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The Antarctic and Southern Ocean Horizon Scan

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Abstract (149): In April 2014 in Queenstown, New Zealand, the Scientific Committee on Antarctic Research (SCAR) conducted a horizon scan to set priority research questions for Antarctica and the Southern Ocean that are relevant for the next twenty years and beyond. A group of 75 leading Antarctic researchers and policy makers refined a list of 866 questions gathered from international open online solicitation rounds to a final list of 80 questions. The use of the horizon scan methodology was effective in setting a directive for future Antarctic and Southern Ocean research but there were limitations to this process that could be remediated. Further prioritisation of the final list of questions is necessary. There is also scope for capacity building within both the framework of SCAR and the horizon scan which will provide vital mechanisms to facilitate the research that will ultimately answer the 80 research questions identified by the horizon scan.

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Introduction

The International Geophysical Year (IGY) of 1957-58 saw a major achievement in providing an opportunity for wide scale international co-operation in physical sciences in Antarctica. The IGY led to the formation of the international Antarctic Treaty in 1959, which primarily set aside the continent for peace and science (NSF, 2009; Summerhayes, 2008). Articles II and III of the Antarctic Treaty promote the following: freedom of scientific investigation; international co-operation; exchanging and sharing of scientific observations and results (Antarctic Treaty, 1959). Antarctic scientific research to date highlights the important role of Antarctica in Earth system sciences but there are a multitude of important scientific questions yet to be answered. To answer these questions effectively there needs to be continued international scientific collaboration and data sharing (NSF, 2009).

Scientific Committee on Antarctic Research

The Scientific Committee on Antarctic Research (SCAR) is a collaboration of leading scientists and policy makers and is an interdisciplinary body of the International Council for Science (ICSU) which consists of 37 member countries (SCAR, 2015¹). It was decided in February 1958 to continue the international coordination of Antarctic scientific research that had begun during the IGY in 1957-58 (Summerhayes, 2008). By the end of 1958 ICSU invited 12 nations involved in Antarctic research to form The Scientific Committee on Antarctic Research (SCAR) (Summerhayes, 2008). SCAR is one of the most prominent of the various scientific organizations set up to coordinate the scientific research conducted in Antarctica (Cole, 2006).

The mission of the SCAR strategic plan for 2011-2016 is to provide ‘Antarctic science and policy advice in a changing world’ (SCAR, 2015¹). The main objective of SCAR is to act as a consultant which can provide independent scientific advice to the Antarctic Treaty Consultative Meetings. Also, SCAR makes recommendations on a variety of issues based on up to date Antarctic scientific research, and many of these recommendations have been incorporated into Antarctic Treaty mechanisms (Cole, 2006; SCAR, 2015¹). In addition to carrying out this primary scientific role, SCAR acts as an official observer to the United Nations Framework Convention on Climate Change (UNFCCC) by attending relevant working groups and meetings of the Intergovernmental Panel on Climate Change (IPCC) which was established in 1988 (UNFCCC, 2014). Alongside UNFCCC the United Nations (UN) supports the assessment of climate change in Antarctica (SCAR, 2015¹). As

SCAR is both scientific and intergovernmental in nature, it embraces a unique opportunity to provide rigorous and balanced scientific information to decision makers. SCAR also provides advice to other organizations regarding conservation issues based on the research that has been undertaken in the region (Cole, 2006).

SCAR is managed by ISCU and involves sending delegates from each nation to biannual meetings (Clarkson, 2006). At these meetings delegates discuss current issues and partnerships with other committees and organisations. SCAR is in partnership with many different organisations, many of which are involved with polar research e.g. International Arctic Science committee (IASC) and the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR). SCAR works alongside the Antarctic Treaty System as many of the members of SCAR are from signatory countries. In addition, SCAR has partnerships with other organisations which specialise in specific areas of research such as ice core sciences or cryosphere science. In the past SCAR has co-sponsored groups such as the International Trans-Antarctic Scientific Expedition (ITASE), who also are involved in Antarctic activities (Summerhayes, 2008).

Conducting scientific research on Antarctica and the Southern Ocean is vital to understanding natural variability, the processes that determine global change and the role of humans in the Earth and climate system (Kennicutt et al., 2014). The potential knowledge to be gained from future scientific research in Antarctica is significant. Therefore, the international Antarctic community came together for the purpose of 'scanning the horizon' with the objective of identifying the highest priority scientific questions that researchers should aspire to answer in the next two decades and beyond.

Horizon scanning

Horizon scanning is a priority setting method that aims to develop issues or questions which are of great global importance (Sutherland et al., 2013). Horizon scanning methodology has been perfected over the last 20 years and is commonly used around the world for a wide array of issues, for example, from ecology to policy options for conservation (Sutherland et al., 2010, Sutherland et al., 2013). Scanning involves the selection of a group of participants to whom is entrusted the responsibility to compile a list of questions or issues to be addressed. These questions and issues are designed to remain valid for the near future i.e. 10-20 years. Other priority setting systems are used throughout the world. Some of these involve similar methods to horizon scans, but others take on a completely different approach. Wide consultation was a fundamental principle for the development

of a co-operative, international view of the most important directions for future Antarctic scientific research. From the many potential scientific issues, the horizon scan identified 80 key scientific questions through structured framework involving a four day retreat for debate, discussion, and revision and voting.

SCAR horizon scan

The horizon scan resulted in the implementation of a renewed spirit of co-operation as advocated by the founders of the Antarctic Treaty in 1959. This horizon scan supports SCAR's vision of leadership in the international Antarctic community, to identify the highest priority scientific questions that researchers should seek to answer in the next twenty years. This has been implemented in SCAR's Strategic Plan (SCAR, 2015¹). On the 31st of May 2013, SCAR conducted its first of two online requests for ideas concerning the future direction of Antarctic and Southern Ocean science. This on-line form was designed to be easy to use in order to make the participation quick and simple. SCAR also did not discriminate on the source and/or affiliation of contributors (SCAR, 2015¹). The aim of SCAR was to gather and broaden the scope of possibilities available for future directions in Antarctic and Southern Ocean science projects. SCAR's horizon scan was developed, organized and managed by an International Steering Committee consisting of 75 leading Antarctic researchers and policy makers. This was the first time the international Antarctic community formulated a collective vision through discussions, debate and voting (SCAR, 2015¹).

The horizon scan saw the narrowing of a list of hundreds of scientific questions (866) to the 80 most pressing ones. The structure of the questions fell largely into seven broad scientific categories; Antarctica's atmosphere and global connections; Southern Ocean and sea ice in a warming world; Antarctic ice sheet and sea level; Dynamic Earth – probing beneath Antarctic ice; Antarctic life on the precipice; Near-Earth space and beyond; and Human presence in Antarctica. The assembled experts drew several conclusions regarding the 80 highest priority questions after a four-day retreat which was held in Queenstown, New Zealand during April 2014. They came to the conclusion that in order to answer these questions it will require long-term stable research, funding, and access to all of Antarctica throughout the year. Also the application of emerging technologies such as remote sensing would be vital to answering these 80 questions as such technologies may gather information via methods that reduce human impact on Antarctica. To secure more funding for these 80 questions there needs to be growth in international co-operation as well as an improvement of communication

between all interested parties. SCAR also realizes that it needs to have improved models to represent Antarctica and the Southern Ocean in the Earth system and a co-ordinated portfolio of cross-disciplinary science (Kennicutt et al., 2014).

Aims of report

This report will reflect on SCAR and the horizon scan. It will answer several key questions. The first of which will briefly touch on SCAR's horizon scan methodology, different horizon scanning systems, how these differ, and briefly examine what other priority setting systems are used in the world. It will also address the limitations to SCAR's current horizon scanning system and discuss some potential improvements. The second question will address the issue of how SCAR could prioritise the final list of questions. Lastly, third question will cover how the framework of the horizon scan can be carried forward in order to achieve the long term goals of the horizon scan.

What other systems are used elsewhere for future casting, and what could be done to improve the process and outcomes of the present Antarctic and Southern Ocean Horizon Scan?

SCAR horizon scan methodology

Individuals were nominated via an online system to partake in the Antarctica and Southern Ocean horizon scan. The International Steering Committee (ISC) appointed by SCAR was responsible for sorting through the nominees and selecting individuals to invite to the retreat via a voting system (Kennicutt et al., 2014). Each of the selected individuals belonged to one of the following categories: geosciences; life sciences; physical sciences; social sciences; humanities; and policy making (Kennicutt et al., 2014). The ISC members were also invited to the retreat (Kennicutt et al., 2014). In total, 75 individuals were invited to the retreat representing 22 different countries. The initial list of questions was submitted to an online solicitation (Kennicutt et al., 2014). The 866 questions were then reviewed over four days by the retreat attendees (Kennicutt et al., 2014). The attendees chose which questions and issue they wanted to address over the four day retreat via a pre-retreat survey.

On day one, attendees removed those questions that were not highly voted upon during the pre-retreat survey (Kennicutt et al., 2014). The remaining questions were then ranked by importance into three categories: gold; silver; and bronze (Kennicutt et al., 2014). By the start of day two, only 249 questions remained. Day two involved sessions for discussions about the importance of particular questions and whether any could be amalgamated or edited to achieve a higher degree of importance and priority. At the start of day three only 162 questions remained. On day three, a single discussion session was held with all participants in attendance to finalise the question list. Following the retreat, the final set of questions was edited to ensure that each question was formatted the same way. The titles for the themes were also further edited and the questions were placed under theme headings, but in no particular order. These 80 questions have been published by SCAR and are the main priority research questions for Antarctic and Southern Ocean research for the foreseeable future. The remainder of the 866 questions have been assigned to a shortlist to be examined when the questions are reviewed after a period of five years (Kennicutt et al., 2014).

Differing horizon scan methods

Horizon scans are a commonly used tool around the globe. Whilst the basic objectives of scans may have many similarities, the methodology can vary greatly. Horizon Scans have been used to produce all of the following: one hundred ecological questions; one hundred priority global conservation questions; UK policy options in conservation; identification of 100 priority questions in global agriculture; and USA + Canada questions for conservation (Kennicutt et al., 2014; Sutherland et al., 2010; Sutherland et al., 2011; Sutherland et al., 2012; Sutherland et al., 2013). Within these scanning systems many different methods were used.

The common methods amongst these scans were the types of participants involved. These included scientists, policy makers, and some individuals from the non-scientific community (i.e. individuals who specialise in the social science). The key aims of the scans, (i.e. to produce either leading research questions or key issues to be addressed), were similar. All scans involved some form of voting and ranking systems, however these differed greatly in methodology. All horizon scans include some form of discussion, but whether this discussion is between large numbers of individuals or a select few varies between scanning systems. Discussion can also take place with members of the public who are not involved in the scanning process. These discussions typically take place at a workshop or retreat over a few days.

Some differing aspects of these scans include the following: the selection process; group sizes; voting style; scope of questions; the number of themes; and ways of eliminating bias. The selection process can involve either direct invitation or invitation via nomination, such as with SCAR horizon scanning recruitment. Invitation by nomination is a way to reduce biasing as a more collective group of people will be selected. Group sizes vary a lot between different horizon scan groups. SCAR's committee consisted of 75 members whereas the USA and Canada scanning teams contained only seven members (Kennicutt et al., 2014; Sutherland et al., 2011). With variations in the size of a group the process of question determination changes. If the group is of a larger size they will hold discussion exclusively within the large group itself. Whereas, if the group is smaller, interviews with other individuals outside of the group are conducted.

Voting is used as a way of ranking questions in order of importance. The way in which voting is conducted varies dramatically between scans. Some scans employ a voting system that uses a 1-10 ranking system, others use 1-1000 (Sutherland et al., 2011). The scope of the questions is determined by the area of interest. If addressing a specific place or issue, the questions may tend to be rather narrow in scope. Whereas, when addressing a whole area of science, or a whole country's policy issues, the questions will tend to be broader. Broad questions are sometimes frowned upon in the voting process as it is believed that broad questions are more likely to receive more votes as they will cover a wider range. Some scans purposely exclude broad questions to avoid such bias. Tied in with the question of scope is the number of themes. If the desired objective of a scan is to cover more areas of interest, there will be multiple themes. For example, there were 12 themes for the 100 ecological questions (Sutherland et al., 2013). If the objective of the scan is to produce narrow questions such as, SCAR's Antarctica and Southern Ocean scan, then fewer themes are required. Eliminating bias is by far the most difficult part to any priority setting system. Great care is taken when selecting individuals to partake in the scan. Further measures are often taken to eliminate bias, for example, voting on questions or issues that individuals may be familiar with. If, in such cases, more than 60% of individuals vote on one question, then that question will be removed from the list (Sutherland et al., 2013). Horizon scanning methodologies are constantly evolving by adapting and taking on ideas from other priority setting systems that are used throughout the world (Sutherland et al., 2011)

Different priority setting systems

Horizon scanning is not the only form of priority setting. In fact there are many different ways in which priorities can be set. A system commonly used around the world is to categorise issues into four different areas of importance, the first category being for those important issues that need to be addressed urgently. The second category will be for issues that are important but considered to be not quite so urgent. The third category is for not so important and not quite so urgent issues. Finally, the fourth category is for those issues which are not considered to be important nor urgent and which can thus be discarded. In order to class different ideas into these categories a list of topics needs to be addressed. For example, cost and logistics need to be taken into consideration to identify if a task is feasible. If the task is possible and of high importance it will be classed as important and urgent. If, however, the task is found subsequently to be infeasible or impossible to address then it will be placed in the not urgent category and it will be discarded.

This method for priority setting and categorising the importance of issues is commonly used throughout the world. Public health systems for example, typically use this priority setting system. They have developed their own way of prioritising issues through the use of importance categories. In particular, the World Health Organisation (WHO) has a priority setting method in place. This involves separating issues into three different categories. These categories are for: issues that require immediate attention; issues that require moderate attention and issues that require only minimum attention (Chalkidou et al., 2013). Within these categories the World Health Organisation rank the issues in order of importance by taking into account their cost, logistics, world impact, international agreements, and the current global health situation (Chalkidou et al., 2013). In order to achieve this, discussions are carried out between groups of specialised individuals within the World Health Organisation rather than during a workshop or retreat as is typically conducted during a horizon scan (Chalkidou et al., 2013). A draft is then written up from the discussions and is sent for review by the board. Stakeholders are then invited to have an input into the document (Chalkidou et al., 2013). A final document is then put in place to cover priority setting for the near future, the most recent document covering the period from 2014-2019 (Chalkidou et al., 2013). The World Health Organisation revises their priority setting methods regularly to ensure that their approach is still valid (Chalkidou et al., 2013). Similar priority setting approaches are used also when it comes to funding for medical research (Thesenvitz et al., 2011). For example, the higher the disease burden, the greater the cost will be to society and therefore such issues will have a greater priority for research (Thesenvitz et al., 2011). The World Health Organisation system can be used as a good model for priority setting. For example, SCAR could take on the WHO method of prioritising issues by

creating categories that reflect the relative importance and urgency of each issue that is under consideration.

Priorities are often set also by getting input from the general public. This takes shape in the form of town hall meetings where important individuals within the community are invited to take part in priority setting meetings. Unfortunately some bias can still occur following town hall meetings as not every individual can be invited to attend the meeting. People from the lower socio-economic classes are less likely to be invited, and this results in an uneven representation of opinions within the community. To overcome this problem, online forums have been used. SCAR themselves used an online forum for nominations and questions submission (Kennicutt et al., 2014). Online forums allow a wider range of individuals to partake in discussions. By setting up internet access at local libraries, almost all members of a town will have the opportunity to gain access to the forum and could therefore participate in the discussion. This would therefore provide the potential for a fair and non-bias priority setting system.

All the aforementioned priority setting systems are designed to address present and future issues. Each system outlined in this report has something in common with another. There is a limit to the different ways in which you can prioritise issues or tasks before all systems become similar. The common trend amongst priority setting systems is to have large discussions amongst a wide range of individuals to gain as many different ideas as possible. Tackling the largest and most costly task first is also a common trend amongst these priority setting systems. SCAR could perhaps benefit from adopting some of the ideas from other priority systems used elsewhere in the world to refine the prioritisation methodology used to conduct their scan. By following a similar approach to the WHO's method of checking the questions against a shortlist of issues, the prioritising of SCAR's 80 questions into categories of great importance, moderate importance and low importance could easily be achieved.

Limitations to the current SCAR horizon scan methodology

The Antarctic and Southern Ocean horizon scan process initiated by SCAR, prides itself on being inclusive and transparent. They have also stressed the fundamental importance of having a wide consultative approach in order to get a shared international view for the future scientific research trajectory of Antarctica (Kennicutt et al., 2014). To achieve this, SCAR tried to ensure a sense of

balance by considering the following factors in their selection process for attendees to the Queenstown retreat: disciplinary expertise; geographical origin; gender; stage of career; and SCAR partnership organisations and stakeholders. The preliminary selection process, however, was initiated by the 25 members of the International Steering Committee (ISC) appointed by SCAR. These, in turn, selected invitees by an online nomination system. As a result, the final list of 75 attendees came from 22 countries and comprised scientists, policy-makers, Antarctic programme managers and early-career scientists. Although, on the surface, this might appear to be a fair way to select attendees, some might argue that it has limitations in that it is a closed system that excludes a larger public input. Members of the world community might well have some great ideas about the future of Antarctica and its environs, and should at least have an opportunity to be heard. For example, should senior high school students be included, who more importantly, present our future decision-makers? SCAR does talk about 'optimising impact and visibility' which some might say has not been applied to the selection procedure. There is a need to raise SCAR's profile to encompass public contributions.

The manner of question selection by means of SCAR's horizon scan method, at first, appears to be quite rigorous. This process involves a series of structured debates, discussions, revision, voting and elimination. However, once these top-priority questions have been fleshed out then what happens next? Kennicutt et al. (2014), describe the SCAR Antarctic and Southern Ocean Horizon scan as a 'roadmap' which implies it leads to a destination. One could argue that this is not the case here. Further guidance on the next steps is lacking and more refinement may be necessary to simplify the process which could perhaps include another round of discussion, ranking and voting to further prioritise the questions. SCAR acknowledges that questions need continual re-assessment and must therefore be forward thinking with an appreciation for emerging trends such as human impact caused by tourism, for example. Another limitation of the horizon scan process is what happens when the initial research questions get answered? Are there potential sub-questions to fill any gaps that may arise in an area of research or does SCAR go to the next level of questions identified in their ranking process? It is not clear from the roadmap how they intend to address this. SCAR, however, has since indicated that they would look to the next level of ranked questions to fill any openings that arise (Kennicutt, personal communication January 23, 2015). Although SCAR admits they need to revise and update questions on a regular basis, this does not actually address what happens when research questions have been answered. A waiting list of the next priority questions could perhaps have a greater profile.

SCAR could also be more proactive in their role as a leading facilitator, co-ordinator and advisor for Antarctic research and offer additional guidance to researchers in their next steps. This, for example, could involve support in developing methodologies and acting as preliminary peer reviewers. There is also a need for improved transparency and accountability by researchers who are successful in obtaining support from SCAR and other bodies. Effective liaisons between National Antarctic programmes, for example, and SCAR might reassure people that they were getting value of money. SCAR admits that there are impediments to international collaboration which need to be diminished. Improved communication between researchers and SCAR, together with the regular revision of questions, could make the whole process more credible to the public. After all, dissemination of findings via outreach and education programmes is an important part of the Antarctic Treaty System (Heap, 1994).

The whole process of the Horizon scan question selection appears to have ignored the major issues attributed to climate change, according to Gales et al. (2014). Gales et al. (2014) believes social changes over the next few decades are likely to have a significant influence on Antarctic study and research priorities and argues that conflict between conservation and resource utilization is inevitable. Climate change also will continually give rise to new research opportunities which, over the next few decades, are likely to indicate the need for strategies that will mitigate or minimise any adverse changes. Although SCAR's mission is to identify emerging trends, this may not encompass some aspects of the climate change debate, as pointed out by Gales et al. (2014). There is a concern that the main thrust of future Antarctic research will be more adaptation-based, for example, geo-engineering. With a warming world and less snow and ice around, accessibility would be easier for exploration and resource extraction opportunities as well as for tourism. These trends are evident already in the Arctic. Fishing sustainability in the Southern Ocean also needs to be considered especially in the light of increased krill catches in response to greater human demand. The cascading effect to other trophic levels in the marine food web will potentially lend itself to more priority research questions. Gales et al. (2014) also expresses concern that the future of the Antarctic Treaty System may well be steered by influential parties in an increasing membership having their own agendas primarily focused on the extraction of resources. By 2048, when the Madrid Protocol on Environmental Protection to the Antarctic Treaty is reassessed, there is the concern that some members undoubtedly will be poised to extract resources (Atkin, 2015). It would appear, therefore, that SCAR's first Antarctic and Southern Ocean horizon scan may need to add a social dimension. This will inevitably raise some new questions and will require also the reprioritisation of some existing key questions.

Improvements to the horizon scan process and outcomes

The final list of 80 questions may still be considered by some to be too large. As mentioned in the previous section on limitations, more refinement may be necessary to simplify the process which could include another round of discussion, ranking and voting to further prioritise the questions. It is also important to recognise that priorities are likely to shift, especially when looking into the future. At the outset, SCAR encouraged participants to focus on the future of science as a whole (Kennicutt et al., 2014). Questions therefore need to be more focused and address things beyond the current state-of-knowledge and to recognise any developing movement such as impacts from climate change. An effective way to manage these needs to be addressed, which needs further discussion.

When deciding the key priority questions, it is important to involve a broad spectrum of people rather than just experts in the field. Some of the scan methodologies described earlier in this report have shown that some individuals can influence decision making in the selection and prioritization process and hence introduce bias (Sutherland et al., 2013). SCAR do emphasise the need to ‘set aside self-interest and short-term needs’ (Kennicutt et al., 2014), which is good, but how do we know if it is applied? Parochialism needs to be avoided at all costs if the process is to have integrity and credibility. Again, some might argue that the system is too closed and needs a public voice. Inclusiveness might make it a fairer arrangement. As mentioned in the previous section, closer monitoring and evaluation of research stemming from the horizon scan needs to be developed. In our ever-changing world, where changes may occur in the relevance of research and tighter reigns need to be held by SCAR, it may be necessary to re-assess some programme objectives. The initial Horizon scan carried out by SCAR included representatives from only 22 countries. Considering there are about 196 countries in the world, 11% global representation seems quite small. Countries that are not part of the Antarctic Treaty System or do not currently express an interest in the Antarctic region should not be excluded. Indeed more effort should be made to embrace them and any ideas they have regarding the future of Antarctica.

Should the final list of questions be prioritized, if so, how?

Yes, SCAR's final list of 80 priority questions should be prioritised further, however, there are many factors to consider in doing so. Prioritization can be subjective in itself and lead to further debate. How it is defined and how things can be prioritized ultimately depends on the context. A few examples have already been given in this report with reference to bodies like the World Health Organisation (WHO). In business, multiple-criteria decision-making or multiple-criteria decision analysis (MCDA) is widely used by analysts when several criteria need to be considered in decision-making (Murat et al., 2011; Triantaphyllou, 2000). In most cases, cost or price is top of the list followed by quality and value for money. With SCAR and their Horizon scan of Antarctica and the Southern Ocean, similar criteria can be applied within this context. Cost is obviously going to be an important consideration when prioritising the order of research questions. The sheer uniqueness of Antarctica and its surrounding ocean present challenges in themselves which means logistics would be another important factor. Other considerations for prioritization include the temporal and spatial nature of research projects and their timeframes. Some programmes may require greater assistance over decades as opposed to over shorter periods? A decision-making model and further debate would be necessary in order to decipher priority. The global significance of the research will also determine where it comes on the list. As Gales et al. (2014) has already pointed out, the social changes brought about by climate change need to be factored in as inevitably there will be shifts in priorities as years go by.

How can the framework developed through the horizon Scan be carried forward?

The horizon scan conducted by SCAR was an excellent start that has set in place a directive for Antarctic and Southern Ocean research for the next twenty years and beyond. The list of 80 priority research questions that resulted from this international and interdisciplinary horizon scan could be considered the preliminary stage directive of what could be a much larger framework that enhances the quality of scientific research and output for Antarctica and the Southern Ocean. There is an opportunity now for SCAR to further refine and develop its scanning method for future use and to focus on developing a broader framework within itself, as an organisation, through various ways of capacity building. This will give SCAR the ability to deliver the support that researchers answering these priority questions will need.

Capacity building is essentially the development and application of various activities that can build the ability of programs and people in order to conduct high quality scientific research. Capacity can be built or enhanced through increasing human resources and/or infrastructure and facilities. For example, one of the ways in which SCAR is currently trying to develop capacity is through early and mid-career scientists. SCAR initiated the SCAR Fellowship Programme which is designed to encourage the active involvement of early career scientists and engineers in Antarctic scientific research, and to build new connections and further strengthen international capacity and cooperation in Antarctic research (SCAR, 2015²). The Visiting Professor program is directed at mid- to late-career scientists and academics whose work contributes to the scientific objectives of SCAR. This program offers them the opportunity to undertake a short-term visit to another SCAR member country to provide training and mentoring (SCAR, 2015²). Successful candidates may contribute their experience towards strengthening the scientific research capacity of nations with smaller or less well-developed Antarctic research programmes (SCAR, 2015²). The goal of this program is to promote capacity building in the host institute and to develop long-term scientific links and partnerships leading to advances in Antarctic research (SCAR, 2015²).

SCAR has also tried to promote capacity building through the horizon scan framework by trying to create priority questions that could be answered using remote sensing techniques. Remote sensing is the use of techniques/methodologies that do not require “boots on the ground” for example, sensing properties by techniques deployed remotely from the site of study. Typically this is via satellite-borne sensors but it may also include airplane-borne or balloon-borne sensors. Other remote sensing equipment may also include UAVs, AUVs and ROVs and the deployment of sensor packages and observatories such as those in used in the ocean on moorings or as floats (Kennicutt, personal communication January 21, 2015). While many scientific questions in Antarctica and the Southern Ocean are already being addressed by remote sensing technologies others need to explore these approaches and technologies especially when answering the future priority questions. Here the objective of SCAR is to reduce environmental impact while enhancing science, and remote sensing can do this by reducing the need for and/or the extent of human presence and activities in Antarctica. (Kennicutt, personal communication January 21, 2015).

Horizon scan capacity building

The improvements previously mentioned in this report with regard to the SCAR horizon scan methodology could be considered as ways of capacity building because they will improve the

efficacy of the scanning methodology and thus the quality of its outputs. The horizon scan was a SCAR initiative and therefore SCAR has an opportunity to further develop its leadership role as a leading organisation in Antarctic and Southern Ocean research by taking responsibility for the next steps after the scan. They need to find some way to ensure that national Antarctic programs will address these questions and this could be achieved by further strengthening their relationship with COMNAP that largely supply the funding to Antarctic research programs. SCAR could actively recruit and mentor emerging national Antarctic programs and/or encourage those countries without Antarctic programmes to develop them and then guide these programs to focus their research efforts on the priority questions highlighted by the horizon scan. SCAR could also develop their data sharing infrastructure by creating an online, openly accessible meta-data base that shares the collective data and results from all research projects working on the priority questions (N.B. recognition of work by others must be made if it is used so that researcher's contributions are acknowledged). This would save research time and money especially if the results help to answer more than one question.

SCAR could act also as a consultant to researchers addressing these priority questions. By this means, SCAR could guide researchers in their development of methodologies and encourage the use of low impact remote sensing technologies. SCAR could act also as a preliminary peer reviewer to their work and initiative already employed by the New Zealand Antarctic Research Institute. This would make use of the collective expertise contained within SCAR and increase the likelihood of research being published in distinguished journals like Nature, Polar Research, and Antarctic Science for example. Having research published in distinguished journals would add further credibility when the science is presented to policy makers. By providing this support throughout the research process SCAR could monitor and review the progress and quality of research projects that aim to answer the 80 priority questions. This would fulfil their mission statement as it would enhance the quality of scientific research and output that is ultimately communicated to policy makers. Kennicutt et al. (2014) describes the horizon scan as a 'roadmap', and by staying involved and engaged in the research process SCAR will carry forward the framework of the scan in the direction they envisage and in doing so achieve their target destination.

SCAR capacity building

There is huge scope for capacity building within the framework of SCAR that, if realised would facilitate the way in which the framework of the horizon scan could be carried forward. In order to

build capacity the financial means to do so must be made available. The revised budget available to SCAR for 2015 capacity building, education and training programs is \$39,700. The funds are spread across four capacity building schemes; SCAR fellowships (\$30,700); SCAR visiting scholar scheme (\$5000); capacity building-early career scientists and general (\$3000); and SCAR secondments (including internships) (\$1000) (SCAR , 2015³). Most of this funding comes from SCAR members, and two awards SCAR has received together with other sources of revenue as they become available (SCAR, 2015²). This shows that if it is to achieve its current capacity building aspirations and those that we recommend in this report, SCAR must make a concerted effort to increase its financial status by developing its methodologies for sourcing funds.

One such avenue that could supply SCAR with the funds to support their current capacity building initiatives and others which are currently not financially feasible would be to approach companies and/or corporations for donations or continuous financial support. SCAR could develop a model where they appeal to the global conscience of companies who are looking to improve their public relations image and mitigate their negative environmental impacts through developing sustainability strategies. In return for donations or continual funding such companies could be proud to say that they are investing in the future of Antarctica. SCAR could then develop a system within its organisational framework to become an intermediary link that recruits funding partners and delivers the money to research programs which address the priority research questions that either the company specifies from the list of 80 priority questions or that SCAR votes on. This process must be kept transparent and unbiased so that all donations are in keeping with the terms of the Antarctic Treaty. To further clarify this, companies offering financial support would not be allowed to dictate any of the details of how the research is conducted or the presentation of results. They would be giving 'no strings attached' financial support and have no other involvement with the research. For example, Air New Zealand has partnered with the New Zealand Antarctic Research Institute (NZARI) as a key component of Air New Zealand's sustainability strategy. This includes a range of operational initiatives aimed at reducing their footprint, and also some conservation projects that contribute to New Zealand's biodiversity (NZARI, 2015).

The NZARI is also funded by philanthropists. This is an avenue that SCAR could also take to gain funding for its research questions. Gaining support from philanthropists such as Sir Richard Branson and Leonardo DiCaprio, who are already ambassadors for the Antarctic Oceans Alliance (a non-governmental organisation which aims to protect the Southern Ocean) (AOA, 2015), would not only help fund the research aimed at answering the priority questions, but also raise significant public

awareness due to the high profile/celebrity status of such individuals. Similar to sourcing funding from companies, SCAR could also form funding alliances or partnerships with other non-governmental organisations like Greenpeace. For example, Greenpeace would take a percentage of the donations it receives and donate it to SCAR specifying which research questions they want it to support based on what they think matters most to their organisation and members. In return, Greenpeace could distribute the scientific information after it is published to their members via newsletters in language they can understand. This would not only fulfil their member's global conscience (they know their money is going to address questions they want answered in order to bring about the change they want to see in the world) but it would also educate them and enhance their understanding of Antarctica and the Southern Ocean processes by providing them with credible scientific information. By supporting scientific research and having access to it Greenpeace would be able to redefine and further legitimise their global image as they would have more scientific credibility to their claims. Furthermore, by partnering with a scientific body such as SCAR, Greenpeace would increase their power to petition policy makers and effect more change.

As well as securing funding for its priority research questions SCAR should also continue to focus on its development of early and mid-career scientist schemes mentioned previously. This area of capacity building needs more funding. There needs to be more opportunities available within SCAR for a greater number of early career Antarctic and Southern Ocean specialising scientists. SCAR could perhaps host more workshops and symposiums and further develop mentoring schemes. They could perhaps obtain funding from the sources suggested above, as well as from scientific journals. Scientific journals could help fund these SCAR capacity building initiatives and/or supply scholarships for example. By investing in the development of early career scientists they would essentially be investing in the quality of future scientific research and material that might be published in their journals. SCAR should also develop similar schemes for early career artists, especially documentary makers and musicians, as they can communicate the same information via different mediums to those people who do not relate to scientific information. By incorporating artists SCAR could reach and impact a much wider audience and so this is something SCAR should incorporate into their capacity building scheme.

In order to increase their global visibility SCAR must increase public awareness. Public support would help strengthen the ability of SCAR to influence policy makers and thus the decisions that will ultimately determine the future of Antarctica and the rest of the world. There are many ways SCAR could achieve greater public awareness /recognition. Currently SCAR does have several social media

platforms which include Facebook, Twitter, Google+, and YouTube. However, the use of these social media tools is not being fully realised. For example, the SCAR Facebook group currently only has approximately 2,317 members, and there are two members and eight subscribers on Twitter; 63 followers and 8,490 views on Google+; and 12 subscribers and 1,211 views on YouTube since 2012. In a social media driven world these numbers are very low, and more needs to be done to increase the amount of followers on each of these platforms particularly as social media is one of the most effective tools in existence for reaching large numbers of the public on a global scale. Effectively seeking out and utilizing media opportunities would be another effective way for SCAR to communicate with the public.

Recent media coverage of the SCAR horizon scan last year in New Zealand missed an important opportunity to inform the public that it was a process they could have been involved with, the results of which will inevitably impact their future. New Zealand is a small island state that is directly affected by Antarctic and Southern Ocean processes and what happens there is of great significance to New Zealand, as its impacts will be felt. SCAR could have used this opportunity to provide links to its website and social media platforms to gain more followers and educate the general public about the important role SCAR plays, but no mention of these were made during the news bulletin or the written articles about the SCAR horizon scan. SCAR could also raise its global profile and awareness about Antarctic research through other media outlets such as science programs on national radio and/or getting speakers to deliver TEDx Talks. The TEDx Program is designed to help communities, organizations and individuals to spark conversation and connection through local TED-like experiences (TED, 2015). TEDx events consist of either a screening of TED Talks videos or a combination of live presenters and TED Talks videos which aim to spark deep conversation and connections at the local level. TEDx events are planned and coordinated independently, under a free license granted by TED (TED, 2015). This could be a good crowd sourcing capacity building tool for SCAR.

SCAR also needs to move away from parochialism and create a subsidiary online public membership that is separate from the current SCAR membership. Currently members of the public can only subscribe to SCAR newsletters. A formal membership (that is subsidiary to the existing form of membership) could offer a unique opportunity for members of the public to fulfil their global conscience principles by allowing them the opportunity to participate in online discussion forums, and/ or sponsor research projects of their choice through online donations (one off, regular payments or bequests). SCAR would be responsible for the delivery of this money to the relevant research

programs. Members could have the opportunity to become local ambassadors that could be tasked with raising donations and awareness within their communities (similar to Greenpeace members). Members of the public would feel good knowing that they were helping in their own way to achieve the wider global goal of answering the top priority research questions in order to advance scientific discovery in the Antarctic and Southern Ocean. What happens in this region is intrinsically tied to their future. SCAR could advertise this membership globally through magazines such as National Geographic, and New Scientist, and through universities and science societies, (e.g. the New Zealand Antarctic Society or the Ecological Society of New Zealand,) and at events such as Ice fest.

Finally, SCAR needs to strengthen the role of its area delegates, or create ambassadors in order to raise their profile and get them interacting within the community more. For example, they could travel around science societies, schools (primary and secondary) and universities to educate staff and students and raise awareness of science in Antarctica, how it relates to them, and what they could do in the future to be involved. SCAR could openly invite all students around the world, who might be enrolled in Antarctic programs, to join LinkedIn (which currently has only 857 members) or similar networking sites as a way for early career scientists to network and build Antarctic research relationships and opportunities. SCAR could also improve their website by making it more user friendly, interactive and captivating to attract and engage younger members of the public. Young people in particular are our future and will ultimately be the ones who will be affected by changes to the Antarctic and Southern Ocean and therefore, it is important for them to feel a part of what is going on by allowing them the opportunity to become involved.

Conclusion

In summary, SCAR's Horizon scan could be improved by being more inclusive and representative of public and global opinion, and more effort should be put into recruiting people from more countries in the original horizon scan process. The key questions could be further refined and should encompass social change forecasts brought about by climate change and should avoid conflict between conservation and resource utilization. SCAR should also be prepared to be more proactive in acknowledging and acting upon shifting priorities in global issues and attitudes. The 'roadmap' produced by Kennicutt et al. (2014) could be more definitive to enable researchers to take the next steps by benefiting from extra support and consultation from SCAR. Inevitably, cost will be the key

prioritizing factor but other aspects such as logistics, spatial and temporal research projects as well as future global importance should be continually reviewed when establishing the order of importance of research ideas.

In order to develop and take the framework provided by the horizon scan forward on the scale it demands SCAR needs to first build capacity within itself. It is imperative that SCAR makes a concerted effort to develop its capacity to source funding, because without the resource of money SCAR can effect very little change to its current structure and functional capabilities. It is also important for SCAR to increase its global visibility and this will be achieved through capacity building strategies that will raise public awareness. Scientific research in Antarctic and the Southern Ocean will only be supported and valued if people and policy makers are educated about it, its significance to the global ecosystem, and how this relates to the everyday lives of people and their future. SCAR has the potential to realise their vision for the future of Antarctic and Southern Ocean scientific research but it will involve many changes, some being fundamental to the way they currently function. The first step will be to adopt a new way of working so that the science is not constrained by what SCAR thinks they can achieve with existing support but be further developed to achieve what the science questions demand.

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