLOBAL WARMING, 2001–2010. Sociological Quarterly. 2011;52(2):155-94.

106. Tjernshaugen K. Frp-toppene er splittet om menneskeskapte klimaendringer. Aftenposten. 2015.
107. TNS Gallup. Spørreundersøkelse om verdier, natur og miljø, 2000, norsk del av ISSP. In: Programme ISS, editor. NSD. Norske spørreundersøkelser2000.
108. Shah A. Climate Change and Global Warming Introduction n.d. [30.05.2016]. Available from: http://www.globalissues.org/article/233/climate-change-and-global-warming-introduction#WhatisGlobalWarmingandClimateChange.
109. IPCC. Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA: Intergovernmental Panel on Climate Change, 2013.
110. IPCC. Climate Change 2014: Mitigation of Climate Change. Working Group III Contribution to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA: Intergovernmental Panel on Climate Change, 2014.
111. Normannsen SW. Flere må formidle mer. Universitetsavisa. 2013.
112. Alstad I. En kort bok om sosiale medier. Bergen: Fagbokforlaget; 2012.
113. Jenkins H. Convergence Culture. Where Old and New Media Collide. New York and London: New York University Press; 2006.
114. Dahlstrom MF. Using narratives and storytelling to communicate science with nonexpert audiences. Proceedings of the National Academy of Sciences. 2014;111(Supplement 4):13614-20.
115. Negrete A, Lartigue C. Learning from education to communicate science as a good story. Endeavour. 2004;28(3):120-4.
116. "CO2-ekvivalent*" [Internet]. 2016 [cited 20.03.2016]. Available from: http://ret-web05.int.retriever.no/services/archive/search.
117. Statistisk sentralbyrå. Utslipp av klimagasser, 1990-2014, endelige tall ssb.no2015 [01.04.2016]. Available from: https://www.ssb.no/natur-og-miljo/statistikker/klimagassn/aar-endelige/2015-12-18.
118. Achtnicht M. Do environmental benefits matter? Evidence from a choice experiment among house owners in Germany. Ecological Economics. 2011;70(11):2191-200.
119. Munksgaard J, Pedersen KA, Wien M. Impact of household consumption on CO2 emissions. Energy Economics. 2000;22(4):423-40.
120. Jiang L, Hardee K. How do Recent Population Trends Matter to Climate Change? Population Research and Policy Review. 2010;30(2):287-312.

Appendix A

Hello fellow IndEcoler!

I am currently writing my master thesis about environmental research and communication. In connection to this, I want to kindly ask for your participation in filling out this short survey I have made.

The purpose of the survey is to map some of the communicational practices here at Industrial Ecology, and to see if there are new ways to better convey environmental science. The survey is anonymous, and the results will be handled confidentially.

It is voluntary to participate; however, I do hope you take the time to do so. Should you have any questions about the project, please contact me on my email.

Thank you!

Sincerely,

Julie Schwabe Strand
master candidate
julie.schwabe@gmail.com

Survey: Communicating environmental science

1. **Gender**
   ◯ Male ◯ Female

2. **Position at Industrial** Ecology:____

3. **How interested would you say you are in communicating environmental issues to stakeholders outside of the research community?**
   ◯ Not interested at all
   ◯ A little interested
   ◯ Neutral
   ◯ Quite interested
   ◯ Very interested

4. **Do you think you are more or less interested than your colleagues are?**
   ◯ More
   ◯ Less
   ◯ The same
   ◯ Don't know

5. **Approximately, how much time have you spent on science communication each month in the past year (not including teaching your regular classes at NTNU)?**
   ◯ Nothing
   ◯ Less than 30 minutes
   ◯ 1-2 hours
   ◯ 3-4 hours
   ◯ 5-6 hours
   ◯ 7-8 hours
   ◯ 9-10 hours
   ◯ More than 10 hours

6. **How important do you think it is to find time to communicate environmental science?**
   ◯ Not important at all

◯ Not so important
◯ Neutral
◯ A little important
◯ Very important

7. **Have you ever taken a communication class/course?**
◯ Yes ◯ No

8. **Would you want to take a communication class/course?**
◯ Yes
◯ No
◯ I don't know
◯ I have taken one before

9. **What environmental topic do you think is the most important one to communicate to society?**
____

10. **The field of Industrial Ecology uses different methods/tools in research. Please select those you have communicated to stakeholders outside the field.**
◯ Input-output analysis ◯ Life cycle analysis
◯ Material flow analysis ◯ Risk analysis
◯ Substance flow analysis ◯ None
◯ Life cycle costing ◯ Environmental footprinting
◯ Other (please specify): ________________________________

11. **Do you think it is useful/important for people outside of academia to be familiar with such tools?**
◯ Yes ◯ No

12. **Why/why not?**
____

13. **Do you think it is useful/important for people outside of academia to be familiar with the results obtained from these tools?**
◯ Yes ◯ No

14. **Why/why not?**
____

15. **Which channel(s) have you used (at least once) to communicate environmental science in the last year? (Multiple options are available to select)**
◯ None ◯ Scientific report
◯ Newspaper (paper) ◯ Newspaper (online)
◯ Book ◯ Debate
◯ Public presentation ◯ Magazine
◯ Science fair/research center (e.g. Vitensenteret) ◯ Journal article
◯ Museum ◯ Scientific summary/info sheet
◯ Webpages (not newspaper) ◯ Television
◯ Radio ◯ Festival

◯ Social media ◯ Conference
◯ Other (please specify): ______________________

16. Which three channels have you used the most?

1. ___________________________
2. ___________________________
3. ___________________________

17. Which channel(s) do you prefer to use to communicate environmental science? (Multiple options are available to select)

◯ None
◯ Newspaper (paper)
◯ Book
◯ Public presentation
◯ Science fair/research center (e.g. Vitensenteret)
◯ Museum
◯ Webpages (not newspaper)
◯ Radio
◯ Social media
◯ Other (please specify): ______________________
◯ Scientific report
◯ Newspaper (online)
◯ Debate
◯ Magazine
◯ Journal article
◯ Scientific summary/info sheet
◯ Television
◯ Festival
◯ Conference

18. Would you communicate environmental research/science more often if you had more time?

◯ Yes ◯ No

19. Would you communicate environmental research/science more often if it was better recognized by…

	Yes	No	I don't know
…the university?	◯	◯	◯
…your peers here at NTNU?	◯	◯	◯
…the Industrial Ecology society?	◯	◯	◯
…society?	◯	◯	◯

20. Are there any channels you wish you could explore more and use in science communication? If so, which one(s)?

◯ None
◯ Newspaper (paper)
◯ Book
◯ Public presentation
◯ Science fair/research center (e.g. Vitensenteret)
◯ Museum
◯ Webpages (not newspaper)
◯ Radio
◯ Social media
◯ Other (please specify): ______________________
◯ Scientific report
◯ Newspaper (online)
◯ Debate
◯ Magazine
◯ Journal article
◯ Scientific summary/info sheet
◯ Television
◯ Festival
◯ Conference

21. Which of the following activities do you wish you could spend more time on during your typical workweek?

◯ Research

◯ Teaching
◯ Administration
◯ Science communication

22. Compared to your situation today, how much more/less time do you want to spend on…

	A lot less	A little less	Neither	A little more	A lot more
…research	◯	◯	◯	◯	◯
…teaching	◯	◯	◯	◯	◯
…administrative tasks	◯	◯	◯	◯	◯
…science communication	◯	◯	◯	◯	◯
	◯	◯	◯	◯	◯

23. Please select to which degree you agree or disagree with the following statements:

	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
The consequences of climate change is often exaggerated in the public debate in media	◯	◯	◯	◯	◯
It is not important that the general public understands the causes for climate change	◯	◯	◯	◯	◯
Scientists who communicate environmental science through "unconventional" channels such as YouTube, blogs, other social media or similar are frowned upon	◯	◯	◯	◯	◯
It is important for everyone to have general knowledge about environmental issues	◯	◯	◯	◯	◯
Politicians (and other governmental employees) have too many opinions about environmental issues	◯	◯	◯	◯	◯
It is not important that the general public understands the causes for loss biodiversity and ecosystem services	◯	◯	◯	◯	◯
Environmental scientists have too much power due to their knowledge	◯	◯	◯	◯	◯
The people who are visible in the news media regarding the climate- and environment debate often have a hidden agenda	◯	◯	◯	◯	◯
It is valuable for scientists to have a dialogue with the public	◯	◯	◯	◯	◯
Many environmental scientists use their position to promote their own political standpoint	◯	◯	◯	◯	◯
My research is not interesting to the public	◯	◯	◯	◯	◯
In my experience, scientists who are frequently in the public debate are frowned upon	◯	◯	◯	◯	◯

Appendix B

Klima og miljø: kunnskap og interesse

Introduksjon

Forespørsel om deltakelse i forskningsprosjektet "Kommunikasjon og forståelse av miljøforskning".

Bakgrunn og formål

Miljøforskere formidler resultater og informasjon om drivere og konsekvenser av miljøendringer til samfunnet. Formålet med denne spørreundersøkelsen er å se på hvordan kommunikasjonen mellom miljøforskere og samfunnet fungerer i dag, og hva som eventuelt kan forbedres. Svarene fra undersøkelsen vil bli brukt i en masteroppgave ved Program for industriell økologi ved Norges teknisk-naturvitenskapelige universitet [NTNU].

Utvalget er basert på tilfeldige respondenter via personlige nettverk for å få et bredt utvalg.

Hva innebærer deltakelse i undersøkelsen?

Undersøkelsen omhandler hvordan individer innhenter informasjon om miljøproblemer, og hvordan disse blir forstått i samfunnet. Spørsmålene vil i all hovedsak handle om oppfatning av miljøproblematikk, og hvordan denne kunnskapen skapes. All data registreres gjennom en nettbasert undersøkelse, før en fil hentes ut med svarene.

Hva skjer med informasjonen om deg?

All informasjon vil bli behandlet konfidensielt, og resultatene vil bli presentert slik at ingen enkeltpersoner kan gjenkjennes. Det er kun innsamleren (masterstudenten) som vil ha tilgang til datamaterialet. Data vil bli fullstendig anonymisert når datainnsamlingen avsluttes, senest ved utgangen av April 2016.

Frivillig deltakelse og samtykke

Det er frivillig å delta. Du samtykker å delta i undersøkelsen ved å besvare spørsmålene og sende dem inn ved å klikke på «Ferdig» på siste side. Du kan når som helst i løpet av undersøkelsen velge å trekke deg uten å oppi noen grunn.

Undersøkelsen er meldt til Personvernombudet for forskning, Norsk samfunnsvitenskapelig datatjeneste AS.

Dersom du har spørsmål om undersøkelsen, ta kontakt med Julie Schwabe Strand (tlf. 48 18 05 82) eller Francesca Verones (tlf. 73 59 89 46).

Takk for at du er villig til å delta!

Julie Schwabe Strand
mastergradsstudent

Francesca Verones
førsteamanuensis, veileder

Program for industriell økologi, NTNU

1. Kjønn

○ Kvinne ○ Mann

2. Alder

○ <20 ○ 20-30 ○ 31-40 ○ 41-50 ○ 51-60 ○ 61-70 ○ >70

3. Bosted

○ Akershus
○ Aust-Agder
○ Buskerud
○ Finnmark
○ Hedmark
○ Hordaland
○ Møre og Romsdal
○ Nord-Trøndelag
○ Nordland
○ Oppland
○ Oslo
○ Rogaland
○ Sogn og Fjordane
○ Sør-Trøndelag
○ Telemark
○ Troms
○ Vest-Agder
○ Vestfold
○ Østfold
○ Utenfor Norge

4. Høyeste fullført utdanning (hvis du fortsatt er i utdanning, velg alternativet som gjelder når du har fullført studiet du er på nå)

○ Ikke fullført grunnskole
○ Grunnskole
○ Videregående skole
○ Universitet/høgskole, inntil 3 år
○ Universitet/høgskole, over 3 år
○ Doktorgradsutdanning

5. Yrke/yrkesgruppe/yrkessektor

○ Administrasjon, økonomi, kontor, og juss
○ Handel, kundeservice, restaurant, og reiseliv
○ Helse, omsorg, medisin, og biologi
○ Ikke-statlig organisasjon
○ Industri, bygg/anlegg, håndverk, og verkstedarbeid
○ Jord-/skogbruk, fiske, og matproduksjon
○ Kultur, religiøst arbeid, og idrett
○ Politiker
○ Service- og sikkerhetsarbeid
○ Skole, undervisning, og forskning
○ Student
○ Transport, logistikk, kommunikasjon, og IT
○ Annet

6. Hvilket parti føler du mest tilhørighet til?

○ Rødt ○ Sosialistisk Venstreparti ○ Arbeiderpartiet
○ Senterpartiet ○ Kristelig Folkeparti ○ Venstre
○ Høyre ○ Fremskrittspartiet ○ Kystpartiet
○ Miljøpartiet De Grønne ○ Ingen ○ Annet

7. Hvor interessert eller uinteressert vil du si at du er i klima- og miljøspørsmål?

○ Veldig uinteressert
○ Litt uinteressert
○ Verken eller
○ Litt interessert
○ Veldig interessert

8. Tror du på menneskeskapte klimaendringer?

◯ Ja ◯ Nei

9. Hvor bekymret er du for miljøutfordringene verden står ovenfor?

◯ Veldig ubekymret
◯ Litt ubekymret
◯ Verken eller
◯ Litt bekymret
◯ Veldig bekymret

10. Hva anser du som den største miljøutfordringen Norge står ovenfor?

◯ Ingen
◯ Økt vannstand
◯ Global oppvarming
◯ Økt flom og ekstremvær
◯ Tap av biologisk mangfold
◯ Lokal luftforurensning
◯ Ressursknapphet
◯ Tap av økosystemtjenester (grunnleggende goder vi får fra naturen)
◯ Syreregn
◯ Annet (vennligst spesifiser):

11. Hva anser du som den største miljøutfordringen verden står ovenfor?

◯ Ingen
◯ Økt vannstand
◯ Global oppvarming
◯ Økt flom og ekstremvær
◯ Tap av biologisk mangfold
◯ Lokal luftforurensning
◯ Ressursknapphet
◯ Tap av økosystemtjenester (grunnleggende goder vi får fra naturen)
◯ Syreregn
◯ Annet (vennligst spesifiser):

12. Omtrent hvor mange tonn CO2-ekvivalenter tror du Norge slipper ut årlig?

◯ Under 300 tonn
◯ 500 tonn
◯ 4 000 tonn
◯ 35 000 tonn
◯ 10 millioner tonn
◯ 50 millioner tonn
◯ Mer enn 70 millioner tonn

13. Hvilken økonomisk sektor tror du er den største kilden til drivhusgasser på globalt basis?

◯ Transportsektoren
◯ Energisektoren (elektrisitet, varme, annen energi)
◯ Jordbruk, skogbruk, og annen landbruk
◯ Industri
◯ Bygningssektoren

14. Omtrent hvor mange plante- og dyrearter tror du er utrydningstruede i Norge i dag?

◯ 100 ◯ 500 ◯ 1 500 ◯ 3 000 ◯ 4 500 ◯ 6 000

15. Miljøforskere bruker mange metoder/verktøy i forskning. Kryss av de du har kjennskap til:

◯ Kryssløpsanalyse (IOA)
◯ Substansstrømanalyse (SFA)
◯ Risikoanalyse (RA)
◯ Ingen
◯ Materialstrømanalyse (MFA)
◯ Livssykluskostnader (LCC)
◯ Livssyklusanalyse (LCA)
◯ Andre (vennligst spesifiser):

16. **Syns du det er nyttig/viktig å ha kjennskap til slike metoder/verktøy? Hvorfor/hvorfor ikke?**
   - ◯ Ja, det gir større mulighet til å være kritisk til forskningen
   - ◯ Ja, man forstår mer av vitenskapen bak miljøproblemer
   - ◯ Ja, ingen spesifikk årsak
   - ◯ Nei, vitenskap er for forskere
   - ◯ Nei, det skaper bare forvirring rundt miljøproblemer
   - ◯ Nei, ingen spesifikk årsak
   - ◯ Andre årsaker:

17. **Nedenfor finner du en del påstander om klima- og miljø. Les hvert utsagn, og angi i hvilken grad du er enig/uenig i hver av dem.**

	Svært uenig	Litt uenig	Verken eller	Litt enig	Svært enig
Det er viktig å ha generell kunnskap om miljøproblemer	◯	◯	◯	◯	◯
Kina har mest av skylden til miljøproblemene vi har i dag	◯	◯	◯	◯	◯
Teknologisk utvikling vil være en av de viktigste områdene for å overkomme miljøutfordringer	◯	◯	◯	◯	◯
Det er ingenting vi kan gjøre for å forhindre klimaendringene	◯	◯	◯	◯	◯
Lokale miljøproblemer er mer alvorlig enn globale klima- og miljøendringer	◯	◯	◯	◯	◯
Miljøforskere har for mye makt på grunn av kunnskapen sin	◯	◯	◯	◯	◯
De som er mer fremtredende i klima- og miljødebatten har ofte en skjult agenda	◯	◯	◯	◯	◯
Det er viktigere med beskyttelse av miljøet fremfor økonomisk vekst	◯	◯	◯	◯	◯
Norge slipper ut så lite på verdensbasis at det ikke spiller noen rolle hva vi gjør her hjemme	◯	◯	◯	◯	◯
Informasjon om klima- og miljø er ofte vanskelig å forstå	◯	◯	◯	◯	◯

18. **Nedenfor finner du ytterligere påstander om klima- og miljø. Les hvert utsagn, og angi i hvilken grad du er enig/uenig i hver av dem.**

	Svært uenig	Litt uenig	Verken eller	Litt enig	Svært enig
Konsekvensene av klima- og miljøutfordringer blir ofte overdrevet	◯	◯	◯	◯	◯
Myndighetene bør redusere forurensningen av miljøet, men det bør ikke koste meg noe	◯	◯	◯	◯	◯
Informasjon om klima- og miljø er ofte utydelig	◯	◯	◯	◯	◯
Det er opp til de store utslipps-nasjonene som USA og Kina å fikse miljøproblemene vi står ovenfor	◯	◯	◯	◯	◯
Det er ikke viktig å ha kunnskap om verktøy og metoder forskere bruker for å studere miljøproblemer	◯	◯	◯	◯	◯
Informasjon om klima- og miljøproblemer er lite tilgjengelig	◯	◯	◯	◯	◯
Klima- og miljøforskning kan ikke utgjøre noen forskjell i utfordringene vi har i dag	◯	◯	◯	◯	◯
Privatpersoners utslipp spiller en stor rolle	◯	◯	◯	◯	◯

19. Hvilke informasjonskanaler har du brukt (i løpet av det siste året) for å tilegne deg kunnskap om klima og miljø? (flere alternativer mulig å velge)

◯ Avis (papir)
◯ Avis (nett)
◯ Magasiner/blader
◯ Artikler (i Tidsskrifter eller lignende)
◯ Vitenskapelige rapporter
◯ Vitenskapelige sammendrag
◯ TV (vanlig)
◯ TV (nett)
◯ Radio (vanlig)
◯ Radio (nett)
◯ Bøker
◯ Offentlige presentasjoner/foredrag
◯ Forskningssenter (f.eks. Vitensenteret)
◯ Museum
◯ Debatter
◯ Internettsider (ikke nettavis)
◯ Sosiale medier
◯ Festivaler (f.eks. Klimafestival, Forskningsdagene)
◯ Ingen, jeg leser ikke om klima og miljø
◯ Annet

20. Av kanalene du har brukt, hvilke er de tre viktigste? Velg maksimum 3.

◯ Avis (papir)
◯ Avis (nett)
◯ Magasiner/blader
◯ Artikler (i Tidsskrifter eller lignende)
◯ Vitenskapelige rapporter
◯ Vitenskapelige sammendrag
◯ TV (vanlig)
◯ TV (nett)
◯ Radio (vanlig)
◯ Radio (nett)
◯ Bøker
◯ Offentlige presentasjoner/foredrag
◯ Forskningssenter (f.eks. Vitensenteret)
◯ Museum
◯ Debatter
◯ Internettsider (ikke nettavis)
◯ Sosiale medier
◯ Festivaler (f.eks. Klimafestival, Forskningsdagene)
◯ Ingen, jeg leser ikke om klima og miljø
◯ Annet

21. Hvor ofte konsumerer du slik informasjon

◯ Daglig
◯ 3-4 ganger i uken
◯ 1-2 ganger i uken
◯ 3-4 ganger i måneden
◯ 1-2 ganger i måneden
◯ Sjeldnere
◯ Aldri

22. Hvor godt eller dårlig informert vil du si at du er om klima- og miljøinformasjon?

◯ Meget dårlig
◯ Litt dårlig
◯ Verken godt eller dårlig
◯ Litt godt
◯ Meget godt

23. Har du noen gang hatt problemer med å forstå klima- og miljøinformasjon? Hvis ja, hvorfor?

◯ Nei, det har jeg ikke
◯ Vanskelig språk
◯ Ukjente begrep
◯ Utydelig beskjeder
◯ For mye informasjon - vanskelig å filtrere
◯ Kilder ikke oppgitt
◯ For lite informasjon - vanskelig å finne

◯ Vet ikke om kilden er troverdig
◯ For lite "vitenskap" i informasjonen
◯ For mye "meninger og oppfatninger" i informasjonen
◯ Vanskelig å skille vitenskap fra meninger
◯ Annet (vennligst spesifiser):

24. I forbindelse med klima- og miljøinformasjon, hvor ofte hører du "stemmene" til følgende aktører:

	Veldig lite	Lite	Verken eller	Mye	Veldig mye
Politikere	◯	◯	◯	◯	◯
Andre kommunalt ansatte	◯	◯	◯	◯	◯
Klima- og miljøforskere	◯	◯	◯	◯	◯
Lokal befolkning	◯	◯	◯	◯	◯
Ansatte fra næringslivet	◯	◯	◯	◯	◯
Samfunnsforskere	◯	◯	◯	◯	◯

25. Hvor troverdig anser du de ulike aktørene i klima- og miljødebatten?

	Ikke troverdig overhodet	Ikke så troverdig	Verken eller	Litt troverdig	Velig troverdig
Politikere	◯	◯	◯	◯	◯
Andre kommunalt ansatte	◯	◯	◯	◯	◯
Klima- og miljøforskere	◯	◯	◯	◯	◯
Lokal befolkning	◯	◯	◯	◯	◯
Ansatte fra næringslivet	◯	◯	◯	◯	◯
Samfunnsforskere	◯	◯	◯	◯	◯

26. I hvilken grad stoler du på...

	I svært liten grad	Litt	Moderat	En god del	I svært stor grad
at informasjon fra forskere om klima- og miljø er riktig?	◯	◯	◯	◯	◯
at klima- og miljøforskere er objektive og ikke har en skjult	◯	◯	◯	◯	◯

27. Savner du noen "stemmer" i klima- og miljødebatten? Hvis ja, hvilke?

◯ Nei, savner ingen
◯ Politikere
◯ Lokal befolkning
◯ Ansatte fra næringslivet
◯ Samfunnsforskere
◯ Klima- og miljøforskere
◯ Kommunalt ansatte
◯ Andre (vennligst spesifiser):

Tusen takk for at du deltok!

Appendix C

Table C.1 Overview of background and control variables

Variable	Value	Coding	Reference
Male	1=Female	1=0	Female
	2=Male	2=1	
Young age	1=<20	1=1	Older age
	2=20-30	2=1	
	3=31-40	3=1	
	4=41-50	4=0	
	5=51-60	5=0	
	6=61-70	6=0	
	7=>70	7=0	
High education	1=Not completed primary school	1=0	Low education
	2=Primary school	2=0	
	3=High school	3=0	
	4=University/college, up til three years	4=1	
	5=University/college, more than three years	5=1	
	6=PhD	6=1	
Interested	1=Very uninterested	1=0	No nterest
	2=A little uninterested	2=0	
	3=Neither	3=0	
	4=A little interested	4=1	
	5=Very interested	5=1	
Green	1=Rødt	1=1	Other/non-green party
	2=Sosialistisk Venstreparti	2=1	
	3=Arbeiderpartiet	3=0	
	4=Senterpartiet	4=1	
	5=Kristelig Folkeparti	5=1	
	6=Venstre	6=1	
	7=Høyre	7=0	
	8=Fremskrittspartiet	8=0	
	9=Kystpartiet	9=1	
	10=Miljøpartiet de Grønne	10=1	
	11=Ingen	11=0	
	12=Annet	12=0	

Table C.2 Overview of predictor variables

Variable	Text	Coding
CHtraditional	Newspaper	Dummycoded: 1=1; SYSMIS=0
	TV	Dummycoded: 1=1; SYSMIS=0
	Radio	Dummycoded: 1=1; SYSMIS=0
		All: computed. Dummycoded: 0=0; 1, 2, 3=1
CHtradnewplat	Newspaper, online	Dummycoded: 1=1; SYSMIS=0
	TV, online	Dummycoded: 1=1; SYSMIS=0
	Radio, online	Dummycoded: 1=1; SYSMIS=0
		All: computed. Dummycoded: 0=0; 1, 2, 3=1
CHnewmedia	Social media	Dummycoded: 1=1; SYSMIS=0
	Webpages	Dummycoded: 1=1; SYSMIS=0
		All: computed. Dummycoded: 0=0; 1, 2=1
CHscientific	Article (journal)	Dummycoded: 1=1; SYSMIS=0
	Scientific report	Dummycoded: 1=1; SYSMIS=0
	Scientific summary	Dummycoded: 1=1; SYSMIS=0
	Books	Dummycoded: 1=1; SYSMIS=0
		All: computed. Dummycoded: 0=0; 1 thru 4=1
CHpopscience	Magazine	Dummycoded: 1=1; SYSMIS=0
	Research center	Dummycoded: 1=1; SYSMIS=0
	Museum	Dummycoded: 1=1; SYSMIS=0
	Festival	Dummycoded: 1=1; SYSMIS=0
	Debate	Dummycoded: 1=1; SYSMIS=0
	Public presentation	Dummycoded: 1=1; SYSMIS=0
		All: computed. Dummycoded: 0=0; 1 thru 6=1
CHother	Other	Dummycoded: 1=1; SYSMIS=0
CHnone	None	Dummycoded: 1=1; SYSMIS=0
Language	Difficult language	Dummycoded: 1=1; SYSMIS=0
	Unknown jargon	Dummycoded: 1=1; SYSMIS=0
	Unclear messages	Dummycoded: 1=1; SYSMIS=0
		All: computed. Dummycoded: 0=0; 1, 2, 3=1
Source	Don't know if the source is reliable	Dummycoded: 1=1; SYSMIS=0
	Sources are not given	Dummycoded: 1=1; SYSMIS=0
		All: computed. Dummycoded: 0=0; 1, 2=1
SCvsOP	Too little "science" in the information	Dummycoded: 1=1; SYSMIS=0
	Too many opinions in the information	Dummycoded: 1=1; SYSMIS=0
	Hard to differentiate between science and opinions	Dummycoded: 1=1; SYSMIS=0
		All: computed. Dummycoded: 0=0; 1, 2, 3=1

Appendix D

Table D.1 Complete hierarchical multiple regression, all models

Model	Variable	B	Std. Error	β	t	Sig.	*p* <
1	(Constant)	7.037	0.475		14.823	0.000	0.001
	Male	-0.672	0.387	-0.111	-1.739	0.083	ns
	HiEd	1.774	0.427	0.264	4.156	0.000	0.001
	Young	0.970	0.409	0.151	2.369	0.019	0.05
2	(Constant)	5.881	0.581		10.121	0.000	0.001
	Male	-0.597	0.372	-0.098	-1.605	0.110	ns
	HiEd	1.383	0.415	0.206	3.333	0.001	0.01
	Young	0.846	0.393	0.131	2.152	0.032	0.05
	Interested	1.313	0.465	0.174	2.826	0.005	0.01
	Green	1.639	0.425	0.238	3.853	0.000	0.001
3	(Constant)	5.025	0.830		6.055	0.000	0.001
	Male	-0.504	0.371	-0.083	-1.360	0.175	ns
	HiEd	1.240	0.406	0.185	3.057	0.003	0.01
	Young	0.474	0.427	0.074	1.109	0.269	ns
	Interested	1.291	0.456	0.171	2.830	0.005	0.01
	Green	1.394	0.422	0.202	3.306	0.001	0.01
	CHtraditional	0.559	0.490	0.078	1.141	0.255	ns
	CHtradnewplat	0.311	0.534	0.040	0.582	0.561	ns
	CHnewmedia	0.764	0.435	0.114	1.757	0.080	ns
	CHscientific	0.064	0.421	0.010	0.153	0.879	ns
	CHpopscience	1.055	0.419	0.169	2.520	0.012	0.05
	CHother	0.181	0.932	0.012	0.194	0.846	ns
	CHnone	1.174	1.154	0.071	1.017	0.310	ns
	Language	-0.582	0.372	-0.095	-1.566	0.119	ns
	Source	0.500	0.404	0.079	1.238	0.217	ns
	SCvsOP	-1.272	0.384	-0.209	-3.310	0.001	0.01

Note $R^2 = 0.102$ for **Model 1** ($p < 0.001$); $\Delta R^2 = 0.087$ for **Model 2** ($p < 0.001$); $\Delta R^2 = 0.095$ for **Model 3** ($p < 0.01$)