Unlocking Successful Sustainability

Innovative communication strategies for science based policy

Saahil Waslekar

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A thesis submitted in partial fulfillment of the requirements of Lund University International Master's Programme in Environmental Studies and Sustainability Science (30hp/credits)

LUCSUS
Lund University Centre for Sustainability Studies

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Submitted May 16, 2016

Supervisor: Elina Andersson, LUCSUS, Lund University

Abstract

Environmental policy should be made up of scientific evidence. This thesis paper supports science based policy and its formulation through innovative communication strategies. It is important to be innovative in communicating science when dealing with the policy community as there could be confrontations owing to the nature of relation between science and policy. This is where the professional environment science communicator surfaces to function as a bridge between the science and policy communities in order to ensure the furthering of science into policy. Seen from the point of view of sustainability science, the role of a science communicator is imperative towards communicating science and advocating for science-evidence based policies. The initiative of the professional environment science communicator will have a future impact on the way bills are drafted. Hence, allowing this thesis to make its way into sustainability science. In context, a science communicator is a boundary spanner who sits on the boundary of science and policy, working at a boundary organization. The paper explains six communication strategies and their limitations, as a foundation for furthering the debate. Furthermore, this paper has adopted a case study method and in doing so searches for the innovative aspect in two projects of the Stockholm Environment Institute and how the innovative communication strategy in these projects influenced policymaking in each case. The results section highlights internal and external factors that affect a communications strategy and continues to discuss the innovative aspect in science communication strategies in detail, through comparative analysis. The paper concludes with a suggestion that science communicators need to recognise that their role is that of an innovation broker. This is in the benefit of sustainability science, which will seemingly support one and all.

Keywords: Science communication, Science Policy Interface (SPI), Boundary work, Professional Environment Science communicator (PESC), Science-based policy

Word count - 13771

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Student life at Lund University has been way too precious. I thank Lund University and its environment that has given me friends, valuable lessons and experiences which will remain with me for a lifetime. Finally, I thank my family for being so supportive all through the way.

From here on, I look forward and embrace the continued journey.

Table of Contents

1 Introduction

1.1 Bridging science and policy

Introducing the fundamental challenges confronting scientists and legislators/policymakers

Environmental policy should be made up of scientific evidence. This thesis supports science based policy and its formulation through innovative communication strategies. It is important to be innovative in communicating science when dealing with the policy community as there could be confrontations owing to the nature of relation between science and policy. This is where the professional environment science communicator surfaces to function as a bridge between the science and policy communities in order to ensure furthering of science into policy.

Science attempts to draw the complex relations shared between human activities and environment, hereby scientists, irrespective of their academic discipline, play an important role in securing a sustainable future (McCool S.F. & Stankey G.H., 2004). However, in the course of furthering science (Lang, y otros, 2012), it would benefit scientists to strategically approach the systemic challenges (EEA, 2015) inherent to the nature of their work.

In 2014, on the occasion of the 40th anniversary celebrations, *Cell*, peer-reviewed scientific journal, launched a '40 under 40' interview round on their website. One of the questions the journal asked each of the forty scientists from around the world was, **'**what is the biggest challenge facing young scientists? Do you have a solution?' (Cell, 2016). The following bar chart summarises the interview answer given to the aforementioned question by each of the forty scientists –

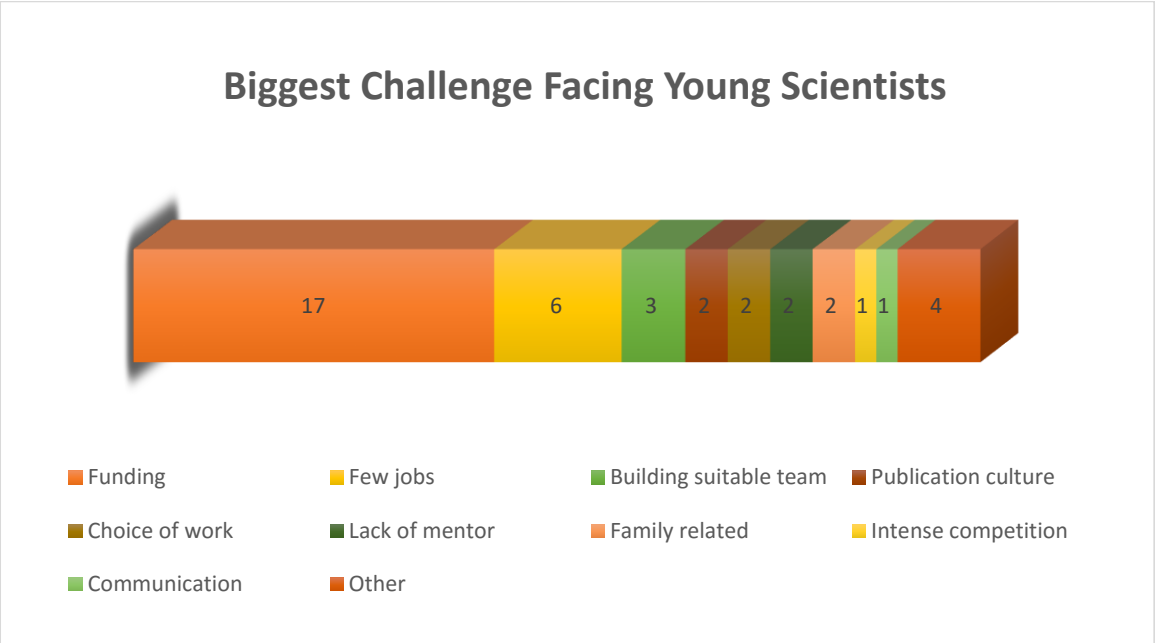

Figure 1 (based on interview answers): Biggest Challenge Facing Young Scientists, (Cell, 2016)

In the above chart, it is evident that a major challenge facing young scientists is the lack of funding, as answered by seventeen out of forty young scientists. Furthermore, six out of forty scientists drew a direct link between the lack of funding or research grants and few jobs being available to young scientists on completing post-doctoral studies. Lack of funding has also resulted in 'intense competition', cited as a primary challenge by one scientist and considered to be a major second challenge among seven other young scientists.

On the bright side, the application for funds, has given rise to a need for developing skills like personnel management, grant and manuscript writing, formal and informal oral presentation, and *scientific communication* (Cell, 2016).The need for improving communication skills was also on the agenda of two other scientists.

Concentrating on a single country, in October, 2015, 'Pew Research Center in collaboration with the American Association for the Advancement of Science (AAAS)' produced a report with emphasis on the role of science in public policy (Pew Reseach Centre & AAAS, 2015) in the United States of America (U.S.A). This report, titled, 'Public and Scientists' Views on Science and Society', found that there was a significant opinion gap between the general public and scientists on a range of science and technology topic areas (Pew Reseach Centre & AAAS, 2015). Three findings relevant to the thesis, from this report, include -

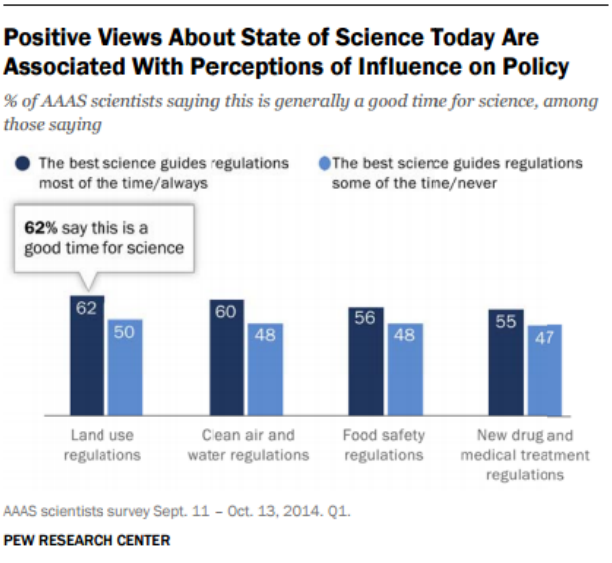

Figure 2 Positive views about state of science today (AAAS, 2016)

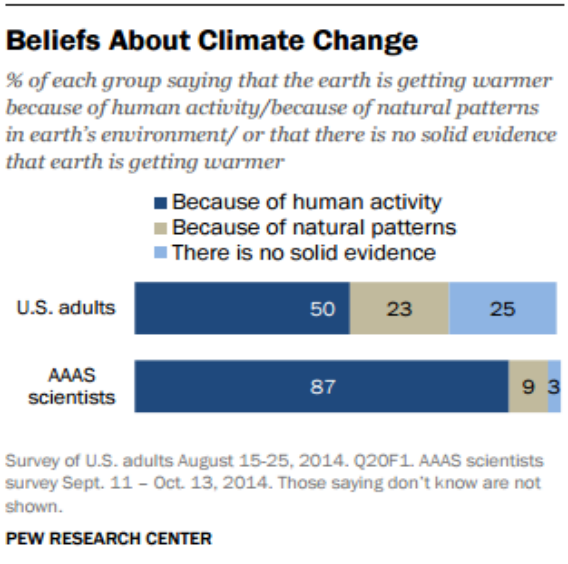

Figure 3 Beliefs about climate change (AAAS, 2016)

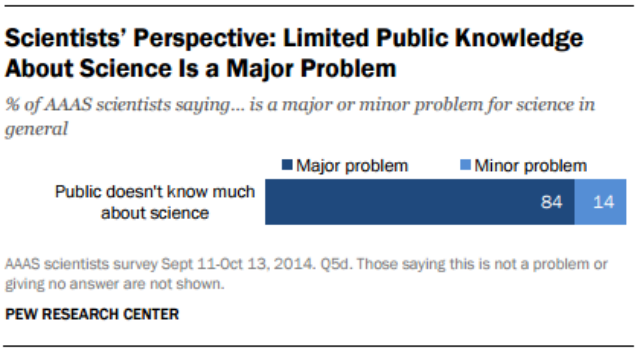

Figure 2 Scientists' perspective on limited public knowledge about science (AAAS, 2016)

Each of the three bar charts above, specific to the U.S.A, make it evident that there is a communication gap. Intangible attributes such as perception, belief and perspective, whether be it that of scientists towards the policy environment (image 2), towards climate change (image 3) or that scientists have of public knowledge (image 4), include a certain degree of discrepancy, which can be nullified through science communication.

In either case, concerning application of grants for scientific research or perception of stakeholders in society towards scientific issues, scientists may face unprecedented hindrances in developing effective communication materials for stakeholders and the public (Bruin & Bostrom, 2013). Broadly, the cost of ineffective communication would have to be borne by science and society. From a social perspective, the success of scientists' communication depends on their awareness of the weight of their work on society and in shaping the public discourse (Fischhoff & Scheufele, 2013). It is thus imperative for scientists to recognise that if they wish to be effective in their communication, they must understand and address the perspectives of stakeholders, especially those that require scientific expertise (Fischhoff & Scheufele, 2013).

Hereby, there is an association connecting funding for science research and communication between the science and policy communities. Such an association serves as a basis for dialogue between scientists and policymakers. Furthermore, climate scientists and policymakers have traditionally agreed upon issues pertaining to uncertainty, adaptation, and mitigation, serving as an open window for further dialogue and engagement (Arvai, et al., 2006). Whilst scientists and policymakers have several forums to interact, traditionally, policymakers, have systemic challenges of their own.

Over an email interview with Sir Graham Watson, former Member of the European Parliament, I presented my claim: 'legislators do not have time for science advice as they are heavily occupied with parliamentary activities'. The reply that I received, read '*I think the claim is a fair one…from my personal experience of twenty years in the European Parliament I would say that MEPs take too little scientific advice.'*

In essence, the above reply cautions scientists, that, in order to ensure continuous use of scientific knowledge in policymaking (Cheng, et al., 2008), scientists, possibly through 'science communicators' will have to use innovative strategies of communication by putting a more modern and interesting angle on science communication (Mullahy, 2004). Innovative strategies in communicating science to policymakers will not only address the 'lack of communication between science researchers and policymakers but also enable productive exchange of ideas (Lee & Belohlav, 2014).

Whilst policymakers are occupied with scrutinizing work of the government, making laws, debating (UK Parliment, 2016) and fulfilling other parliamentary responsibilities, essentially, a professional science communicator and their equal in the government can bridge the gap between scientists and politicians by initiating communication between both these communities (Jasanoff & Martello, 2004). Engagement of the professional science communicator will have multifaceted benefits. Not only will the professional science communicator advance the interests of the science community, such as funding concerns, improve the perception of science among policymakers and possibly even contribute to designing policy interventions (Arvai, et al., 2006) but also, in effect, help policymakers see benefits of the 'science-policy nexus' (Graffy, 2008).

1.2 Aim and research questions

Through internal dynamics of systemic challenges confronting scientists and policymakers separately, it becomes increasingly clear that communication between these two communities will aid in meeting the uncertainty challenge by producing socially robust knowledge led by scientists and similarly, meet the implementation challenge by producing better accepted decisions led by policymakers (Newig, et al., 2013). At the core of which, and in the context of this thesis, exists, the role of the professional environment science communicator –

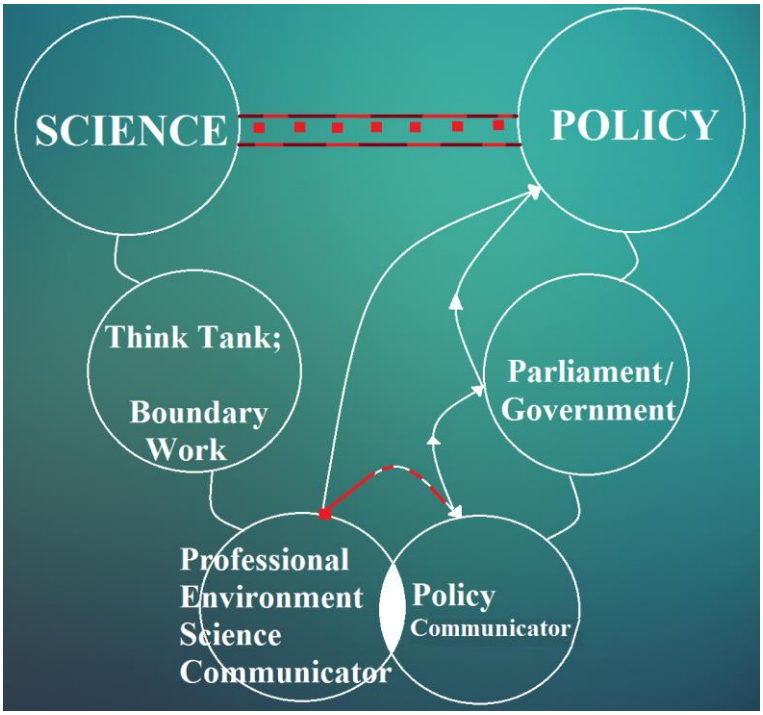

Figure 3 Professional environment science communicator, bridge between science and policy

Above is a diagram I have created to illustrate the position of the professional environment science communicator in the science-policy interface, showing how science can best inform policy (Bielak, Campbell, Pope, Schaefer, & Shaxson, 2008). Accordingly, I have studied the Stockholm Environment Institute as case study organisation. This thesis postulates that the process where science influences policy begins with the efforts of the science communicator.

In such regard, the **aim** of my thesis is to contribute to the science-policy debate by indicating specific innovative strategies used by professional environment science communicators to generate more science-based policy.

Accordingly, the **research question**, at the forefront of this thesis that I am asking is –

Which are the various innovative communication strategies employed by professional environment science communicators, such that science can influence policy?

The two sub **research questions** that I am asking are the following –

a) *Why (and how) are these strategies innovative?*

b) *Why do these innovative communication strategies manage to influence policy making*

In effect, my main contribution will be, to –

- Show various innovative communication strategies used by professional environment science communicators
    - in the process, I will analysis the communication strategy behind projects of the Stockholm Environment Institute
- Highlight the urgency in having more professional environment science communicators

1.3 Analytical Framework: The information deficit model

The relationship between science and policy is assumed to be linear, in reality such is not the case. It is assumed that scientific "truths" inform policymakers who may or may not agree and choose to accept them (Graffy, 2008). Such a linear model of scientific rationale is the deficit model approach to science communication (Dickson, 2005), where one way communication is carried from experts to those in the public who do not have such knowledge (Trench, 2008).

The model aims at educating the general public about facts, truths and more facts, hereby increasing their general knowledge on issues such as climate change (Hart & Nisbet, 2011). As a result, once the knowledge deficit is filled, the supposed outcome is that the public will embrace the science and technology produced from such knowledge, inclusive of other scientific benefits (Dickson, 2005). Whilst scientists have deep knowledge through rigor in scientific research, such knowledge would reach its optimum potential if scientists help science find its place in society (Baron, 2016). One way, and in the interest of the limitations of this thesis, scientists can help science find this 'proper place', is through policymakers.

It should not surprise scientists that policymakers like to adopt evidence that supports their thinking and will stay away from evidence that will conflict with such thinking (Choi, et al., 2005). This is how, supposedly, policymakers surmount deficit of deep knowledge. Scientists must accept that science literacy to policymakers is not of primary concern to them and that policy 'does not have a need to always depend on good evidence' (Choi, et al., 2005). Hereby, while the 'one-way communication' of science imparted to reduce knowledge deficit might prove effective in informing society at large, it is not necessarily the best informant of policy.

Finding the knowledge gap: limitations of the information deficit model

With rise in problems such as climate change, there is a direct rise in the need for robust science to inform policy in order to combat the associated outcome (Dilling & Lemos, 2011). Policymakers take advantage of other knowledge domains which may conflict with the lessons of science and technology (Sturgis & Allum, 2004) and accordingly design policy. Availability of multiple knowledge forums on one hand, weakens prominence of the information deficit model, correspondingly, impacting the prominence of scientists as prime science knowledge providers. On the other hand, the demand for and the supply of information may contribute to bridging information gaps (Wesseler & Brinkman, 2003).The following diagram illustrates that 'policy change' is the result of collective input from 'policymakers', 'scientists' and others –

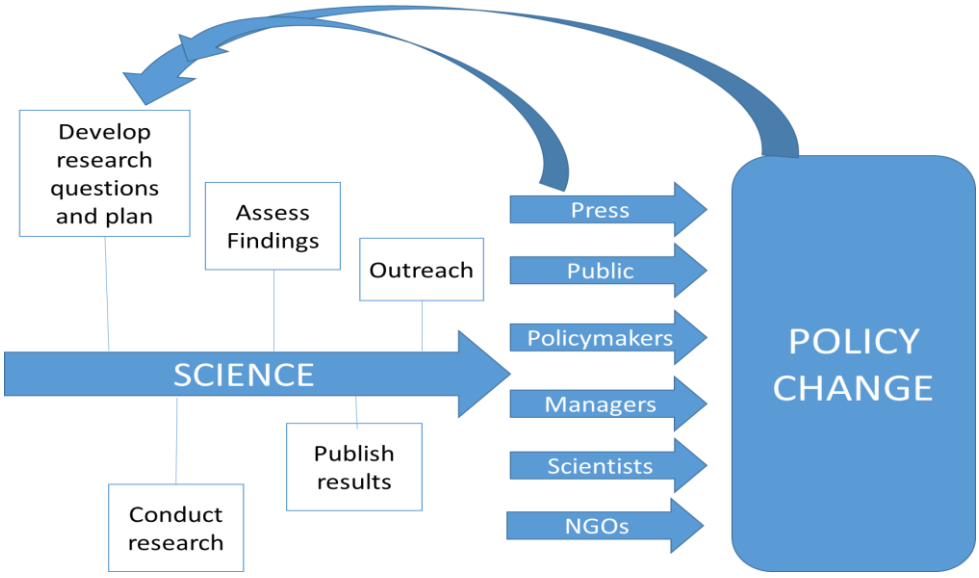

Figure 4 Science based policy pathway (Baron, 2016)

1.4 Contextual background: characteristics of communication requirements with legislators/policymakers

From the above diagram it is evident that policymakers communicate with, directly or indirectly, many stakeholders for the benefit of influencing policy. Specific to scientists, an international study of policymakers at the national level, across six countries, concluded that 'key barriers to evidence-based policy-making cited by policy-makers included poor communication and dissemination of research; lack of technical capacity in policy processes and their own inability to understand technical data' (Hyder, et al., 2011 p.74). This indicates that alongside communication being a weakness between scientists and policymakers, there are certain peculiarities in communicating with policymakers.

It is evident by now that policymakers need to respond to the requirements of varied stakeholders as they belong to only a small portion of the many groups of people that policymakers interact and consult with (Choi, et al., 2005). Due to insufficient time in the hands of decision-makers this requires for scientists or science communicators to be concise and simple (Christensen, 2007) in communicating scientific briefings. In order for science to inform policy, researchers and policymakers collaborate and aid the process of evidence based policy making. This is done by incentivising the process for scientists to include policy considerations in their scientific analysis (Lee & Belohlav, 2014). Nancy Baron, in her book, *Escape from the Ivory* Tower, has developed a non-linear and concise message box (Baron, 2016) that would aid the non-policy community to communicate with legislators/policymakers. Taking into consideration the implications of science on policy and stakeholders alike, might prove beneficial to scientists or science communicators in the long run.

Owing to differences in the nature of work, 'scientists are often unable to tolerate the impreciseness of the ''big picture'' whereas ''broad-brush'' but with specific recommendations is often more useful to practitioners' (Weichselgartner, 2010, p. 273). It has been identified that legislators/policymakers would prefer evidence based policy over political ideology or prejudice (Parsons, 2002) and at the same time be aware of how policy would affect economy, society, finance, industry business, religion, environment, home affairs, international relations and other criterions with lasting implications in the future.

Hereby, consequently, legislators/policymakers should find a systematic means to review emerging and future scientific issues and scenarios (Mee & Adeel, 2012) within their purview. Legislators/policymakers are keen on collecting as much reliable data as possible (Wesseler & Brinkman, 2003). Accordingly, concerns of data science and future scenarios, such as, risk communication and health communication (Trench, 2008) become significant bridging points for scientists and legislators/policymakers. Over time, such 'personal contact between researchers and policymakers, clear summaries of findings with recommendations for action' and 'good-quality research' (Mitton, Adair, Mckenzie, Patten, & Perry, 2007, p.735) will form long term relations between these two stakeholder communities.

It is evident that while both stakeholders have absolute differences, they cannot do without each other. 'Science practitioners and mediators, as well as other science-related groups including scientific businesses, politicians, decision makers, and members of the media, may benefit from using the tools of science communication to share scientific messages' (Burns, O'Connor, & Stocklmayer, 2003, p.193). Information overload is a common risk (SEI, 2015b) during exchange of science communication, although such expanse of messages not only furthers science into policy but also generates demand for professional environment science communicators.

1.5 Presenting the case: the professional environment science communicator

Scientists and policymakers are often unable to see eye to eye on the pathway to resolve environmental issues either due to the inability to implement solutions that have been based on the study of "ideal" situations or due to the lack of time and understanding of both parties (Hoppe, 2005), such is one harsh interpretation of the relation between these two communities, justifying the need for a strategic solution. 'Because science communication seeks to inform decision making, it must begin by listening to its audience, to identify the decisions that its members face—and, therefore, the information that they need' (Fischhoff & Scheufele, 2013). Although, predominantly, the traditional and overarching goal of scientists and their research is to further science and that of policymakers is to focus on gaining popularity and support (Choi, et al., 2005). This information sets the stage for that character who can strategically bridge these two conflicting fields, that of truth and of power.

Colthorpe through his study states that a successful professional environment science communicator (PESC) should be able to recognize their audience and enable them to access scientific information in a clear and concise format that is understandable to them (Colthorpe, Rowland, & Leach, 2013). This is a person who is able to gauge the understanding of the audience and is able to design and present information in an acceptable format (Bennet & Jennings, 2011) when communicating messages of scientists to the policy community. 'They are communicators and leaders who inform and influence policy, and can talk about their science in ways that make people sit up, take notice, and care' (Baron, 2016, p.7). Science communicators, in the grand scale of responsibilities, need to be excellent mediators (Cheng, et al., 2008) and a 'boundary spanner (people who can communicate across sectors) within their groups or organizations to bridge boundaries and ensure their maintenance' (Cheng, et al., 2008, p.194).

In this regard, when science communicators multi-task (Cheng, et al., 2008) their credibility as professionals is automatically validated. They try to be most up-to-date on recent studies in their field and update their skill set in order to best perform communication measures to the highest level possible (Mullahy, 2004). At an AAAS organised conference, on the Communicating Science to Policy-Makers panel, Dr. Arthur Lupia, professor of political science explains, 'policymakers want you to take your phenomenon and make it close to their experience, their day to day life, their aspirations and their fears, whether it's a politician or someone in the community, they may be interested in your science, but the way the learning works is that it must be on their terms' (AAAS, 2016). Alongside training 'scientists to be better communicators (because of the ever-increasing science and technology component in modern decision-making)' (Bielak, Campbell, Pope, Schaefer, & Shaxson, 2008, p.208),

PESCs should advance their own skills by developing innovative communication strategies, in order to instil more evidence based science into policy.

By doing so, it will serve a twofold purpose. For one, a new set of skills, innovative in nature, will emerge, to disseminate the scientists' message. Hereby becoming the fourth and modern pillar to the existing 'skills triangle' of 'scientific skills (press releases, educational material, web pages, exhibitions), graphical skills (posters, brochures, PR images) and technical skills (video news releases, CD-ROMS)', used for the traditional and 'practical production of science communication' (Christensen, 2007, p.21). Second, innovative communication strategies will supposedly attract and produce a greater number of professional environment science communicators over time, through prospects of a tech element in communicating science.

Not only will this resolve dilemmas found locally at the interface of science and policy but also, and hopefully, build trust essential to influence policy (Janse, 2008).

1.6 Methodology

The primary method for research included an in depth literature review of publications inclusive of peer reviewed journal articles, book chapters, reports and flyers, each specific to the case being studied, within the theme of science-based policy and aspects of bridging science and policy through communication. In addition to the information from these sources, information regarding the specific cases considered were collected through personal interviews with communication personnel at the Stockholm Environment Institute offices in Africa and Asia.

In order to study the impact of innovative communication strategies, one international organization, the Stockholm Environment Institute, was selected. Within the organisation, two case study projects were selected and the communication strategy behind each of the projects has been analysed. Initial contact was established over email with SEI headquarters in Stockholm. After having an initial meeting with Mr. Robert Watt, the Director of Communications of SEI, projects from SEI Tallinn, SEI Africa and SEI Asia were identified, however on further research and interviews, the projects from SEI Tallinn were not studied further as they did not meet the selection criteria (elaborated in Section 3.2).

In the SEI Africa office, Ms Sarah Odera, the Communications Officer was consulted on project selection and interviewed for further information on the selected project. Similar contact was established with Mr. Rajesh Daniel from the SEI Asia office for an interview on the Ayeyarwady Futures project.

The main questions covered in the interview were on the lines of project drivers for the project, policy community involvement, communication efforts, the considerations behind the selection of the

implemented measures and the main aspects of success for communication efforts. This was mainly to understand different aspects that influenced the decision to choose one or the other strategy adopted by the organization in order to communicate their content and achieve their goal, in their respective modes, of furthering science into policy.

In order to analyse this input collected, information gathered from each interview was characterized based on the internal (to the organization) and external influencing factors leading to the decision of the communication strategy executed. These factors were further analysed in order to understand their role in the outcome of the project and hence the communication effort. A comparative analysis of the two projects was then conducted to analyse impact of the innovative strategies in meeting the goals of the project.

1.7 Scope

The following are the main points that describe the scope of the thesis –

a) Relation between Science and Policy – The thesis explores the interface between science and policy in a scientific context. It does not explore the relation between environment science and business, economy, entertainment, finance, home affairs, industry, international relations, society, religion or any other discipline
b) One protagonist – This thesis is interested in investigating efforts of the professional environment science communicator in furthering science into policymaking. It does not dive into depths of the functions specific to scientists or policymakers
c) Unable to select 4 projects from one country as per initial plan of action – The ideal selection would have been a study of total number of selected projects from one SEI centre, in one country. I thought that showcasing 4 projects in total would cover expanse of communication strategies. Eventually, owing to the criteria points for project selection that I had created for the thesis, limited my choices.

1.8 Why is this a thesis at LUCSUS

This LUMES thesis, being transdisciplinary in nature, captures elements from environment science, science communication and environment policy. The thesis explains the interface between these three social science disciplines and in doing so, contributes to the nature of work carried by researchers at the faculty.

The thesis explores the function of boundary organisations, professional environment science communicators and cooperation mechanisms between the science and policy communities, where each, jointly, contribute to sustainable development. I am happy to have assembled several storylines,

academic in nature, that concur with academic requirements of this Master's programme. Furthermore, it is an honour to be conducting such research in a boundary organisation such as LUCSUS, that sits on the cutting edge of academia and research.

2 Literature Review

2.1 Science policy interface

The proposed solution, in this thesis, to the communications issues mainly faced in the Science Policy Interface on a global level (Young, King, & Schroeder, 2008) is to increase the number of professionals dedicated to communicating environment science to the policy community, based on scientific evidence. The role of PESCs is imperative towards communicating science and advocating for science-evidence based policies. The initiative of the professional environment science communicator will have a future impact on the way bills are drafted. Hence, making its way into sustainability science.

The professional environment science communicator, among other figures, is the one responsible for mediating a smooth dialogue between the scientific community and policymakers (EC, 2016a). The way PESCs facilitate such interaction, happens through the strategies they execute. In doing so they contribute to the science policy interface (SPI).

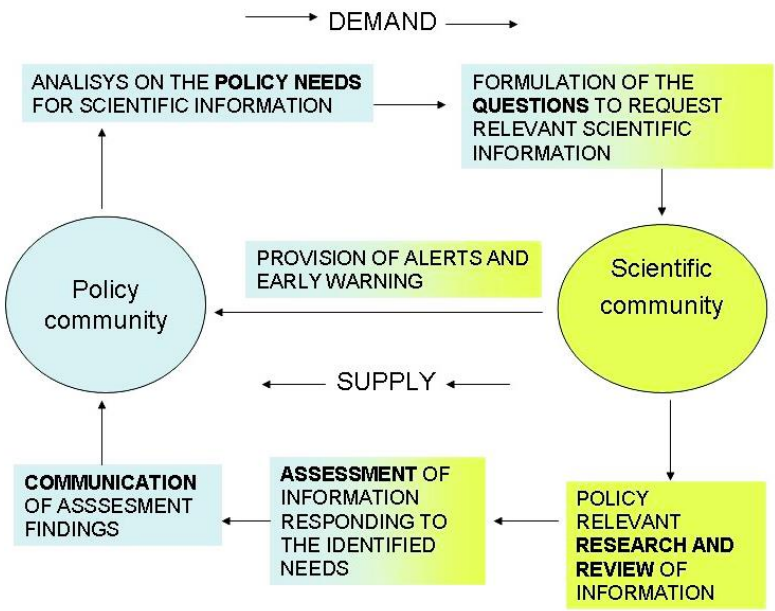

Figure 5 Cycle of science-policy interface (IUCN, 2016)

The Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES), defines SPIs. 'Science-policy interfaces are social processes which encompass relations between scientists and other actors in the policy process, and which allow for exchanges, co-evolution, and joint construction

of knowledge with the aim of enriching decision-making at different scales. This includes two main requirements:

a) that scientific information is relevant to policy demands and is formulated in a way that is accessible to policy and decision makers; and
b) that policy and decision makers take into account available scientific information in their deliberations and that they formulate their demands or questions in a way that are accessible for scientists to provide the relevant information' (IUCN, 2016)

While practical impact of 'the science–policy interface is perhaps unrealistic, at least in the short term' and knowledge that communication is a continuous and ongoing process, it has been found that the SPI has the potential to support and strengthen decision making (Bielak, Campbell, Pope, Schaefer, & Shaxson, 2008). 'The idea of simple linear knowledge transfer from science to policy – 'truth' speaking to 'power' – is not adequate to explain the complex interactions in real SPIs. The effectiveness and impact of SPIs depends on the perceived credibility, relevance and legitimacy (CRELE) of knowledge and processes' (Young, Watt,, van den Hove, & the SPIRAL project team, 2013, p. 1).

Seemingly, through SPI communications both communities invest in each other by 'spending time on developing common language, building trust, and developing capacities to understand others' positions, views, needs and constraints. Effective SPI communication is best seen as an on-going process' (The SPIRAL project). As an outcome, it enables 'increased opportunities in the research process and in funding decisions for policymakers to make their knowledge needs known to scientists and funding bodies' (Young, King, & Schroeder, 2008). To the science community, SPI initiates the selection process, designing solutions and addressing the scientific problems (van den Hove, 2007). Such intersections advance the science-policy interface, such that active examples of SPIs are found through boundary practices and organizations at the frontiers of science–policy (Willis, Samers, Prudham, & Bridge, 2009).

Boundary organisations cater to the activities of both parties along with actors who have the experience of mediating the science policy bridge (Guston, 2001). It is at such an organisation where a professional environment science communicator is positioned in order 'to confront emerging environmental problems and sets of interdependent problems' (Young, King, & Schroeder, 2008).

2.2 Boundary organisations: communicating science

Boundary work sits on the 'interface between science and policy', as an intermediary between science and action (Clark, y otros, 2011). Within the purview of boundary work, lie, boundary organisations, that 'cross the boundary between science and politics and draw on the interests and knowledge of

agencies on both sides to facilitate evidence-based and socially beneficial policies and programmes' (Drimie & Quinlan, 2011). Simply put, boundary organisations have a responsibility of communicating science to the policy community and correspondingly, informing the science community of policy and requirements of policymakers.

Amidst fulfilling the communications link, boundary organisations sit at the forefront of experiencing differences between these two communities. A successful boundary organisation is one that achieves its stability by considering and responding to opposing views and external authorities (Guston, 2001). Furthermore, looking closer, boundary partners are those organisations with whom a project interacts directly (Saunier & Meganck, 2007), utilize boundary objects, tools or terms of cross-disciplinary communication even when understanding of the precise meaning of these terms differ between the disciplines (Michaels, 2009), 'to facilitate communication across boundaries that would otherwise be difficult to bridge' (Hellström & Jacob, 2003).

It is crucial to note that communication by itself cannot translate science into policy or action, hereby 'science has little chance to enter into decision-making or inform action at all when communication is poor or non-existent' (Vogel, Moser, Kasperson, & Dabelko, 2007). Hereby, in the process of communicating science to policymakers, boundary organisations must consider five key requirements. First, communication should not be viewed as a onetime effort, instead an ongoing process. Second, every stage of the 'decision-making process' has its own requirements, hence communicating science, must be flexible. Third, while communication is an ongoing process, it requires jargon free negotiation, especially in order to explain the fundamental need to address crucial environmental issues. Fourth, it is possible that the policymaker might be well informed, although the communication must be context specific, unique to a particular challenge at hand and beyond the generic. Finally, owing to human nature, results of communication objectives could have a higher rate of success through personal contact with the policymaker which, in the long run, would form and be based on mutual trust (Vogel, Moser, Kasperson, & Dabelko, 2007).

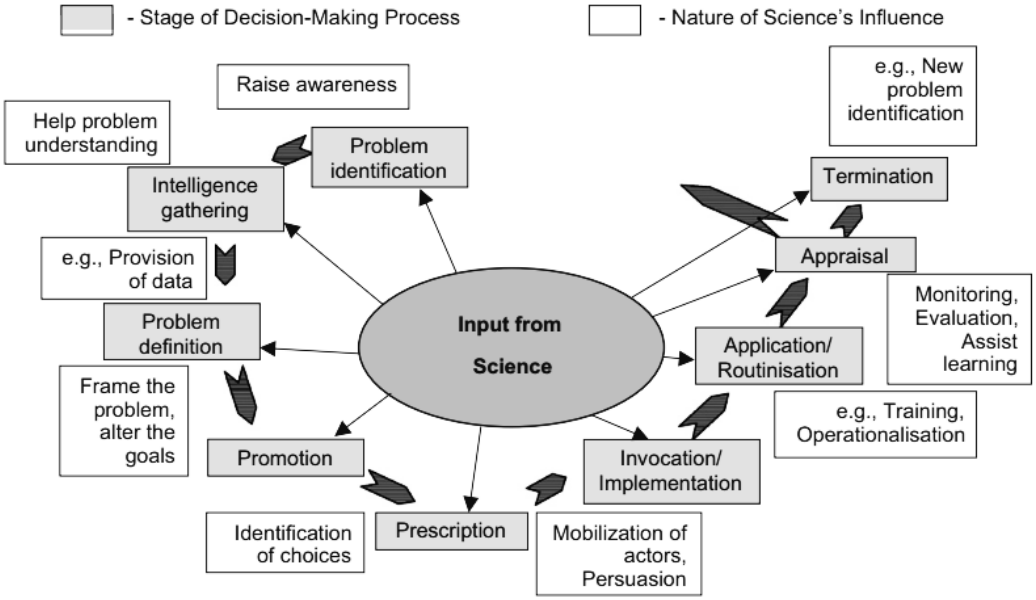

Figure 6 Scientific input at various stages of the decision-making process and the nature of science's influence (Vogel, Moser, Kasperson, & Dabelko, 2007)

Through the above diagram it is clear that communication of science takes place at every stage of the decision making process. It is the job of a forward thinking professional environment science communicator to understand what a policymaker does and which decisions are pending in the decision making process (Vogel, Moser, Kasperson, & Dabelko, 2007). In essence, this is where the professional environment science communicator develops innovative communication strategies.

2.3 Being innovative: towards science communication strategies and limitations

There is a well-defined difference between 'innovation' and being 'innovative'. It is important to highlight the difference between the two, as this thesis is not about innovation. This thesis is about identifying innovative science communication strategies and employing these strategies for the benefit of influencing and improving environmental policy.

Oxford Dictionary defines innovation as 'the action or process of innovating'. Further, making the definition clearer, the dictionary defines innovation as 'a new method, idea, product etc.´. This definition draws attention to the end product, which could possibly be the outcome of Research and Development and economic production. In context, Evert Rogers' Diffusion of Innovations theory is about how an individual makes a decision about adopting an innovation (Klockner, 2015) and the manner in which communication channels, the medium of transmitting a message, are employed in the diffusion process (Rogers, 1983). This thesis goes under the surface, investigating innovative strategies behind communication channels developed by the professional environment science communicator, where, communication channels is what is seen to the public eye and is one part of a strategy.

Being innovative is a process. Oxford Dictionary defines being 'innovative' as '(of a person) introducing new ideas; original and creative in thinking'. An innovative communication strategy for environment is a strategic idea leading towards 'sustainability pathways' (Wilbanks & Wilbanks, 2010)through science based policies 'in the face of uncertainty and change' (McGreavy, Hutchins, Smith, Lindenfeld, & Silka, 2013) ideally developed by a professional environment science communicator, within the science community. Whilst it is the job of a professional environment science communicator to use communication strategies, it is important for the PESC to identify and use innovative strategies to best advantage, also bearing that strategies can be made more innovative when used in combination of each other for optimum results.

Seeing through a broad lens, the overarching goal of PESCs is to influence policy through the use and communication of scientific evidence. They see a benefit for environment and sustainability through environment and related policies, being based on sound scientific evidence. In relation, there are 'visible and 'invisible' reasons, the latter finding prominence on the basis of hindrance found in the opening chapter of this thesis, that uphold the importance and relevance of being innovative in the strategies used for communicating science to the policy community.

Policymakers operate in society, making decisions with 'democratic involvement of citizens', hereby, scientific advice to policymakers by the science community will be applied in a way such that it is relevant and to the benefit of society (Peters, 2008). For this reason, it is crucial for the PESC to ensure that the policymaker has understood the science being discussed and is able to engage in discussion or even debate on the topic. It is on the basis of this understanding that the policymaker has of scientific topics, visible to the PESC, in relation to other socio-economic considerations, through discussions and an innovative communication strategy that science policy will be disseminated to citizens, the audience of policymakers.

While policymakers seemingly communicate through policies, every policy process is designed to achieve a unique outcome, making the process, context specific. Policy formulation linked to issues within the scientific domain such as, genetic engineering or nuclear energy, 'may depend on scientific expertise' (Peters, 2008) backed by an innovative strategy in which clarity of the issue at hand is improved through the use of ICT or modern communication tools. However, the success of specialised information generated and presented to policymakers through innovative science communication, having an impact on decision-making, will depend on the ability of policymakers to overcome challenges owing to the 'systemic and structural' design of government and policymaking (Colloquia, 2016). In the process science has a risk of being influenced by politics.

Accordingly, an innovative communication strategy, has a subtle and invisible importance, the function to ensure that science and policy communities, respectively, share a common perception of the environmental or sustainability issue before them (Colloquia, 2016). A message's perceived appeal (Logan, 2008) is what the receivers of the message make of the message and how they act upon the message as per their understanding. Hence, an innovative communication strategy should ensure that policymakers, having understood the issue for themselves and among each other, perceive it in a way such that there is no place for misconception or prejudice.

The primary aim of enabling policymakers and scientists to achieve a common perception of a given issue is in order for them to act on the issue in time, 'without losing out on important' details (Colloquia, 2016). It is of importance that an innovative communication strategy, through its tools and channels of presenting information, save on time, which can be invested in solving environment science issues. An innovative strategy not only saves time but also highlights the urgency of the issue, hereby, proving to be efficient and effective.

Although, the reality is, 'prejudices of the public operate in policy-making and guide communication efforts' (Bauer, 2008, p.122) to an extent that, one, it shows that the science-policy interface is non-linear and two, that science communications by itself, even though innovative, has limitations.

The root limitation of innovative SPI communication is that, in a natural way, many scientists distance themselves from politics, policymakers and the policy community as a whole, owing to ethical and professional reasons (Vogel, Moser, Kasperson, & Dabelko, 2007). Scientists can overcome such a barrier over time through mutual trust and relationship-building (Vogel, Moser, Kasperson, & Dabelko, 2007). Although, such relationship-building is time consuming and in the scientific community, lack of time, as an 'inhibiting factor', implies that science communication suffers (Bowater & Yeoman, 2013).

Other limitations include, relevance of scientific results to policymakers and questioning the legitimacy of scientific knowledge. To the scientist, having their work published in peer-reviewed journals might pass such work as an 'expert' revelation or finding, although to a policymaker, legitimacy might be in the form of 'non-scientific knowledges' when addressing key stakeholders (Vogel, Moser, Kasperson, & Dabelko, 2007).

Finally, science communication is also affected due to the emotional levels of scientists, influenced greatly due to 'discomfort, exposure and vulnerability' in communicating with policymakers and the public at large (Bowater & Yeoman, 2013). As such, lack of communication and misinterpretation leads to the failure of the science-policy interface (Lidskog, 2014).

These limiting factors call for urgent strategic intervention on the science communication front and in accordance to overcome these limitations, there is requirement of a professional environment science

communicator to produce these strategies, sitting on the boundary between science and policy.

2.4 Existing innovative communication strategies

As this thesis is specifically about innovative strategies for science communication in order to influence that policy which will lead to sustainability, it is imperative to explain that a strategy is different from methods, tools and channels.

The Oxford Dictionary defines strategy as 'a plan of action designed to achieve a long-term or overall aim'. This suggests that by nature, exercising a strategy means implementing a plan which is flexible and designed to achieve the best outcome as per the given situation. In similar context, supporting this thesis, it is relevant to highlight the definition of decision theory. Defined by Oxford Dictionary, decision theory is 'the mathematical study of strategies for optimal decision-making between options involving different risks or expectations of gain or loss depending on the outcome'. This shows that in order to achieve a desired outcome, a decision needs to be made. A decision is made up of strategies which might be several in number, and could be used in combinations of each other for a best desired outcome.

With relation to innovative communication strategies, the following are various existing strategies available for use in order to communicate with a policymaker. These strategies have been explained as 'knowing for brokering' strategies by Sarah Michaels, in her paper 'Matching knowledge brokering strategies to environmental policy problems and settings' (Michaels, 2009). In this thesis paper the table has been re-titled to 'communication strategies for furthering science into policy' –

Table 1 Range and their corresponding intent, for communication strategies for science-policy intervention ion (Michaels, 2009)

Strategies	**Intent**	**Examples of broking techniques**
Inform	Disseminate information	Fact sheets and websites
Consult	Seek out known experts in the field for advice on problems solving	Meetings and social assessments
Match make	Identify the expertise needed, who can provide it and the best way to make connections	Introduction or outreach to the people who do not usually meet
Engage	To engage with another party by the means of a contract for the timeframe of the decision making in order to deal with major parts of the problem solving	Royal commissions, Technical committees etc.
Collaborate	To jointly frame the process of interaction and negotiate the method to address a specific policy problem	Joint agreement

Build Capacity	Parties jointly frame the process of interaction and negotiate substance with the intention of addressing the multiple dimensions of the policy problem considering what can be learned from the interaction that can be used in future scenarios and related policy concerns	Co-management, Joint fact finding, co-production of knowledge

From the above table, we have already discussed shortcomings of the 'inform' strategy, traces of which are found within the information deficit model, where policymakers will not spend their time in participating as one way recipients of scientific knowledge. Although, bearing in mind that the conversation has to begin from one side – science or policy – every collaborative effort will begin from a single information source, where the recipient of the message will decide whether to act upon the disseminated message or take 'no action' (Michaels, 2009).

In each of the following strategies, as the strategy keeps advancing, it subsumes the details and proceedings found within each of the previous strategies (Michaels, 2009). It also provides for greater opportunities in terms of communication channels and tools. Using this logic, a collaborative and capacity building are the most advanced with scope for maximum possibility of furthering science into policy. Although, before investigating the scope of these two strategies, it is important to look into the innovative ways of implementing each or a combination of the preceding strategies, their ability to further science into policy and their respective limitations in terms of scope.

Already having introduced and discussed limitations of the inform strategy of one way communication, a valid example of this strategy includes the European Commission's Science for Policy initiative, 'a free news and information service published by Directorate-General Environment, European Commission. It is designed to help the busy policymaker keep up-to-date with the latest environmental research findings needed to design, implement and regulate effective policies' (EC, 2016b). In working towards improving policymakers' understanding of science, this online news service serves as an effective communication channel, tailored to the needs of policymakers.

As inform strategy can be initiated by the science knowledge producer, a suggestion for one way modern ICT based environmental communication could include the use 'of an augmented reality platform for environmental simulations' (Klopfer & Squire, 2008). Application of augmented reality software is best used in a single environment context. Information collected through such a software is not only modern but could also prove to be an innovative means of disseminating information to policymakers.

A consult strategy involves a seeker, reaching out to an expert for consultation on a given environmental situation, in order to find a solution (Michaels, 2009). For example, in 2011 when the

nuclear reactor plants accident took place in Japan, The Fukushima Nuclear Accident Independent Investigation Commission was set up to consult and recommend solutions to the given problem. The Government of Japan, seeker of the solution, formed the Commission, with the intention of 'having potentially valuable insights, if not solutions, into the problem at hand' (Michaels, 2009, p.5). The primary limitation of a consult strategy is that it is executed by the policymaker, hereby, not a strategy initiated by the science community. As such, role of the professional environment science communicator is towards the end of the process if there is need for knowing what content and in which manner is the content to be presented (Michaels, 2009). Also, this is less of a strategy and more of a reaction to a given environmental problem.

Matchmaking strategy is a PESC specific function where, the science communicator facilitates contact between the scientist and the policymaker in order to communicate expert knowledge through a selection and match making process (Michaels, 2009). For instance, in the book *Escape from the Ivory Tower*, the author recollects her experience as an environment matchmaker, 'I fashioned my role as that of a matchmaker, working to figure out more ways to bring scientists and journalists and scientists and policymakers together' (Baron, 2016). This shows that a matchmaker can either work from within an organisation focused on environmental and sustainability science research or work as an independent expert, working through their own consultancy. This strategy is limited by the capacity of the communicator to network.

In similar context to the consult strategy, the engage strategy is implemented with the policymaker reaching out to those existing and concerned stakeholders in society who have the expertise to solve a pressing environmental issue by engaging in a special committee or panel (Michaels, 2009). The difference between the two strategies is that while an engagement might be for a longer period of time, a consult strategy might span over a single consultation meeting and be one sided, replicating elements found in an information deficit model or inform strategy (Michaels, 2009). A suitable example highlighting the consult strategy includes, Caring for Climate: The United Nation's Initiative for Business Leadership on Climate Change, combining global business leaders with the task of 'engaging more actively with national governments, inter-governmental organizations and civil society to develop policies and measures to provide an enabling framework for business to contribute effectively to building a low-carbon and climate-resilient economy' (UNEP). The role of the science communicator here is that of identifying who needs to be engaged and how (Michaels, 2009).

Before proceeding with discussion on the final two strategies I would like to highlight the difference in developing a communications strategy when the audience is society versus it being policymakers. In January, 2016, I met with Mr. Owen Gaffney, Director of Communications, Future Earth. *'Future Earth is a major international research platform providing the knowledge and support to accelerate*

our transformations to a sustainable world' (FutureEarth, 2016). Furthermore, it aims to produce research, designed and conducted in partnership with society in order to produce knowledge necessary for the transformation of society towards sustainability (Mauser, et al., 2013).

Catering to a target audience of society stakeholders, Mr Gaffney's communication strategy is to 'place engagement at the heart of Future Earth' (Owen, 2016). His innovative plan to promote science communication through experimental communications, is by 'setting up a Future Earth Media Lab and experimenting with new technologies and new groupings for communications' (Owen, 2016). This produces two characteristics, one, channels of communication of a communication strategy need not be limited by idea or scope in terms of being innovative, unless there is a limit due to resources, and two, the PESC when communicating with policymakers, needs to develop innovative ideas in order to collaborate with the policymaker.

The two final strategies, that of, collaborate and build capacity strategy, have similarities and a thin line difference. While both strategies involve participants from the science and policy community, jointly interacting to negotiate and address the sustainability issue before them, the build capacity strategy goes further to increase the ability and enables people and institutions to perform those tasks that is required of them, especially in the future (Michaels, 2009). Through these strategies, science and policy community, both, negotiate meanings, shape the issue and set the agenda (Trench, 2008).

Going in-depth, the following case studies, projects by Stockholm Environment Institute, show how collaborate and built capacity strategies have been executed in an Africa and Asia context.

3 Case Study

3.1 Stockholm Environment Institute: Rationale behind selection

The Stockholm Environment Institute (SEI), established in 1989, is 'an international non-profit research organization that has worked with environment and development issues from local to global policy levels', and in the process 'bridges science and policy to find robust responses to the challenges of sustainability' (SEI, 2016b). SEI Strategy, 2015-2019 explains that their overarching communications objective is 'to produce and share knowledge more effectively, in partnership with decision-makers' (SEI, 2015b). Mr. Robert Watt, Director of Communications, SEI, explains that the fundamental principle behind SEI communications is 'engagement' (Watt, 2016). Over an interview with Mr. Watt at the SEI headquarters in Stockholm in January, 2016, he explained that SEI aims to establish conversation and 'see communication as being the interface between science and policy' (Watt, 2016). Furthermore, in 2015, SEI's 'geographic focus of research funding' was majorly 'global' (49%) (SEI, 2015a) and in 2014, 'sources of finance by sector' was primarily by 'government' (37%) (SEI, 2014). All

of these considerations establish that SEI is an important organisation within the environment science-policy landscape. In accordance with the focus of this thesis, to analyse how innovative communication strategies are employed to impact policy through evidence based science, there is complete justification and rationale for selecting Stockholm Environment Institute as the case study organisation for the thesis.

3.2 Narrowing Down: Project Selection

This thesis is interested in indicating innovative communication strategies that produce science evidence based policies. With regards to the overarching goal of the thesis, Mr. Watt's explanation that SEI is 'a project funded organisation' provided further direction. He explained that, 'the actual day to day work is done in projects' and that 'it is in those projects where' 'strategies and plans for communication' are made (Watt, 2016).

My next step was to narrow down and shortlist a handful of SEI projects among the '150 projects going on at any one time, sometimes even 200' (Watt, 2016). The overarching criteria for selecting projects was the following –

a) national level project
b) SEI as lead organisation
c) communications officer of that SEI centre was involved
d) implementation of an innovative communication strategy in the project
e) the innovative communication strategy enabled science to enter policy
f) find online research material pertaining to given project in English language

3.3 Research project on Citizen Science and Air Pollution monitoring (CSAP)

3.3.1 *Introducing the project*

'The mission of SEI's Africa Centre is to support close collaboration with African organizations and networks on key environmental and development issues' (SEI, 2016a)**.** The CSAP pilot project was the result of health consequences such as asthma and tuberculosis faced by the local population of Mukuru informal settlement in Nairobi, caused by air pollution from local industry. Stockholm Environment Institute, Africa, executed this project with a citizen science approach by involving the Muungano local community by 'training them and working with them to collect data', as explained by Mr. Philip Osano, SEI Africa (SEI, 2016c). Air quality guideline levels for particulate matter (PM) given by the World Health Organisation had exceeded in every region of the settlement. Mr. Patrick Bueker, SEI York, explained that there were even incidences where there was a 'ten-fold exceedance of the guidelines' and that this was 'a clear mandate for policymakers to take action' (SEI, 2016c).

General

Table 2 General overview of CSAP monitoring project, SEI Asia, SEI Africa (SEI, 2016c) (SEI, 2014)

Geographical Focus	Mukuru (informal settlement), Mombasa Road, Nairobi, Kenya
Key focus area of pilot project	Air pollution monitoring (to address health concerns)
Aims of the project	- Perform a pilot study on monitoring of indoor and outdoor particulate matter (PM) levels - Inform the affected public about the risk air pollution poses to their health and options how to overcome these threats - Identify capacity gaps with indoor and outdoor air pollution with specific focus to the environment and health policy communities at the county (Nairobi) and national levels
Partners	SEI Africa and SEI York
Stakeholders involved	- Community members (Muungano community informal settlers) - Ministries of Environment and Health, Kenya - National Commission for Science Technology and Innovation - African Population and Health Research Centre - International and local NGOs - University of Nairobi - Media
Target audience	- Muungano community settlers (learnt capacity development) - Ministries of Environment and Health (research helped government change ways of the community)
Budget	In SEI Africa, at least 10% budget goes to communication
Year	2015
Achievement	Creation of an air pollution task force involving the Ministry of Environment, Ministry of Health, NACOSTI, UNEP and community members who have met twice until 19th April, 2016, to draw an agenda to see how to go forward on the discussion on air pollution

Policy

Table 3 Policy overview of CSAP monitoring project , SEI Africa (SEI, 2016c)

Ministry in charge:	Ministry of Environment, Ministry of Health, Kenya
Contact point	Directors from both Ministries, Director for Health at county level, Permanent Secretary in Ministry of Environment, Director of National Environment Management Authority (NEMA)
Goal of government	- Address air pollution - Arrest respiratory infection

Nature of support	There were difficulties encountered where officials from the Ministry of Health blamed officials from Ministry of Environment and vice versa; also the Muungano community members and NGOs did not feel the government was doing enough; government accused the media for manipulating information
Primary mode of communication	- Email with policymakers - Face to face interaction with policymakers and community - Trainings and workshops with community

3.3.2 Description of communication strategy carried throughout the project –

This project managed to hold the interest of policymakers throughout, due to the fact that SEI Africa involved policymakers with the project from the beginning. The idea was to initiate dialogue with the government even before the project had begun, in order to ensure best results through an inclusive process. SEI Africa had one-on-one discussions with different government bodies highlighting that there was need to conduct ground research and that the government's support was essential (Odera, 2016). Ensuring successful implementation of the pilot project was very crucial due to severe health impacts the Muungano population was facing.

While Mr. Philip Osano, SEI Africa and Mr. Patrick Bueker, SEI York were co-leaders of the project, Ms. Sarah Odera from SEI Africa was the Communications in-charge for the entire project, being based in Kenya. Ms. Odera made effort to communicate two key messages, one that the project is relevant in terms of addressing health impacts of air pollution on the given population and second that it is urgent as SEI has looked into the problems prevalent in this area previously, although problems still continued to exist (Odera, 2016).

The communication strategy involved method of collaborative effort among concerned stakeholders. This is also where the innovative aspect of the project was situated whereby 'through training and doing their own research, the community, learnt about air pollution' (Odera, 2016). The pilot project raised 'awareness on how to prevent and stay away from particulate matter emissions, as well as contributing to the development of effective air pollution mitigation policies' (SEI, 2016a). One community member and a SEI researcher formed a pair, such that the community member could learn from the researcher and teach others within the community.

Citizen science, the core innovative method within the strategy of the project, was found at all stages of the project - pre-planning, during the course of the project and even on completion of the pilot through discussions towards creation of a task force to combat air pollution. The language of communication varied between Swahili and English, where Swahili was used when communicating

with the community and English was used when communicating with the policy sector and international NGOs (Odera, 2016). Amidst progress of the pilot project, media was instructed not to distribute any content produced as there was a requirement for content to be shared with stakeholders first (Odera, 2016).

Communications of the Citizen Science and Air Pollution (CSAP) monitoring pilot project achieved best outcome on the front of education for community members. Owing to continued communications, air pollution awareness was raised, 'to a high level within the policy sector' (Odera, 2016), which was a planned and intended outcome. A third and surplus outcome was that this project raised SEI Africa profile through project findings among working peers. Finally, scientific evidence proved to raise awareness, by 'involving other science based organisations' as well (Odera, 2016).

The end result of the pilot project was expected to have had better results by the project team. As it was a pilot study, 'it was on a very small scale' and SEI Africa did not recommend any intervention to the governmen. The hope was to achieve funding for another pilot project in another informal settlement 'such that data is more credible (Odera, 2016). The goal was to collect data in order to be able to prove through scientific evidence that there is a problem and that there is a need to look at this 'deeper and at a larger scale'. Funding for replication of the project in another area, was however, not extended (Odera, 2016).

A short film explaining this project was shown by the Stockholm Environment Institute at the Swedish Forum for Science Communication in April, 2016 to inform viewers of the issue in the Mukuru Settlement and spread awareness of the situation in Kenya.

3.4 Ayeyarwady Futures Partnership (AFP) Ensuring the sustainability of development in the Ayeyarwady River Basin in Myanmar

3.4.1 *Introducing the project*

The Ayeyarwady Futures Partnership (AFP) is a long-term programme designed for the management of Ayeyarwady river basin in Myanmar, essentially a basin wide strategy of managing resources through evidence-based participatory planning processes (Daniel , 2014). Considering that the basin covers a great geographic expanse and that the SEI Asia team was keen on 'quick gains, in terms of policy' (Daniel R. , 2016) they are currently in the process of conducting a national level pilot study of Chindwin river basin, a tributary of the Ayeyarwady river basin. Studies completed as of 2014 have provided evidence of issues 'including the security of river-related livelihoods, deteriorating water quality, dry season water provision and allocation, and the management of sediments and river

channels for transport that require significant scientific as well as governance capacities to address' (SEI-Asia, 2015). These issues have created need for AFP project.

General

Table 4 General overview of Ayeyarwady Futures Partnership (AFP): Ensuring the sustainability of development in the Ayeyarwady River Basin project, SEI Asia (SEI-Asia, 2015)

Geographical Focus	Ayeyarwady (Irrawaddy) River Basin, Myanmar
Key focus area of project	River Basin management (through Integrated Water Resource Management practices)
Aims of the project	- Establish the Ayeyarwardy Futures Partnership (AFP) as a boundary organization working between policy - Strengthen the capacity of state and civil society actors in Myanmar to inform, and effectively engage in, assessments and deliberations on water resources planning and development strategies and decisions - Influence the design of emerging institutional frameworks for water governance in river basins
Partners	- Stockholm Environment Institute (SEI) in collaboration with Directorate of Water Resources and Improvement of River Systems (DWIR) - Myanmar Environment Institute (MEI) and other organizations from Myanmar - Mekong regional experts from Chulalongkorn University, Bangkok (Thailand) - Sustainable Mekong Research Network (SUMERNET) - Mekong Program on Water, Environment and Resilience (M-POWER), and other organizations
Stakeholders involved	- Policymakers - Civil Society
Target audience	- Policymakers - Civil Society (Myanmar Environment Institute (MEI) and other organizations from Myanmar)
Budget	
Year	Phase 3 – January, 2014 to June, 2017
Achievement	Considerations in process to institutionalize river basin management through the setting up of a River Basin Organization (RBO) as part of the government as suggested by SEI Asia. RBO to be constituted by all stakeholders through a consultative management process. Funding provisions need to be fulfilled by the government. There was resistance to mobilise funding initially but agreement to move forward through meetings, after the project results were communicated

Policy

Table 5 Policy overview of Ayeyarwady Futures Partnership (AFP): Ensuring the sustainability of development in the Ayeyarwady River Basin project, SEI Asia

Ministry in charge:	Ministry of Transport
Contact point	- Mr. U Aung Kyaw Hmuu, Deputy Director, DWIR - Mr. U Kya Zin Than, Assistant Director, DWIR - Mr. U Aung Myo Khaing, Assistant Director, DWIR
Goal of government	- Detract from the current piecemeal approach of addressing environment issues such as mining, water pollution etc - Adopt basin wide solution approach (which became driver for the project)
Nature or lack of support	Due to lack of local expertise among policymakers and civil society there was a need to invite experts from the West
Primary mode of communication	- Email - Face to face interaction and interview with policymakers - Workshops for policymakers

3.4.2 Description of communication strategy carried throughout the project –

The project lead is Dr. Chayanis Krittasudthacheewa, Deputy Director, SEI Asia. On the government front, collaboration and communication proceedings followed guidelines of 'agreed minute' diplomatic protocol, whereby, a government department works with an international organisation (SEI Asia) in order to implement studies of a project. In the case of SEI Asia, the Directorate of Water Resources and Improvement of River Systems (DWIR) is the host government agency, which is also the Secretariat of National Water Resources Committee (NWRC), hereby, completing the formal cooperation arrangement. The DWIR is a department within the Ministry of Transport, Myanmar. To the government of Myanmar, the Ayeyarwady River Basin serves as a crucial water transport and navigation route, hence, the project is within the purview of the Ministry of Transport.

Communications of the project, led by Mr. Rajesh Daniel, Communications Coordinator, SEI Asia, to a great extent, has focused on improving 'understanding of the science behind the river basins' (Daniel R. , 2014) among government officials of Myanmar. This is where SEI provides its scientific expertise, for example, hydrology, floods modelling, soil, sedimentation, erosion and water quality monitoring. SEI found that there was a need for bureaucrats and government scientists in Myanmar to learn basic modelling techniques. Through workshops, scientific evidence pertaining to the project that was collected was shared with bureaucrats. The workshops also served as a knowledge dissemination platform.

It is worth noting that Myanmar was in economic hibernation and needed to update the level of science in the country (Daniel R. , 2016). Accordingly, workshops with policymakers, an ideal face-to-

face communication platform, were organised in Yangon and Monywa (on the Chindwn basin). At these workshops, SEI conducted interviews with policymakers to ensure that ideas were communicated effectively. Furthermore, study visits were organised such that bureaucrats from Myanmar could interact with the Pollution Control Department, Bangkok.

An innovative aspect of the communication strategy included, 'assessments and joint fact-finding' (SEI-Asia, 2015) whereby SEI experts made policymakers perform the research themselves. This included making trips in boats through the Chindwin basin, where soil and water samples were collected and then tested in laboratories in Yangon and Bangkok for further investigation.

Communication was led by SEI Asia. To support communication efforts, MEI and students from Myanmar helped with the communication, especially during filming of the project video and translation of interviews. Alongside workshops that were directed at policymakers and video for mass public, local communication efforts on the part of SEI included using channels such as policy forums, bilingual printed fact sheets, poster flyers and even presence at World Water Day celebrations in order to promote the project. Macro level communication efforts were directed towards the rest of the world through the website to inform about the project and about what is happening within Myanmar.

Mr. Daniel explains that innovative science communication strategies are 'always tough' to get through to the audience just as the science behind it is. For this purpose, it is imperative that the communication process is consultative and collaborative. It is most effective when information in information packages can be transmitted to several channels of communication with ease. Hereby, during consultations with policymakers, it was imperative to be on the same page in recognising that this project follows the characteristics of an Integrated Water Resource Management project. Thus, when it comes to adopting a joint and united river basin approach, it is through the joint communication efforts from preliminary stages with common language, channels and innovative approaches that it would be possible to pursue the formation of a River Basin Organisation.

Finally, outreach efforts of the Ayeyarwady Futures programme confirms that communications is a means to an end. Communications for science based policy depends on the resources available in terms of finances, modes, expertise of the communicator, involvement of community in communications and the experiences and the expertise of policymakers.

3.5 Limitations

The process beginning from initial search for case study projects to finally settling on the two above documented projects faced limitations. These limitations have been explained as follows –

a) Lack of project detail records and confusion – The initial set of projects I had selected from SEI Tallinn centre that had concluded in or prior to 2013, did not have sufficient records, either due to concerned expert no more being associated with the centre or the fact that the centre did not have a Communications in-charge to maintain detailed records of the projects. This showed that size of personnel was also a determining factor for project selection. Hence, I shifted my project selection strategy to consider combinations of projects, for example, 2 from SEI Africa and 2 from SEI Asia.

   The 3 projects that I had initially selected to study from SEI Africa, were 'not SEI Africa projects', they were projects 'from Stockholm but research had been carried out in Africa' as explained by Ms. Sarah Odera (Email correspondence with Ms Sarah Odera, SEI-Africa). As projects were selected through the SEI Africa website, it confused me to learn that factually, such was not the case

b) Restricted to SEI perspective – One of the interests of this thesis is to study the communication strategy executed by SEI. As a result, this thesis only shows the strategy being executed and received by the audience from the perspective of that SEI centre.

   Furthermore, maintaining ethical practices, it would not have been appropriate approaching SEI audience members and stakeholders to grasp their perspective on the given case study project

4 Results

The aim of this section is to analyse the two case studies in depth. This has been done in three parts. This section first shows how SEI researchers identified the knowledge gap in each project. Following this, the section shows the precise communication strategy used at each stage of the project. Finally, internal and external factors affecting and shaping strategic communications of the project have been explained.

4.1 Identifying the knowledge gap - SEI case

Besides having a video produced showcasing work done in each of the projects, both projects have one distinct detail in common. While the entire SEI Africa project was a pilot study, the SEI Asia project graduated into a full time study on the basis of pilot studies carried across the Arrayewady basin of Myanmar. It was in each of these pilot study projects where researchers identified knowledge gaps.

Mukuru slum settlement, an area of 2.3 km^2 along one toxic Ngong River, is characterised by urbanisation, owing to employment opportunities through prevalence of local industry (Gulis, Mulumba, Juma, & Kakosova, 2004). Industry sectors include, heavy metal, polythene/plastic packaging, paints, cables, food, chemicals, farm equipment and others (Roland School of Public Health). Industrial activity combined with charcoal and wood burning has led to deterioration of air quality, consequently impacting health status of local settlers, seen through, acute respiratory infections, bronchitis, tonsillitis, asthma etc (Gulis, Mulumba, Juma, & Kakosova, 2004). Mukuru, traditionally, is a farmland, which has been 'leased for up to ninety nine years to individuals and business' by the Government of Kenya (Wakhungu, Huggins, Nyukuri, & Lumumba, 2010). The lack of academic research on the extent of pollution and institutional capacities to deal with environmental externalities of the industrial sector and the twofold impact, on environment and health, provided SEI researchers evidence to execute pilot study in the settlement.

In the case of the Ayeyarwady river basin project which began in 2013 as a part of the Ayeyarwady Futures programme, research interest on river basin management sparked mainly due to intense activities that the river is used for and the consequent continuous health hazards and environmental problems faced in the river basin (SEI-Asia, 2015). Major threats to the local environment include land use change, logging, deforestation, and search for mineral deposits, unsustainable fishing, habitat destruction, hydropower projects and climate change (Simmance, 2013). These threats have weakened Ayeyarwady basin's ecological and socio-economic integrity (Simmance, 2013). For these evidence based reasons SEI Asia began work on the project.

4.2 Executing the communication strategy

After having defined local environmental problems and knowledge gaps, the SEI Africa team took initiative in 'engaging local leaders, right from the beginning itself' (Odera, 2016). Alongside engaging leaders, SEI Africa adopted a citizen science, capacity building strategy 'by engaging the community members themselves in the research, where, after training, the citizens were the ones who conducted data collection and in turn learned more about air pollution. This way, community members were also able to share with their neighbours and tell others what the situation is all about' (Odera, 2016). In turn, SEI Africa's communications strategy to use citizen science proved beneficial when 'Mukuru settlers themselves, could address (at a final workshop with Ministry of Environment and other officials) and say what they feel' (Odera, 2016) regarding the situation prevalent in their community.

The SEI Asia project followed a different communications strategy. The advantage enjoyed by Ayeyarwady Futures programme was the previous interaction with 'researchers, now part of Myanmar government, through the Mekong Programme, part of SUMERNET research partnership.

They were very keen on SEI Asia getting involved in environment assessments in Myanmar' (Daniel R. , 2016). This previous interaction between SEI Asia and 'former research partners' led to a collaborative communications strategy.

SEI Asia was called upon to provide 'scientific expertise' and accordingly, 'the Deputy Director, [Chayanis Krittasudthacheewa], had initial discussions which then transformed into a SEI work plan, this succeeded with a meeting with DWIR and the formation of NWRC. That is when we stepped on board, fulltime' (Daniel R. , 2016). Cooperation through initial collaboration led to a 'series of workshops and field trips where we went around the Chindwin Basin for 2-3 days in a boat, testing soil, testing water and policymakers would participate in this' (Daniel R. , 2016). Hereby, 'joint fact finding' contributed to the capacity building of policymakers, until eventually and as of today concerned policymakers are in talks to 'set up a River Basin Organisation (RBO)…the institution which will manage resources of the Chindwin River Basin' (Daniel R. , 2016). In overview, an initial collaboration strategy led to capacity building (strategy) of policymakers to move forward and once again formulate a collaboration strategy through the RBO.

While there are context specific differences between the two projects, they are similar in the strategies used, that of, collaborate and build capacity communication strategies. Both were used at intervals, in respective cases, best suiting the given level of progress and future of the project. Alongside project specific communication strategies, common to both, there were internal factors that affected the way the communication strategy was shaped. These internal factors are my findings formed on the basis of my interactions with both communications officers and impression I got about the communications efforts, as part of the given project.

4.3 Factors that affect the communications strategy

Table 6 Internal factors affecting the planning and execution of a communication strategy

Communications strategy	SEI Africa	SEI Asia
PESC perception of influence on policymaker	Relevant (health issue) and urgent (health issues of settlers have persisted for a while but no solution found)	Important - Inform policymakers of the natural and social science related concerns being addressed through the project
Skills of the PESC	Writing, Research. No further information.	Writing, Research, Photography, Film making

Budget of communications	10% of the total budget allocated for communications	Not known
Size of the communications team (for project)	1, fulltime	1, fulltime and 1 SEI staff in Myanmar along with video translation of interviews help from 4-5 students from Myanmar

Communications efforts, inclusive of vision, strategy and execution are largely dependent on the manner in which the communications in-charge perceives the audience.

In order to execute communication activities, especially, such that it fits into the prescribed strategy, the communications in-charge will be prone to using skills they have. For this reason, the video created for the SEI Africa project appeared to have been produced externally versus the video created for the SEI Asia project which was produced and edited by Mr. Rajesh Daniel.

Additionally, funding and personnel dedicated to the communications efforts of the project also affect the planning and outcome of the communications strategy.

Furthermore, through the course of the thesis, I have identified five external factors that affect the communications strategy of a project. These have been explained through details found in the two SEI case studies.

In the case of Stockholm Environment Institute, whose suffix statement is 'bridging science and policy' and the overarching mission is 'to support decision-making and induce change towards sustainable development' (SEI, 2016b), it must be essential to consider the level of expertise the policymaker has on the science behind the given project. Depending on the level, the communication effort would either begin at an inform strategy to fill the knowledge deficit or else involve the policymaker in the course of project research and evidence scoping, as seen through joint fact finding measures seen in the initial stages of the Ayeyarwady Futures programme project.

It is well established that 'useable knowledge' will appeal to the policymaker, especially if found in line with their goals (Holmes & Clark, 2008). One factor contributing towards a policymakers' acceptance of scientific explanation from the knowledge provider is the established image of the organisation in the policy community. Irrespective of the nature of project being undertaken, the Stockholm Environment Institute has built a reputation over 25 years where they have combined scientific research with policy analysis, hereby connecting their work to that of policymakers (SEI, 2016b) In the case of the Citizen Science Air Pollution (CSAP) monitoring project in Kenya, such image of SEI is what

allowed early ‘engagement [strategy] of policymakers’ (Michaels, 2009) during initial stages of the project.

Both case study projects of Stockholm Environment Institute operate within a given political boundary, where the political environment in these countries affect the manner in which the projects are communicated to stakeholders. In Kenya, besides ‘corruption’, there was a tendency ‘where officials from the Ministry of Health blamed officials from Ministry of Environment and vice versa’ (Michaels, 2009). This cautioned the project team and as a result they communicated from the Mukuru settlers point of view, in order to remind the Ministries of the daily challenges the community face.

After having realised what was the challenge to be addressed, who is the audience and how to execute the project, the next step was to recognise the locally available expertise in helping conduct research and communicate the project. In the Ayeyarwady Futures programme, on achieving political support to institutionalise the river basin management of resources, through formation of a River Basin Organisation (RBO), the stakeholders realised that there was none among the existing partners who had the expertise of setting up a RBO. Accordingly, coordinated through SEI, ‘a team from Brazil, who happened to be passing through South East Asia area, was invited to talk to stakeholders, sharing their knowledge on setting up a RBO’ (Daniel R. , 2016). Hereby, lack of local expertise proved to become a communication challenge which was solved using a consult communication strategy.

Finally, different interest groups involved also highlighted the cultural characteristics within the projects, largely visible through language. In the CSAP project, communication among ‘policymakers was in Swahili and with international NGOs was in English’ (Odera, 2016), in the Ayeyarwady Futures programme, ‘policymakers spoke in Myanmar (language) or English although during talks with farmers, fisher-folk, villagers, our local partners spoke in Myanmar (language)’ (Daniel R. , 2016). This affected the communications strategy, as there were times, due to language barrier, when the only way forward was to communicate through local partners.

All of the above, internal and external factors that affect the communications strategy of an environment project contribute to answering the research questions. In light of these questions, a comparative approach to analysing the two case studies has been adopted and the following paragraphs detail the findings and discussions of these.

5 Discussions

The vital role of communications in a boundary organisation is characterised by the nature of transdisciplinary work carried out, requiring collaboration, flexibility and innovativeness ((McGreavy, Hutchins, Smith, Lindenfeld, & Silka, 2013). In both SEI case studies, the projects employed best innovative communication strategies as per requirement of the projects' desirable outcome. In light of this and to answer the question - why are these strategies innovative; the underling factors that contributed to the selection of these strategies and the outcome desired in the projects have been analysed.

The overarching goal and desirable outcome of the Citizen Science Air Pollution (CSAP) monitoring project was to develop a more comprehensive and long-term collaborative programme in informal settlements throughout sub-Saharan Africa. This was to be achieved on the basis of results of the pilot study at Mukuru informal settlement (SEI, 2014). Accordingly, SEI Africa executed a strategic combination of communication strategies based on stakeholder identification. While SEI Africa successfully executed the pilot study in Mukuru, Nairobi County, they were unable to secure funding to replicate the project in other informal settlements. However progress made through collaborative efforts has currently led to discussions on the formation of an air pollution task force.

The Ayeyarwady Futures programme, scaled down to the Chindwin Futures project, has the overarching goal of having 'a basin wide strategy of managing resources opposed to a piece meal approach' (Daniel R. , 2016). The major problem in Ayeyarwady basin management was due to 'weak cooperation among water related agencies' (Win, 2014) in Myanmar. Knowing this and in order to achieve their overarching goal, SEI Asia devised an inclusive strategy based on the decision makers interest. Not only did this solve grassroots environmental problems specific to the Ayeyarwady River basin but also resulted in institutionalizing water management practices.

Prior to launching and in the course of the CSAP monitoring project, SEI Africa executed two communication strategies. One, was an early engagement strategy with policymakers (Michaels, 2009). This strategic move was important in order to gain support of policymakers and NGOs. The engagement strategy was executed through one-on-one discussions with the Director of Health in Nairobi county and Permanent Secretary of the Ministry of Environment, 'before the project even started' (Odera, 2016). Such was SEI Africa's strategy in order to ensure success of the project.

The other strategy adopted by SEI Africa included a build capacity strategy (Michaels, 2009). They found that the community members were receptive to health and environmental concerns in the region and thus SEI Africa, used a citizen science approach to execute this strategy. They found it important to use this strategy in order to involve community members first hand through 'training on

collecting data on air pollution' (Odera, 2016). SEI Africa built the Mukuru community's capacity through technical training for calculating Particulate Matter in order to enable them to have informed opinions and be engaged in the decisions made at the policy level.

Both these strategies, proved to be innovative as they were used in a manner that complemented each other. The build capacity strategy closely succeeded the collaborate strategy, knowing that the former strategy would feed-in into the latter in the future.

The Ayeyarwady Futures programme, in Myanmar, on the other hand, had less emphasis on trying to convince policymakers, as the SEI Asia team had already established contact with the concerned policy stakeholders through the SUMERNET network initiative. Once SEI Asia had formally agreed upon a cooperation plan with officials in the DWIR, the SEI Asia team invited DWIR officials to a 'joint fact-finding' activity, hereby forming the basis of a build capacity strategy. In Myanmar, as public works assessments must happen 'under the presence of officials' (Daniel R. , 2016), the strategy of assessments on the river, using boats proved to be innovative as it met with the formalities of the government, built scientific capacity of DWIR officials by collecting water and soil samples and led to co-production of knowledge, at the same time building a direct relation with officials. For these reasons, capacity building communications proved to be an innovative strategy.

The above discussion answers the question - why are these strategies innovative. Proceeding to the second question, the discussion will analyse – how did the above discussed innovative communication strategies inform policy making.

The CSAP project, from the Communications Officer's perspective, enjoyed three significant achievements. These included, first, educating community members, second, raising awareness of air pollution to a very high level among policymakers and finally, SEI efforts, collectively, resulted in raising SEI Africa's profile among working peers in the African context.

In hindsight, these three achievements, contributed towards collaborative efforts in the direction to form the air pollution task force. Hence, mix of innovative communication strategies worked in favour of SEI Africa. While progress towards institutionalising the air pollution issue through the task force has already witnessed two meetings, as of late April, 2016, the following questions remain unanswered –

a) Why did not SEI Africa receive further funding to replicate the studies in other informal settlements across Nairobi, as planned initially

b) Why did not SEI Africa, the government or other stakeholders question industry during the pilot study, considering that industry was the root cause of air pollution

c) With what authority and power will the to-be air pollution task force function, such that air pollution levels do not exceed WHO standards and consequently, health conditions of Mukuru settlers improve

The fact that the above questions require further investigation highlights the need for further science communication, except, this time, communication will be influenced more directly by political negotiations. This concludes that innovative communication strategies employed in the course of the CSAP project did inform policymaking by generating scientific evidence on the basis of which, policy must act. Although, the CSAP project, similar to any other project, is affected by internal and external limitations, must recognise that from here on, future communication strategies will have to employ a mix of strategies not only to accommodate scientific evidence but also socio-economic considerations. Hereby, this highlights further demand for the professional environment science communicator.

In contrast, Chindwin Futures programme, is a currently existing project. The Communications Coordinator of SEI Asia, recollects the success up until now in the course of the programme to be twofold, one, the achievement of looking at Chindwin River basin 'as a management entity, opposed to a piece meal approach was successfully communicated' and second, 'the policymakers have decided to set up a River Basin Organisation (RBO), in order to manage the resources of the Chindwin River basin (Daniel R. , 2016).

Hereby, a build capacity strategy, which served as the 'evidence-based participatory planning processes' (SEI, 2014) led to the collaborate strategy of institutionalising basin wide management through the RBO. In effect the RBO contains every stakeholder connected with the river basin, 'the local communities, the mining companies, the loggers, the local line agencies, the boat operators and navigation personnel' (Daniel R. , 2016).

It is of most importance to highlight that policymakers welcomed the setting up of the RBO. Such positive response owed to learnings through participatory learning processes. The concerned policymakers were interested in raising money for the RBO even through 'businesses in the area' (Daniel R. , 2016).

In conclusion, the most significant take away from the Chindwin Futures programme is that by building a personal relationship with policy stakeholders, not only does this serve as a unique learning opportunity for the stakeholders but also trust building between the researcher and policymaker will benefit both communities at large.

6 Conclusion

At the core of an innovative communications strategy for the environment lie two considerations. First, that the communication strategy is part of a project, which relies on external factors such as funding for its operation and implementation. Funding, when allocated towards communication efforts of a project, becomes an internal factor that affects communications. Hereby, in order to achieve realistic communications goals, the communications team must be innovative in the course of planning their communication strategy. In this manner, they will make most of the limited funding. Second, the innovativeness component depends on the strategy and not the other way round. Hereby, to facilitate an innovative bridging of the science and policy domains, it is imperative that the communications strategy be flexible, inclusive and trustworthy. These characteristics are shared by a boundary organisation.

It is the role of a professional environment science communicator to identify communication boundary objects and use them to the advantage of both, the science and policy communities. In the CSAP monitoring project, the devises used to calculate particulate matter were good examples of a communication boundary object. For the SEI researcher, the devise served as a training tool which would build capacity of the Mukuru settlers. On the other hand, the settlers used the devise as a fact finding and knowledge tool for the measurement of particulate matter. Employing communication boundary objects in an environment project, not only benefits the project's goals but also opens doors for further opportunities within the domain of innovative science communication strategy building.

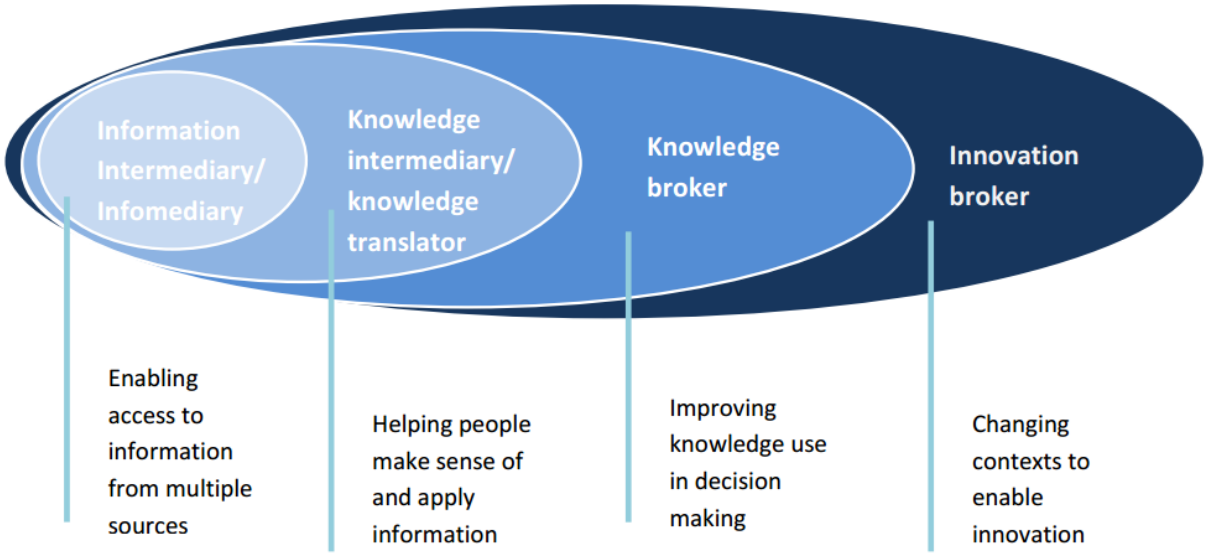

Figure 7 PESC role as an innovation broker

The above diagram shows that the professional environment science communicator's (PESC) role as an innovation broker, encompasses all other roles that they must perform as a boundary spanner in a boundary organisation. The PESCs role is not limited to knowledge brokering. Working on the boundary between science and policy, provides the PESC with access to both communities. Making use of available human and capital resource, the PESC should invite stakeholders from both domains to ideate best innovative strategies, not just limited to communication solutions, but also in the grand scheme of sustainability science.

Finally, in the course of moving forward, towards a future based on sustainability criterion, the professional environment science communicator has a pivotal role to play. The very least of responsibilities is to ensure that environment and communication in union, is not be taken for granted. With regards to highlighting the importance of innovative communication strategies in furthering science into policy, the efforts will have to remain ongoing. The sole idea behind it being an ongoing process is in order for it to ensure that sustainability science and practice moves forward and hereby benefits one and all.

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8 Appendix I

8.1 List of Interviewees with corresponding dates and organizations

Name of Expert	Title of Expert	Date of Interview	Organization
Robert Watt	Communications Director	13th January, 2016	SEI Centre Stockholm
Owen Gaffney	Communications Lead	14th January, 2016	Future Earth
Sarah Odera	Communications Officer	19th April, 2016	SEI Centre Africa (Nairobi)
Rajesh Daniel	Communications Coordinator	28th April, 2016	SEI Centre Asia (Bangkok)

9 Appendix II

9.1 Questionnaire for personal interviews

A semis structured interview was conducted using the following interview guide.

1. General

a) Was the organization responsible for the initiation of the project?

b) Aim of project within the objectives of SEI

c) Language of operation

d) Geographical focus (local, national, regional)

e) Stakeholders involved

f) Budget for the project and for communications team

g) Target audience

h) Achievement of the project

2. Policy

a) Ministry and contact point in government interacted with

b) Goal of the government with regards to the given project

c) Nature or lack of support provided by policymaker

d) Nature of interactions

3. Communication

a) Project lead

b) Communication lead

c) Key communication message (importance, urgency, relevance or magnitude of issue)

d) Key communication method

e) Key communication channel

f) Element of innovation

g) Where is innovation situated

h) Achievement of the communication measures

10 Appendix III

10.1 Organizational structure and reporting hierarchy of expert group in the Myanmar Government (Win, 2014)