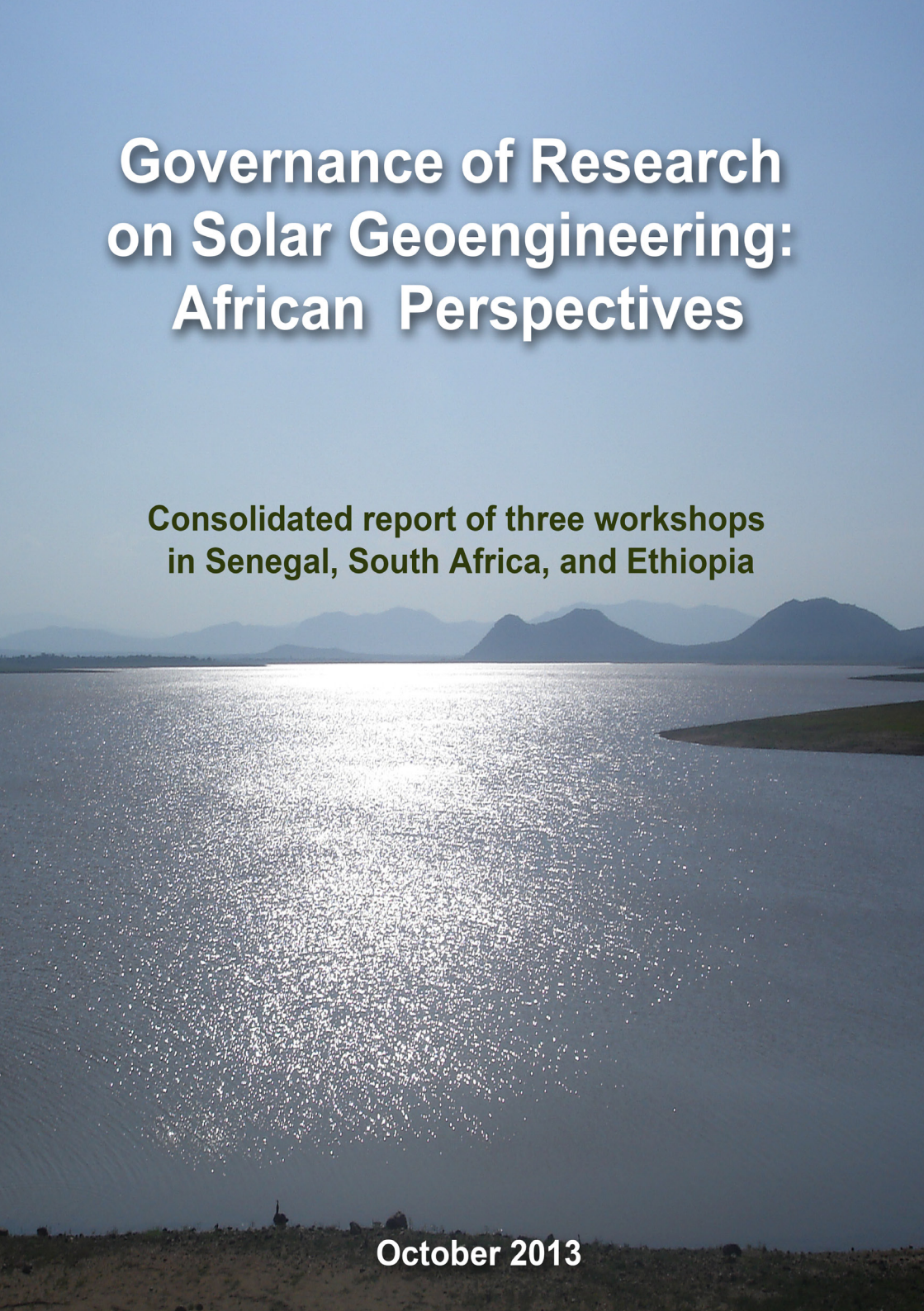
Governance of Research on Solar Geoengineering: African Perspectives

Consolidated report of three workshops in Senegal, South Africa, and Ethiopia



October 2013

In memory of Professor Joseph Massaquoi, a distinguished scientist, esteemed leader and beloved colleague. His presence, wit and brilliant mind will truly be missed.

Cover photo by Adams Namayi. The front cover image is a shot taken at the Ndakaini dam about 80km north of the capital Nairobi.

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Acronyms

AAS	African Academy of Sciences
ANSTS	Académie Nationale des Sciences et Techniques du Sénégal
AMCEN	African Ministerial Conference on the Environment
AU	African Union
EDF	Environmental Defense Fund
GHG	Greenhouse gas
IPCC	Intergovernmental Panel on Climate Change
NGO	Non-governmental organisation
SRM	Solar radiation management
SRMGI	Solar Radiation Management Governance Initiative
TWAS	The academy of sciences for the developing world
UN	United Nations
UNESCO	United Nations Educational, Scientific and Cultural Organisation
UNFCCC	United Nations Framework Convention on Climate Change

Project Partners

The African Academy of Sciences (AAS) is an honorific society. Through its fellowship, AAS recognises Africa's best achievers not only in science and technology, but also in other fields. Founded in 1985 with 33 founding Fellows, the membership has over the years grown to 250 Fellows in 36 African countries. The overall goals of AAS are to strengthen science and technology (S&T) capacity, to mobilise S&T resources in the continent and among the African diaspora, to stimulate problem-solving research and development in the pivotal areas of the continent's development, and to market the Academy's activities widely for greater impact on African social development and economic growth. For more information, see *www.aasciences.org*

The Solar Radiation Management Governance Initiative (SRMGI) is an international non-governmental organisation (NGO)-driven initiative launched in 2010 and co-convened by Environmental Defense Fund, the Royal Society, and TWAS, the academy of sciences for the developing world. SRMGI aims to foster an inclusive, interdisciplinary and international discussion on how research into solar radiation management (SRM) technologies could be governed, and seeks to bring in new voices and perspectives, particularly from the developing world. Governance of SRM research, rather than deployment, is the focus of SRMGI. The long-term objectives of SRMGI are to build a diverse community of well-informed international stakeholders, and to encourage international cooperation and transparency over SRM research governance. To access additional materials from the workshops described here, please visit the SRMGI website, *www.srmgi.org*

Environmental Defense Fund (EDF), a leading US non-profit organisation, creates transformational solutions to the most serious environmental problems. EDF links science, economics, law, and innovative private-sector partnerships. For more information, see *www.edf.org*

The Royal Society is a self-governing Fellowship of many of the world's most distinguished scientists drawn from all areas of science, engineering, and medicine. The Society's fundamental purpose, as it has been since its foundation in 1660, is to recognise, promote, and support excellence in science and to encourage the development and use of science for the benefit of humanity. For more information, see *www.royalsociety.org*

TWAS, the academy of sciences for the developing world, is an autonomous international organisation based in Trieste, Italy. Administered by UNESCO and primarily funded by the Government of Italy, TWAS's principal aim is to promote scientific capacity and excellence for sustainable development in the South. For more information, see *www.twas.org*

Foreword

The fourth report from the Intergovernmental Panel on Climate Change, released in 2007, concluded that warming of the Earth's climate system is unequivocal. In addition, the authors agreed that most of the observed increase in global temperature since the mid-20th century can be attributed to increases in greenhouse gas concentrations from human activities.

Against this background, international negotiations aimed at curbing greenhouse gas emissions are progressing slowly, while emissions themselves continue to rise. For these and other reasons, interest in 'solar radiation management' (SRM) research is growing, as people seek to understand more about the possibility of cooling the Earth by reflecting away a small amount of incoming solar radiation.

Scientists are therefore trying to understand the possible effects of aerosols in the upper atmosphere, or brightening clouds using seawater sprays. Small-scale outdoor experiments have also been proposed. SRM research would be needed, some scientists argue, if, for example, nations cannot agree on reducing greenhouse gas emissions, or the Earth was to suffer from run-away climate change.

As explained in this report of a series of three workshops carried out across the African continent during 2012 and early 2013, such interventions could be relatively cheap to deploy, would take effect quickly and would have global implications. There is, therefore, an urgent need for discussion amongst all stakeholders concerning how, if research progresses from the laboratory to the field to potential deployment, such research should or could be regulated and scrutinized.

There is also a need to sensitise various constituencies, including scientists, non-governmental organisations, policymakers and others, to this new and little-understood concept of 'geoengineering', especially in the developing world where such discussions are yet to take hold to any significant degree.

To raise exactly these issues, the African Academy of Sciences, in partnership with TWAS, the academy of sciences for the developing world, the Royal Society, and the Environmental Defense Fund (which together lead the Solar Radiation Management Governance Initiative, SRMGI), organised a series of workshops across Africa. Funding for this initiative was graciously provided by the IAP - the global network of science academies (formerly InterAcademy Panel).

The diversity of expertise assembled for these meetings ensured that discussions were wide-ranging and informed. In addition, the format of the meetings was designed to enable participants to tease out and develop a number of key themes, many of them with a distinctly African flavour. We believe that these discussions, summarised here, confirm not only the value of the project, but also the fact that such a project was required – and indeed essential – to kick-start this increasingly important and newsworthy science policy discussion.

We thank all those who contributed to making the meetings a success and hope that, through the publication of this report, the results of the three workshops will reach a wider audience and help introduce the debate to an ever-growing number of people both within and beyond the scientific and policy-making communities.

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- Mr Alex Hanafi, Attorney, EDF, USA;
- Prof Joseph Massaquoi, Director of UNESCO Regional Bureau of Science and Technology in Africa, Kenya;
- Prof Aberra Mogessie, President of the Geological Society of Africa (GSAf), Austria/Ethiopia;
- Prof Ahmadou L. Ndiaye, President of AAS and also of ANSTS, Dakar, Senegal;
- Prof Richard Odingo, former Vice President of the IPCC; Kenya;
- Mr Andy Parker, Research Fellow, Harvard Kennedy School, USA;
- Prof Gregoire Sissoko, l'Université Cheikh Anta Diop, Senegal.

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- Ms Olivia Osula, African Academy of Sciences, Kenya;
- Dr Benjamin Gyampoh, African Academy of Sciences, Kenya.

And to the members of the SRMGI organising team:

- Ms Cassandra Brunette, Research Analyst, EDF, USA;
- Mr Alex Hanafi, Attorney, EDF, USA;
- Dr Peter McGrath, Programme Officer, TWAS, Italy;
- Mr Andy Parker, Research Fellow, Harvard Kennedy School, USA.

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Executive Summary

This report summarises the results of a series of three workshops, held in Africa in 2012 and early 2013, on the governance of research into solar radiation management (SRM). SRM (also known as solar geoengineering) is a set of theoretical proposals for cooling the Earth by reflecting a small amount of inbound solar energy back into space, in order to counteract the impacts of climate change. It has been gaining increased international attention, due in part to the slow progress of international negotiations over reduction of greenhouse gas (GHG) emissions.

The basic characteristics of SRM make it very controversial. It would probably be cheap to deploy and could cut the rate of global warming (or even reduce the Earth's temperature) within a few months of deployment, and might therefore be the only way to cool the planet in the short to medium term. However, its effects could not be restricted to one country, and the benefits and drawbacks of SRM methods are unlikely to be evenly distributed across regions. There are also many uncertainties concerning the physical and socio-political risks, feasibility, and impacts of SRM.

SRM could be helpful or harmful for managing climate risks, but not enough is known to understand its full implications

In short, SRM could be helpful or harmful for managing climate risks, but not enough is known to understand its full implications. If efforts to reduce global GHG emissions prove insufficient to prevent severe disruption of the Earth's climate, it will be necessary to understand what other intervention options may exist and what the implications of deploying them may be.

Even SRM research has the potential to be very politically divisive. What research should proceed and when? Who will fund, conduct and oversee that research? Good governance mechanisms can help make sure that any research that proceeds is safe, transparent, inclusive, and responsible, while also encouraging international cooperation. However, there are few governance guidelines or rules under existing international treaties, institutions, or regimes that are directly relevant to managing SRM research.

Most discussions about governance to date, as well as most research activities, have taken place in developed countries. SRM is a technique with global implications and developing countries need to be included in international discussions about research and governance activities. People in developing countries are often most vulnerable to environmental change, and therefore stand to gain or lose the most from SRM.

To lay the foundations for African engagement, the African Academy of Sciences (AAS), in partnership with the SRM Governance Initiative (SRMGI), held a series of three workshops in Senegal, South Africa and Ethiopia on SRM research and governance. The purpose of the workshops was to introduce African stakeholders to the concept of SRM, to seek opinions and ideas on how research of SRM might be governed, and to create the conditions for more sustained engagement on SRM research governance in Africa.

Naturally, meeting participants shared a very wide range of ideas and opinions on SRM and its governance, and it is impossible to do justice to them in this short summary. Some general observations can be made, however. Unsurprisingly, SRM received neither widespread support nor opposition, with participants generally lending cautious support to research but diverging over what research should be permitted to proceed, when and how. Many participants spoke in favour of a staged approach to research, where checks and balances prevent a rush towards large or risky tests of SRM.

There was strong support for continued African capacity-building in this area, so that African experts, policymakers and civil society will be able to make up their own minds about SRM. Many participants emphasised the importance of international cooperation within Africa. Based on ideas put forward by participants, AAS is considering setting up an expert committee on SRM to advise, among other things, on how AAS might continue its work on SRM (For more information see Section 5.3). It is hoped that this report can act as a source of ideas and encouragement for anyone considering similar work.

1. What is Solar Radiation Management?

Solar radiation management (SRM, also called solar geoengineering) is a theoretical proposal for cooling the Earth by reflecting a small amount of inbound solar energy back into space. Proposed techniques include injecting sulphate particles into the upper atmosphere (mimicking the natural cooling effect of large volcanic eruptions) or brightening existing marine clouds by spraying seawater into them.[1]

There has been increased interest in SRM in the last few years as people have grown more concerned about the slow pace of global climate talks, and have started to explore what options might exist if greenhouse gas (GHG) emissions are not reduced far enough or fast enough. The limited research done to date on SRM (mainly computer modeling),[2] indicates that it is likely that:

- it could reduce global temperatures very quickly, within a few months of deployment;
- it could reduce (but not eliminate) regional temperature and precipitation changes due to climate change, with a minority of areas potentially experiencing greater or opposite changes; and
- it could be deployed cheaply (relative to the cost of reducing GHG emissions); but it would mask only some of the effects of increased atmospheric levels of GHGs and thus is not comparable to and not a substitute for reductions in GHG emissions;

but

- there would be unanticipated side effects, both physical and socio-political, as there is a high level of uncertainty about the impacts of the proposed interventions; and
- without reductions in the atmospheric concentrations of GHGs any SRM intervention would need to be sustained for a long time and there would be a large and rapid climate change if it were terminated suddenly.

[1]Royal Society (2009). Geoengineering the climate: science, governance, and uncertainty. London: Royal Society. http://royalsociety.org/uploadedFiles/Royal_Society_Content/policy/publications/2009/8693.pdf

[2]See for example,

Caldeira K. & Wood L. (2008). Global and Arctic climate engineering: numerical model studies. Phil. Trans. Roy. Soc. A, 366, 4039–4056; doi:10.1098/rsta.2008.0132.

Ricke K.L., Morgan M.G. & Allen M.R. (2010). Regional climate response to solar radiation management. Nature Geosciences, 3: 537–541; doi: 1038/ngeo915.

Schmidt H., Alterskær K., Bou Karam D., Boucher O., Jones A., Kristjánsson J.E., Niemeier U., Schulz M., Aaheim A., Benduhn F., Lawrence M. & Timmreck C. (2012). Solar irradiance reduction to counteract radiative forcing from a quadrupling of CO_2: climate responses simulated by four earth system models. Earth Syst. Dynam. 3, 63–78.

Jones A., Haywood J., Boucher O., Kravitz B. & Robock A. (2010). Geoengineering by stratospheric SO_2 injection: results from the MetOffice HadGEM2 climate model and comparison with the Goddard Institute for Space Studies Model E. Atmos. Chem. Phys. 10, 5999–6006; doi: 10.5194/acp-10-5999-2010.

These basic characteristics of SRM make it very controversial. Since it appears likely that SRM could reduce global temperatures quickly, it might be the only option for preventing unexpectedly rapid global temperature increases, if that was deemed necessary.

However, deployment of SRM would also likely have unintended and undesirable side effects, and both the positive and negative effects would likely not be restricted within national borders. Notably, SRM does not present a solution to the impacts of rising GHG concentrations that are not related to temperature (e.g. ocean acidification) and is not an alternative to conventional mitigation, as it does not treat the cause of anthropogenic climate change.

In summary, SRM has the potential to be very helpful or very harmful in managing climate risks, but not enough is known yet to understand its full implications.

President of the African Academy of Sciences, Prof Ahmadou L. Ndiaye, introduces the workshop in Dakar, Senegal

2. Project Background and Objectives

SRM is a new topic of enquiry, and most research and discussions to date have taken place in Europe and North America. With both the technology itself and governance mechanisms to regulate field research still in their infancy, debate is likely to continue to grow around the desirability and acceptability of research into deliberate large-scale human intervention in the Earth's climate.

However, SRM would have global implications if deployed, and it is important for all regions of the world to participate in international discussions of current science and governance issues. Developing countries are often most vulnerable to environmental change, and therefore stand to gain or lose the most from SRM. Indeed, according to the Intergovernmental Panel on Climate Change (IPCC), "Africa is one of the most vulnerable continents to climate change and climate variability, a situation aggravated by the interaction of 'multiple stresses', occurring at various levels, and low adaptive capacity".[3] Likely impacts include lower crop yields, increased areas of land unsuitable for agriculture, increased water stress, sea-level rise, and further spread of infectious diseases, among others.[4]

Some discussion has occurred about whether SRM technologies might be able to offer at least some protection for Africa against otherwise unchecked temperature-related impacts of climate change

Some discussion has occurred about whether SRM technologies might be able to offer at least some protection for Africa against otherwise unchecked temperature-related impacts of climate change.[5] Yet the relative risks and impacts of SRM technologies on other aspects of climate and the environment in Africa remain uncertain, due in part to the very limited amount of scientific research carried out thus far into SRM. Thus, any evaluation of whether African societies and ecosystems would be 'better off' with one type of climate change or another remains highly uncertain, and the subject of debate. In sum, there is a need to explore the opportunities and dangers posed to Africa by the emergence of the novel issue of SRM.

Recognising that early African engagement could help ensure African concerns and issues contribute to shaping international and scientific policy agendas related to SRM, the African Academy of Sciences convened a series of three workshops in Africa on SRM research governance. The workshops were funded by the IAP- the global network of science academies- and were run in collaboration with the SRM Governance Initiative (SRMGI). SRMGI is an international NGO initiative convened by TWAS, the academy of sciences for the developing world, Environmental Defense Fund (EDF) and the Royal

[3]IPCC Fourth Assessment Report: Climate Change 2007, Chapter 9, at 435 (2007), available at http://www.ipcc.ch/pdf/assessment-report/ar4/wg2/ar4-wg2-chapter9.pdf.

[4]Id, pg. 435

[5]Ayalew, M.M. and Gasc F. 2013. Managing Climate Risks in Africa: The Role of Geoengineering. *Geoengineering Our Climate? Ethics, Politics and Governance.*

Society that seeks to increase international dialogue over SRM, and has organised previous workshops in China, India, Pakistan, Singapore, and the UK. Additional funding and logistical support for the meetings was provided by UNESCO and the Académie Nationale des Sciences et Techniques du Sénégal (ANSTS).

Three workshops were held in:

- Senegal, June 2012, at the annual meeting of ANSTS;
- South Africa, November 2012, at the South African National Conference on Global Change; and
- Ethiopia, January 2013, at the 24th Colloquium of African Geology (CAG24).

The objectives of the workshops were to introduce African stakeholders to the concept and implications of SRM, to seek opinions and ideas on how SRM research might be governed, and to create the conditions for more sustained engagement in Africa on SRM research governance. In each workshop, participants were encouraged to engage in the discussions and explore their views and opinions together. In this way, the workshops were designed to foster the development of a cadre of African experts (scientists, ethicists, lawyers, journalists, etc.) who are aware of the issues relating to SRM, and to build a foundation in Africa for an informed and cooperative future global dialogue on SRM research governance that includes more African perspectives.

Participants in Dakar, Senegal break into groups to discuss workshop exercises

3. Project Ethos and Participants

The project workshops were run with an approach and ethos developed at previous meetings by SRMGI for encouraging dialogue on SRM:

- Workshops emphasise participant interaction and engagement, seeking the thoughts and perspectives of local stakeholders rather than telling them what to think;
- It is explicit that group consensus is not sought, and participant opinions are instead explored and recorded. SRM remains poorly understood and characterised so it is too early to try to come to agreement over all aspects of its development and governance. Forced conclusions at this stage could be premature and unproductive.

As with previous SRMGI meetings, participants at all three workshops responded well to this approach, with many reporting that they were pleased to be engaged openly and asked for their input, rather than subjected to lectures.

The organisers tried to attract a wide range of stakeholders to each workshop, and participants across the workshop series included academics, policymakers, representatives of NGOs, the media, and members of the public who saw advertisements in local newspapers. The series of workshops attracted over 100 participants from 21 different African countries. It is perhaps inevitable that the single group most strongly represented was scientists, as the meetings – while open to all interested participants – were held in conjunction with scientific conferences, and since much of the discussion of SRM has been in scientific circles.

Participants in Addis Ababa, Ethiopia explore governance options in workshop exercises

4. Workshop Presentations

Speaker availability, participant numbers and workshop length dictated the specific agendas of the three workshops (see Appendix I for agendas and speaker lists), but they all followed the same core format. As participants came from a range of different backgrounds and had widely varying levels of knowledge on climate change and geoengineering, introductory presentations were given on:

- Climate change and Africa; and
- The science and governance of SRM.

These were followed by brief comments from responders, then group exercises and plenary discussions to provoke open discussion, including:

- The 'line exercise'; and
- Next steps for Africa.

4.1 Climate Change and Africa

In order to understand the context in which scientists explore SRM, each workshop opened with a presentation of climate change in Africa. It covered current environmental pressures, projected changes and population growth, and the threat that climate change poses to people, ecosystems, and economies.

More would need to be known about SRM if it is to be determined whether it could enhance or degrade African efforts to address climate change and poverty

The presentation reviewed actions being taking across Africa to address environmental threats and in particular the Action Plan of the Environment Initiative of the New Partnership for Africa's Development (NEPAD), an African Union strategic framework for pan-African socioeconomic development. It also considered African science and technology capabilities, noting the growing number of success stories for African science, including:

- The Nigerian space programme, with four satellites in space;
- The Square Kilometre Array (SKA) telescope, a joint venture between South Africa, Botswana, Ghana, Kenya, Mauritius, Mozambique, Namibia, and Zambia;
- The Cameroonian-designed touch-screen medical tablet (the Cardio pad), which enables medical examinations to be performed remotely.

The presentation noted the need for African nations to continue developing their science and technology capabilities in order to become global players. It finished by reflecting that more would need to be known about SRM, and the issue debated more within Africa, if it is to be determined whether it could enhance or degrade African efforts to address climate change and poverty.

4.2 The Science and Governance of SRM

This presentation began by introducing the climate context that has led some scientists to start researching SRM, highlighting IPCC projections for global temperature rises, and exploring how the Earth is already committed to decades more of warming due to GHGs already released.

Reviewing the basic science of SRM, the presentation described how it might work, and reported the findings of computer modeling studies. It went on to discuss the possible physical risks from SRM, as well as the numerous potential socio-political risks. It made clear that SRM does not present a solution to climate change or an alternative to conventional mitigation, as it does not address the cause of warming (rising GHG concentrations).

Given that SRM has the potential to be helpful or harmful, but it is not yet possible to know which, good governance has a large role to play in making sure that SRM research is safe, transparent and responsible. The presentation raised some important governance questions without seeking to resolve them.

For example, how can it be ensured that geoengineering research and its results are transparent, and where possible, conducted with international cooperation? There is also much disagreement over the different governance arrangements that might apply to different forms of research. Very few people argue for a ban on indoor research (such as computer modeling) and very few people are in favour of large scale testing of SRM at this early stage when there is still so much that is not understood. However, how to govern research in between these extremes, and whether it should go ahead at all, is contested. Some people argue that no research outside the laboratory should be allowed until there is a global governance regime in place to oversee all activities. Others disagree, pointing out that there is much outdoor research that would be safe and that could help determine risks of and need for future research.

The presentation concluded by introducing important questions for participants to consider, such as:

- Who should govern SRM research at the local, national, and international levels?
- What is the role of the United Nations in governing SRM research, and which part of the UN should have that responsibility?
- How can African institutions play a bigger role in decisions about SRM research, and research governance?

5. Group Discussion and Participant Views

The same facilitated group exercise (the 'line exercise') was used at each workshop to help familiarise participants with potential governance scenarios and to encourage them to share opinions on SRM development. Participants were given different possible scenarios (ranging from full-scale deployment, to low-risk process tests of technologies outside the laboratory, to computer-based laboratory research) and asked where they would place such activities on a theoretical line between "facilitation" and "prohibition":

Facilitate Regulate Prohibit

There are no right or wrong answers to this exercise. It is merely designed to allow participants to explore their views and underlying assumptions about different possible SRM activities. The exercise was effective in stimulating feedback and ideas at each workshop.

Sections 5.1 and 5.2 summarise some of the views and insights that were shared at the workshops. The views were sorted into two broad categories (5.1 The Governance of Different Types of Research and Deployment, and Mechanics of Governance and Public Engagement, and 5.2 Mechanics of Governance and Public Engagement) and are accompanied by selected participants' quotes. A full list of comments (edited for clarity and repetition) appears in Appendix II. Because there was no immediately perceptible convergence of views among participants at any one workshop, there is also no immediately perceptible difference in attitudes between the three different workshops. As a result comments below are not attributed to specific workshops.

5.1 The Governance of Different Types of Research and Deployment

It is unsurprising that at this early stage, where SRM's potential benefits and drawbacks are not fully characterised, there is a wide range of opinion on the technologies and how research should be governed. Some of the first comments voiced in the workshop series demonstrated two of the very different recurring views on SRM:

> *"SRM is an opportunity and we should not ignore it since Africa has made little progress to engage developed countries to subscribe to legally binding [GHG] agreements."*
>
> *"By coming up with SRM the West is seeking solutions for unanticipated results, i.e. a 'plan B' to solve the problem."*

There was no clear emerging picture on desirable governance arrangements, let alone a consensus. The greatest level of agreement amongst participants came on the more extreme cases, for example with a widely expressed support for 'indoors' research into SRM:

> *"Indoors research must be facilitated effectively by universities and governments. Governments must provide the needed support for such studies to be undertaken."*

There was also a high degree of support for the idea that deployment-scale activities are not necessary at this stage and that heavy regulation would be necessary if they were to proceed:

> *"An independent global technical body must be responsible for assessing the risk of large scale SRM deployment before it can be considered."*
>
> *"Deployment of SRM should be heavily regulated. The injection of aerosols into the stratosphere should be regulated on a global scale by a global body."*

Views on research between indoor laboratory studies and full scale deployment were most varied. Some ideas included:

> *"Experiments should start indoors; African nations may need to understand results from indoor experiments and the mechanisms of regulation before any outdoor tests can be considered."*
>
> *"Research and development of small scale outdoors research must be facilitated and also regulated. It is only at this scale of research that needed information can be collected for informed decision making. Development of the technology may have cross-boundary consequences and therefore regulation at both the national and international level could be beneficial."*

Workshop participants discuss research governance in Addis Ababa, Ethiopia

5.2 Mechanics of Governance and Public Engagement

After governance scenarios had been explored using the 'line exercise', participants were asked follow-up questions in small groups or via a plenary facilitator to probe underlying assumptions about research and governance, and to encourage discussion of specific governance arrangements. Again, some concepts (particularly public oversight, transparency, African involvement and stakeholder engagement) received broad participant support, with specific comments including:

> *"Verification of experimental results should be done by independent evaluators, who will be honest about the good or damage of the SRM process."*
>
> *"There should be transparency of those involved in the research and development of SRM, including their research objectives and sources of funding."*
>
> *"Participation of indigenous African people should also be considered."*
>
> *"Power relationships, gender, and cultural aspects should all be included in governance discussions, so that they reflect the true makeup of African society."*

Discussions also raised some specific proposals for research governance:

> *"Irrespective of whether regulation is done globally, each developing world region should be empowered through bottom-up approaches to play a key role in regulation."*
>
> *"The World Meteorological Organisation should be involved in governance of outdoors research."*
>
> *"SRM should likewise be overseen by a newly formed institution, ideally with veto power resting on Africa and other countries most vulnerable to climate change."*
>
> *"The UN should take the responsibility of addressing SRM since poor climate change management can cause conflict."*

5.3 Next Steps for African Engagement with SRM Research Governance

At all three workshops, following the 'line exercise' and subsequent open discussions, attention turned to possibilities for African engagement. Participants considered how African countries, experts, policymakers and civil society might participate in SRM research governance.

In general, participants agreed that it will be important for African stakeholders to be actively involved in deliberations on SRM research governance, but that capacity-building would be necessary to make this possible. Participants stressed the need for

a sensitisation period for all stakeholders, not only experts, which would allow more informed public discourse on SRM. Several people called for more meetings along the lines of this workshop series, to continue to build awareness and bring more people into the discussion. Many also saw the workshops as a potential springboard for getting Africa involved at the early stages of the debate on SRM research governance.

> *"It is desirable to develop the capacity of African experts (scientists, social scientists, and NGO representatives) to enable them to advise their governments and create networks among African scientists and other scientists around the world."*
>
> *"Awareness creation, sensitisation and capacity building in SRM are very important. There should be a programme for awareness creation and sensitisation."*

There was also widespread support for increasing the capacity of African scientists to research and teach topics related to SRM, and participants suggested that this should be done through existing institutions rather than newly invented ones. Given that most of the research into SRM is currently done in the USA and Europe, some participants highlighted the needs for African research looking particularly at the implications of SRM for Africa.

> *"If Africa wants to get involved in SRM research it should start with institutions already in place, i.e. climate research institutions. It does not make sense for Africa to reinvent the wheel, but work with pre-existing structures."*
>
> *"Research on SRM should be mainstreamed in African universities, to develop a base for understanding of SRM across the continent."*
>
> *"We need research by sociologists and other social scientists."*
>
> *"There is need for research in Africa that is relevant for Africa."*

At the first workshop in Senegal, which was also the best-attended and most in-depth workshop, participants developed specific suggestions for how to increase African engagement with SRM. These were then critically reviewed at the South Africa and Ethiopia workshops, and shaped further. There was typically less agreement on specific ideas and on the political side of African engagement, such as a potential role for the African Union (AU):

> *"A short online course on SRM should be developed and distributed to scientists to acquaint them with the technique."*
>
> *"The AU has established a Pan African University and Centres of Excellence in different countries. The Centres of Excellence in Nairobi and AAS can discuss jointly on how to incorporate SRM as a major component of research. SRM research should have a base in the Pan African University."*

"The AU will eventually get involved when we get to the deployment level. It is however important to inform the AU from the very beginning."

"The AU cannot be involved now because SRM is not yet well known in the continent. Sensitisation should be carried out first so that the knowledge will be widespread before taking the issue to the AU."

One prominent suggestion that did receive a high degree of support was the establishment of a pan-African expert group on SRM under the auspices of the AAS. It was proposed that this could keep a watching brief on SRM development, and provide recommendations, information and advice to African stakeholders with an interest in SRM.

"The AAS should lead on African engagement with SRM, and have coordination centres which can engage other stakeholders to ensure that different African countries get involved in the process."

"There should be a physical committee of individuals, who are transparent, competent and skillful, for brainstorming exercises."

"Much effort should be made to seek funding and to acquire knowledge of the pros and cons of the process, etc."

"Governments should be involved in the process, and the AAS should work closely with governments of developing countries. Many countries do not have competent climatologists and meteorologists."

While there were contending views over group details – such as its composition, specific remit and timeline for action – there was general agreement that an independent, diverse and flexible expert group could be an effective way to increase African involvement in international discussion of SRM research governance, to connect African researchers to on-going projects, and to provide a focal point for Africans interested in learning more about the topic.

6. Conclusions and Next Steps

The purpose of the series of three workshops was to introduce African stakeholders to the concept of SRM, to seek opinions and ideas on how SRM might be governed, and to create the conditions for more sustained engagement in Africa. In all, the workshops drew over 100 participants from 21 different African countries, including academics, policymakers, journalists, NGO representatives, and interested members of the public. Discussions were wide-ranging and lively, and the SRMGI workshop ethos (maximise participant interaction and dialogue, without seeking consensus conclusions) was well received as a model for organising discussions of novel and controversial technologies.

There was great interest in further engagement in SRM in Africa

The informative discussions, participant enthusiasm, and the wealth of comments and ideas expressed during the meetings underlined the importance of inclusive international discussion of SRM, particularly in developing countries. It is too early to be able to make an informed judgment about whether SRM will be helpful or harmful, but the more people engage in discussions of the technology, and the more that international cooperation is an integral part of the development of SRM research governance, the greater the chances that SRM research and governance will be handled with humility, wisdom and prudence.

It seems clear that there was great interest in further engagement in SRM in Africa, and a number of ideas for future work were suggested by workshop participants:

- A pan-African expert group overseen by the AAS;
- Increased research into SRM in African universities;
- Teaching about SRM in school/university courses;
- More engagement and sensitisation of Africans from all walks of life.

The African Academy of Sciences will continue to explore how it can follow up on some of these proposals. Similarly SRMGI plans to continue its work of taking international discussions to new regions and audiences, and will continue to seek ideas for meeting locations and NGO partners.

For further information, please visit www.aasciences.org or www.srmgi.org.

Appendix I: Meeting Agendas

Governance of Solar Radiation Management Research: African Perspectives

27 June 2012, 09:00 – 18:30
Hotel Ngor Diarama, Dakar, Senegal
Chaired by Prof Ahmadou L. Ndiaye and Prof Berhanu Abegaz

TIME	ACTIVITY	SPEAKER
08:30-09:00	Registration	
09:00-09:30	Opening ceremony	Prof Ahmadou L. Ndiaye
09:30-10:00	The global state of SRM research	Mr Andy Parker Ms Cassandra Brunette
10:00-10:30	Governance of solar geoengineering, and the SRM Governance Initiative	Mr Alex Hanafi
10:30-11:00	Part I of the 'line exercise'	Mr Andy Parker
11:00-12:00	Panel discussion on scientific aspects of SRM in Africa	Prof Aberra Mogessie Prof Gregoire Sissoko Mr David Stephen Dr Benjamin Gyampoh Dr B. F. Idrissa
12:00-12:30	Implications of SRM for Africa and its role on climate change	Prof Richard Odingo
12:30-13:00	Group discussion and reflections on the morning's discussions	Prof Berhanu Abegaz
13:00-14:00	Lunch	
14:00-14:30	Solar Radiation Management Governance Initiative: Involving Africa	Prof Georges-Ivo Ekosse

14:30-15:45	Breakout group exercises: Governance of SRM research	Mr Alex Hanafi
15:45-16:30	Part II of the 'line exercise'	Mr Andy Parker
16:30-17:30	Presentation and discussion of ideas for the workshop report	Dr Benjamin Gyampoh Mr Andy Parker
17:30-18:15	Group discussion: Next steps in Africa and beyond	Prof Berhanu Abegaz
18:15-18:30	Closing ceremony and photos	
19:00	Group dinner	

Participants of the June 2012 workshop held at Hotel Ngor Diarama, Dakar, Senegal

Solar Geoengineering: Research, Governance, and African Involvement

28 November 2012, 13:00 – 17:00
Birchwood Hotel, Boksburg, South Africa
Chaired by Prof Georges-Ivo Ekosse

TIME	ACTIVITY	SPEAKER
12:30-13:00	Registration	
13:00-13:10	Welcome and introductory comments	Prof Georges-Ivo Ekosse Prof Richard Odingo Prof Joseph Massaquoi
13:10-13:35	Presentation on Climate change and Africa	Prof Georges-Ivo Ekosse
13:35-14:00	The science and governance of SRM	Mr Andy Parker
14:00-14:45	Exploring governance options- 'line exercise'	Facilitator
14:45-15:15	Break	
15:15-16:00	Breakout groups: Exercises on the governance of SRM research	Facilitator
16:00-17:00	Group discussion: breakout conclusions, next steps in Africa	Facilitator

Participants of the November 2012 workshop held at Birchwood Hotel, Boksburg, South Africa

African Perspectives on Solar Geoengineering

14 January 2013, 08:30 – 12:00
Millennium Hall, Addis Ababa, Ethiopia
Chaired by Prof Berhanu Abegaz

TIME	ACTIVITY	SPEAKER
08:00-08:30	Registration	
08:30-08:50	Welcome and introductory comments	Prof Berhanu Abegaz Prof Ahmadou L. Ndiaye
08:50-09:10	Presentation on climate change and Africa	Prof Georges-Ivo Ekosse
09:10-09:30	The science and governance of SRM – presentation and questions	Mr Andy Parker
09:30-09:50	Break	
10:20-11:00	Breakout group working on exploring governance options - 'the line exercise' Breakout conclusions	Mr Andy Parker
11:00-11:50	Plenary discussion: Next steps in Africa	Mr Andy Parker
11:50-12:00	Closing	Prof Berhanu Abegaz

Participants of the January 2013 workshop held at Millennium Hall, Addis Ababa, Ethiopia

Appendix II: Comments by Category

Governance of Research and Deployment

- SRM research should be carried out on a small scale so that other countries will not be affected by its drawbacks;
- A phased approach to research should be employed. There should be fundamental understanding of the concept of climate change, and land surface and atmosphere effects, using desk-based studies;
- Experiments should start indoors. African nations may need to understand results from indoor experiments and the mechanisms of regulation, before any outdoor tests can be considered;
- For a localised experiments that will influence only a localised area, an environmental impact assessment must be carried out to ensure checks and balances;
- Deployment of SRM should be heavily regulated. The injection of aerosols into the stratosphere should be regulated on a global scale by a global body;
- A larger scale experiment will require more stringent regulations be put into the legal or ethical framework;
- The atmosphere is a global good. Any attempts to modify the way the atmosphere behaves will require regulation;
- 'Indoors' research must be facilitated effectively by universities and governments. Governments must provide the needed support for such studies to be undertaken;
- Universities and research institutes must approach national and multinational organisations with proposals for funding for lab research;
- Research and development of small scale outdoors research must be facilitated and also regulated. It is only at this scale of research that needed information can be collected for informed decision making;
- Deployment of SRM technologies in the real world must be heavily regulated by a global body;
- An independent global technical body must be responsible for assessing the risk of large scale SRM deployment before it can be considered. Until such a stage is reached, large scale real world deployment of SRM technologies must be prohibited;
- Due to potential transboundary implications of SRM, regulation should be both at the national and international level. Even though research may not have transboundary implications the development of the technology may have cross boundary consequences and therefore, regulation at both the national and

international level could be beneficial;

- Facilitation and regulation of SRM research and governance should be done concurrently. It should be facilitated due to the potential international importance of the issue. Governance from the onset should be a bottom-up approach, which would create the accountability framework for facilitation;

- If Africa wants to get involved in SRM research it should start with institutions already in place, i.e. climate research institutions. It does not make sense for Africa to reinvent the wheel, but work with pre-existing structures;

- Since climate change is a global problem, there should mechanisms created to allow global synergy. There should be a way to ensure mobility of resources so that no region is left out of geoengineering research and governance discussions. These discussions should happen at the regional level to ensure everyone is on an equal footing. A centre of excellence, based in a region and used by all Africans, can allow for the possibility of training and infrastructure development;

- It is risky to make conclusions for Africa based on a set of experiments that have been carried out elsewhere. Caution is therefore necessary as findings of research undertaken under different conditions will vary;

- SRM is an opportunity we should not ignore since Africa has made little progress to engage developed countries to subscribe to legally binding agreements that would provide Africa with required funding especially with regards to the "polluter pays" approach;

- By coming up with SRM the West is seeking solutions for unanticipated results i.e. a 'plan B' to solve the problem. We however do not expect the West to sit on the principles that they are currently implementing especially since a number of developed countries are not cutting down emissions. SRM should not be an alternative to emissions reductions;

- It is Africa's job as international negotiators to make the West adhere to international agreements;

- Africa lacks adaptation mechanisms and it should focus on working with the West to ensure these mechanisms can be put in place in Africa to safeguard against possible catastrophic events.

Mechanics of Governance

- A multi-body agency should be created to ensure the oversight of a regulatory board, so that failures from the past will not be repeated;

- Management of the governance process should be between university professors, scientists and community members;

- Verification of experimental results should be done by independent evaluators, who will be honest about the good or damage of the SRM process;

- A regulatory body is needed to lead SRM in Africa. Transparency and accountability to the stakeholders is critical;
- The World Meteorological Organisation should be involved in governance of outdoors research;
- Irrespective of whether regulation is done globally, each developing world region should be empowered through bottom-up approaches to play a key role in regulation;
- Governments, through appropriate agencies, must be responsible for facilitating and regulating research and development of SRM technologies;
- There should be transparency of those involved in the research and development of SRM, including their research objectives and sources of funding;
- No one party can satisfactorily regulate SRM. Governance and research cannot develop separately. Guidelines should not be set on regulation until a research understanding is developed;
- The United Nations (UN) should, therefore, take the responsibility of addressing SRM since poor climate change management can cause conflict (especially if resources are scarce);
- If a UN agency had the role of governing SRM and SRM research, SRM should be considered a security issue and hence the Security Council should be in charge. In this case, the veto power should shift to Africa;
- The best approach may be to work with the African Union which in turn will approach the General Assembly in order to influence the Security Council;
- A different body other than existing ones such as the United Nations Framework Convention on Climate Change (UNFCCC) could be given the responsibility of addressing SRM issues. To some extent, the structure in place at UNFCC is not practical for the creation of new initiatives. SRM should likewise be overseen by a newly formed institution, ideally with veto power resting on Africa and other countries most vulnerable to climate change;
- Most multilateral organisations, in developed and developing countries, have proven themselves incapable of taking on new climate initiatives. Programmes for which funds are committed are not being implemented. Therefore, there should be a paradigm shift from the conventional to a new alternative that should focus on proper initiative implementation;
- There is a desire to move away from the traditional power structure in international decision making over this new area of technology to better represent the emerging powers of the African Union. This would allow new voices to be heard more strongly in global discussions;
- Since SRM research and governance is a global issue, everybody should have a voice. Management of the issue should be global but considerations should

be given to implementation at the regional level. There is need for global coordination in both policy and sustainable funding mechanisms in order to drive equity. Globalisation is important and should ensure that everybody is able to contribute. Universal competencies should be pooled together to address work on SRM issues;

- The possibility of the Law of the Sea for regulating SRM research could be considered. There is a piecemeal structure in the international legal framework to address SRM research. The provisions that exist only cover certain jurisdictions and areas and certain types of technology, and none comprehensively addresses SRM. The Law of the Sea is an international instrument that is limited in terms of the media it addresses. It is limited to the sea and currently it does not address the challenges of SRM research governance.

Public Engagement

- All stakeholders must be brought on board to get involved and stay informed;
- There is potential and possibility for SRM in Africa and therefore debates on SRM should be given a cautious chance;
- Power relationships, gender, and cultural aspects should all be included in governance discussions, so that they reflect the true makeup of African society;
- SRM should involve capacity-building of scientists and communities through bottom up approaches. Good quality information on SRM should be made available, covering benefits and drawbacks;
- The perception of the people must be considered before laboratory tests can be conducted;
- Engagement of more people in the SRM debate is essential. The population's opinion on negative effects of the process should also be known;
- Participation of indigenous African people should also be considered;
- We should also consider how local communities can get input into SRM technology development;
- The process of engagement must be scaled up by requesting the submission of views from all stakeholders to widen the scope of contributors. Some or all participants could for example be commissioned to disseminate the information on SRM to their national governments and encourage them to submit views.

Education and Research in Africa

- Research on SRM should be mainstreamed in African universities, to develop a base for understanding of SRM across the continent;
- SRM is very interesting, and should be a topic for doctoral research projects in African universities;

- SRM techniques should be added to the school curricula;
- A short online course on SRM should be developed and distributed to scientists to acquaint them with the technique;
- The AU has established a Pan African University and Centres of Excellence in different countries. The Centres of Excellence in Nairobi and AAS can discuss jointly on how to incorporate SRM as a major component of research. SRM research should have a base in the Pan African University;
- We need research by sociologists and other social scientists;
- Awareness creation, sensitisation and capacity building in SRM are very important. There should be a programme drawn for awareness creation and sensitisation;
- Capacity building in SRM should go beyond scientists; governments, civil societies and communities should all be involved;
- A memo should be sent to the African Union (AU) on SRM and the need for sensitisation on SRM;
- It is desirable to develop the capacity of African experts (scientists, social scientists, and NGO representatives) to enable them to advise their governments and create networks among African scientists and other scientists around the world;
- At the international level Africa would be totally inefficient due to a lack of organisation. A Centre of Excellence on SRM could be set up to represent the voice of Africa at various international fora;
- It is necessary to talk about the effect of solar radiation on agronomy for scientific management. Solar radiation has an impact on plant production. This aspect should be looked into when researching SRM;
- A team of physicians should contribute to discussions on SRM research and governance;
- Sea level rise has the potential to seriously impact coastal Africa. This phenomenon should be researched in conjunction with climate change mitigation;
- The effects of SRM deployment are disparate in Africa. Techniques used in one area may exacerbate problems in another. This has implications for regional governments involved in decision making;
- There is need for research in Africa that is relevant for Africa;
- A lot of research in Africa carried out using European standards for example, and it can be queried whether there is enough synergy between researchers in Africa for Africa to have a claim that it has “African” standards. The division in Africa, climatically and regionally, poses a potential challenge for Africa. This is seen for example in the case of AAS which had less than half of the countries in Africa

represented at the meeting;

- International regulation assumes that the countries involved have the same level of knowledge. This is not the case in Africa. If Africa is to be involved the human capacity, infrastructure e.g. computer modeling, should be developed. There are examples where projects are initiated but money is spent on workshops with no infrastructure developed in Africa. Theory and practical application are not compatible in the case of Africa because the continent lacks financial capacity.

Next Steps for African Engagement with SRM Research Governance

- The AAS should convene experts who will provide information and advice on SRM;
- AAS should lead on African engagement with SRM, and have coordination centres which can engage other stakeholders to ensure that different African countries get involved in the process;
- More expert involvement is needed;
- A regularly updated website and mailing-list is needed for effective communication;
- Creation of an AAS expert group would be a good idea;
- Good governance needs good communication; a communication strategy must be developed. The recent African Ministerial Council on Science and Technology (AMCOST) decision on recommending the AU to work closely with the AAS should be an advantage that can be explored;
- Governments should be involved in the process, and the AAS should work closely with governments of developing countries. Many countries do not have competent climatologists and meteorologists;
- At this stage, discussions should be between researchers only. There should be a sensitisation process for scientists and researchers for a period of time in the different African regions, before the idea is taken to the AU;
- There should be a physical committee of individuals, who are transparent, competent and skillful, for brain storming exercises for about six months or one year;
- The proposal for a six month brainstorming process should be extended to eighteen months, for acquisition of funding, knowledge of the pros and cons of the process etc.;
- The AU will eventually get involved when we get to the deployment level. It is however important to inform the AU from the very beginning;
- The AU cannot be involved now because SRM is not yet well known in the continent. Sensitisation should be carried out first so that the knowledge will be widespread before taking the issue to the AU;

- It may best serve Africa to capitalise on wealthy African philanthropists to provide moral and financial support for African initiatives;
- The negotiations on adaptation and mitigation have so far not been very successful in keeping up with the pace of climate change. There is more space in Africa to discuss other approaches such as afforestation and reforestation that would result in environmental benefits;
- Some of the African satellites in space can be used to advance the study on SRM;
- A group of African countries should discuss how to utilise solar radiation to benefit the rural communities. Discussions of this at the regional level could be beneficial;
- Africa already has an informed body which takes a common position and has common interest on such issues. The African Ministerial Conference on the Environment (AMCEN) has adopted a common position on climate change and they work with the Group of Seventy-Seven (G77) and China. Rather than establish a new body, AMCEN would be the right body to approach SRM. This would facilitate discussion at national and then continental level;
- If AAS is determined to be the appropriate convening authority for this topic in Africa, all African researchers should get under its research umbrella and create research synergy to ensure all results and information are shared. In doing so Africa would be able to defend African interests and speak up in one voice at the international level. It is up to researchers to conduct valid scientific work to assist governments to defend the position of Africa. It is important for African under the AAS to first try and build a typically African scientific community;
- Africa should look at areas in which to build strong capacities. Developing an understanding of SRM as the debate is on-going will enable Africa to give a voice to the envisioned global position;
- African research institutions could be the primary representatives of Africa in international research, and give a more prominent role to African scientists and policy makers;
- A commitment to work with the AAS and other related national academies in the generation and dissemination of information on SRM governance should be affirmed;
- We should consider the establishment of a pan-African expert group, possibly convened by AAS, to keep a watching brief on SRM and to disseminate information to African colleagues;
- AAS should be given a mandate to set up a database of Africans involved in climate science and to document universities or academics engaged in research related to climate change. This could be the focal point for any SRM research in the future;
- Africa should be given leading role and veto power in SRM global implementation on the grounds of the continent's "environmental integrity";

- We should recommend practical outputs from the workshop. Advocate, for example, for a project that will include measurement of solar radiation in meteorological stations in terms of increasing the density of the meteorological stations and ensure that important aspects of solar radiation such as evapotranspiration. The workshop could come up with a proposal for funding to scale up solar radiation measuring, reporting and verification processes (MRV) and increase the number of observation stations;

- Experts should conduct more public lectures or engagement activities on solar geoengineering at local, national and regional levels. There are more opportunities that should be seized to improve knowledge across Africa on geoengineering. This includes holding side events at regional meetings or conferences;

- Information and communications technologies should be utilised for broader and more effective dissemination of SRM information and meetings should be organised per region – Francophone, Anglophone and Portuguese – to share experiences;

- The precedent set by this workshop is in Africa's best interest and ensuring and maintaining sustainability should be key;

- African academies should act as facilitators between scientists and policy makers. They should 'police' the process and to ensure, for example, that funds allocated for SRM are used for SRM by universities or scientists;

- Research should be based on geographic zones, available capacities, and comparability of data;

- Multidisciplinary projects designed, planned and developed in the programme must have elements of comparison;

- A survey should be created of available human resources so that Africa can be evaluated for its increasing capacity in SRM.

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