British Geological Survey
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Workshop Report: Earth and Environmental Science for Sustainable Development (Lusaka, September 2017)

BGS Global - Eastern Africa ODA Platform

Open Report OR/17/064

BRITISH GEOLOGICAL SURVEY

BGS GLOBAL - EASTERN AFRICA ODA PLATFORM
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Keywords

Zambia, Eastern Africa, Sustainable Development Goals, Partnerships, Water, Energy, Climate Change, Food Security, ODA.

Front cover

Participants discussing pathways to development impact in Lusaka, Zambia.

Bibliographical reference

GILL, JC. AND MANKELOW, J. 2017. Workshop Report: Earth and Environmental Science for Sustainable Development (Lusaka, September 2017). *British Geological Survey Open Report*, OR/17/064. 42pp.

Keyworth, Nottingham British Geological Survey 2017

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Foreword

This report describes the outcomes of a two-day interactive workshop in Lusaka (Zambia), in September 2017. The British Geological Survey (BGS) gathered 26 delegates from 14 organisations based in Zambia, Malawi and Zimbabwe to explore sustainable development priorities in eastern Africa and consider the role of Earth and environmental science. This workshop was an activity of the BGS Eastern Africa *Official Development Assistance* (ODA) Research Platform. We used a collaborative approach to foster dialogue and gather information to inform future planning of BGS ODA activities.

Acknowledgements

The information in this report is a product of two-days of workshop discussion. We are grateful to representatives from the following organisations for sharing their time and insights:

Zambia: University of Zambia; Zambian Open University; Copperbelt University; Ministry of Agriculture and Cooperatives - Zambia Agriculture Research Institute; Ministry of Health; BGR – Technical Cooperation Programme (Zambia); Basa Agro; Zambian Sustainable Environmental Solutions Ltd; BioGas Solution; Association of Zambian Mineral Exploration Companies.

Zimbabwe: University of Zimbabwe (Soil Science Department); Ministry of Agriculture, Mechanization and Irrigation Development (Chemistry and Soil Research Institute).

Malawi: Lilongwe University of Agriculture and Natural Resources (Soil Science Department); Ministry of Agriculture, Irrigation and Water Development (Agricultural Research Services).

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Summary

This report describes the outcomes of a two-day interactive workshop in Lusaka (Zambia), conducted in September 2017. We gathered 26 delegates from 14 organisations based in Zambia, Malawi and Zimbabwe to determine sustainable development priorities and consider the role of Earth and environmental science in addressing these. Delegates came from diverse disciplines (e.g., geology, agriculture, geography, hydrology) and sectors (e.g., academia, commercial, government). Using the UN Sustainable Development Goals (SDGs) as a reference tool, participants identified primary development challenges and their research and data needs to help address these. Key themes included food security and nutrition, clean water and sanitation, and energy and climate change. Participants co-designed a set of draft science-for-development projects relating to these themes.

BGS are using this information, together with the results of additional workshop activities, to inform the development of collaborative *science-for-development* activities in eastern Africa as part of our commitment to Official Development Assistance (ODA) in the region. We will further develop specific project ideas, using information gathered at this workshop, with appropriate regional and international partners. Information from this workshop provides supporting evidence of expressed development need and stakeholder expertise in eastern Africa. This information will guide future project applications to the *Global Challenges Research Fund*, and other appropriate research and innovation funding sources.

Key Results and Conclusions

During the workshop, small group discussions and group voting generated a collective ranking of SDG priorities. Participants also reflected on where they believe Earth and environmental science can make the greatest contribution to development impact. These rankings were:

Overall SDG ranking (Eastern Africa) based on summing of small groups votes:	*Role for Earth and environmental science rankings:*
1. **Quality Education** (SDG 4)	1. **Climate Action** (SDG 13)
2. **No Poverty** (SDG 1)	2. **Clean Water and Sanitation** (SDG 6)
3. **Water and Sanitation** (SDG 6)	3. **Zero Hunger** (SDG 2)
4. **Good Health and Wellbeing** (SDG 3)	=4. **Good Health and Well-Being** (SDG 3)
5. **Zero Hunger** (SDG 2)	=4. **Affordable and Clean Energy** (SDG 7)
	=4. **Life on Land** (SDG 15)

Group discussions suggested that interconnectedness of SDGs and basic (immediate) development needs were likely to influence the prioritisation process. For example, participants noted that improving access to education (SDG 4) would improve access to jobs and economic growth (SDG 8), which enables enhanced investment in water and sanitation (SDG 6) and health (SDG 3).

We used these rankings to establish three thematic working groups, with each tasked to identify specific challenges, research priorities, information needs and potential projects. Groups were:

- **Food security and nutrition.** This group explored the environmental inputs required to improve nutrition in humans and animals.
- **Clean water and sanitation.** This group explored water pollution, emphasising the need for stronger and more informed management of activities causing pollution.
- **Energy and climate change.** This group explored ways to raise awareness of climate change and its impacts, and improve the understanding of future energy demand and locations.

Developing these activities will require effective science-for-development partnerships. Partnership characteristics of greatest importance to participants attending this Lusaka workshop were (i) sharing of data, (ii) access to training and capacity building, (iii) sharing of project outputs, (iv) shared responsibility for project design, and (v) respectful dialogue.

1 Introduction

1.1 BACKGROUND

The UN Sustainable Development Goals (SDGs) and the UK Aid Strategy (UK Government, 2015) emphasise the need to invest in strengthening resilience and response to crises, promote global prosperity, and help to tackle extreme poverty in the world's most vulnerable communities.

As part of the UK Government's commitment to the SDGs and its Aid Strategy, the British Geological Survey (BGS) is increasing the proportion of its budget spent on Official Development Assistance (ODA). BGS will deliver this via three research platforms, each of which will seek to develop new partnerships with a wide range of expertise to co-design and deliver a 3-year programme up to 2020.

In Eastern Africa, exponential population growth, rapid urbanisation and economic development, confounded by the effects of climate change, are having an increasing impact on health and well-being, national security and the ability of governments and aid agencies to cope. Such changes present challenges and new opportunities for science to support delivery solutions in respect to the sustainable use of natural resources (e.g., soils, minerals, water), infrastructure and services, training and skills enhancement.

Our long-term ambition therefore is to develop a platform of research and capacity building that enables our partners in ODA-recipient countries to use their natural resources to maximum benefit in an environmentally acceptable manner. Here we report on an introductory workshop organised in Lusaka that aimed to explore development priorities and understand how geological research can help support sustainable development. This workshop used an approach presented in Gill *et al.,* (2017), a report outlining an initial workshop within this programme, in Nairobi (Kenya).

1.2 BGS ENGAGEMENT IN EASTERN AFRICA

BGS has worked extensively across Eastern Africa for over 70 years on a variety of projects in support of governmental and non-governmental agencies. For example, national geological surveys, with projects focused on mineral resources, water supply, natural hazards, infrastructure and energy Currently we have active projects in a range of countries, including Malawi, Zambia, Zimbabwe, Ethiopia, Kenya, and Uganda. Examples include:

- **Malawi/Zambia/Zimbabwe**. Funded by the Royal Society and UK Department for International Development, BGS is working with project partners in Malawi, the UK, Zambia and Zimbabwe to enhance spatial predictions of soil type and chemistry to help combat low agricultural productivity and micronutrient deficiencies (so called "hidden hunger") in vulnerable communities. In addition, BGS is the lead partner in a RCUK-funded project on Conservation Agriculture, through the UK Global Challenges Research Fund, and will contribute to an RCUK-funded project 'Geonutrition' in Malawi, Zimbabwe, Zambia and Ethiopia.
- **Ethiopia/Malawi/Uganda**. BGS are leading the Hidden Crisis consortium project as part of the international collaborative research programme Unlocking the Potential of Groundwater for the Poor (UPGro). The Hidden Crisis project aims to develop a robust evidence base of the large-scale status of rural groundwater supply functionality in Ethiopia, Malawi and Uganda, and understand the underlying conditions leading to poor functionality of boreholes fitted with hand pumps.
- **Kenya**. Funded by the UK Department for International Development, BGS are providing technical assistance to the Government of Kenya as they establish a National Geodata Centre. BGS is leading a Newton Fund project on 'Aquaculture – Pathway to Food Security in Kenya', working with the University of Nottingham (UK), University of Eldoret

(Kenya) and the Kenyan Marine and Fisheries Research Institute. This project will explore pollution pathways from geogenic and anthropogenic inputs, their influence on fisheries, and implications for ecosystems and human health. BGS is also contributing to an International Agency for Research on Cancer (World Health Organisation) led project evaluating the spatial links to incidences of oesophageal cancer in the Rift Valley, funded by the US National Institute for Health.

- **Uganda**. BGS are working with the African Union, International Geoscience Services, GeoSoft, and the Uganda Chamber of Mines to facilitate access to geological, environmental and social data to enhance inward investment.

This report synthesises the perspectives and input from 26 delegates from 14 organisations who attended a workshop in Zambia, including representatives from both Malawi and Zimbabwe. Diverse sectors (government, academia, industry) were also represented. Using interactive group exercises enabled BGS to listen and collate the views, thoughts, and ideas of the workshop participants that lead to a better understanding of the sustainable development priorities.

The workshop represents an activity of the BGS Eastern Africa ODA Research Platform, informing the planning of a programme of *science-for-development*. Our work aims to build scientific collaborations, foster networks of scientists across the Global South, and support capacity building through focused training, research interactions, and applying for additional research funding (e.g., Global Challenges Research Funds).

1.3 WORKSHOP OBJECTIVES

Primary workshop objectives are noted below, with the sections of this report that provide evidence that these objectives were met:

Stakeholder Mapping	Better understand existing stakeholder networks, responsibilities, and research interests and capabilities.	Achieved by mapping out participating organisations and their activities (see **Section 2**).
Needs Assessment	Determine development priorities in eastern Africa at a range of scales (i.e., from broad overview development goals to specific challenges), and consider the Earth and environmental science research required to inform solutions.	Achieved by a set of activities aiming to prioritise and discuss development objectives (see **Section 3**), and potential solutions (see **Section 4**).
Partnership Building	Facilitate respectful dialogue between and across BGS and potential in-country partners.	Relationships enhanced during the workshop (see feedback in **Appendix B**), with information on participant-priorities helping to facilitate future strong partnerships (see **Section 5**).
Consolidate Positive BGS Reputation	Build trust and respect through delivering a workshop centred on meaningful engagement and listening.	Workshop feedback provides evidence that participants felt their perspectives were valued (see **Appendix B**).
Multi-Disciplinary and Multi-Sectoral Perspectives	Include diverse science and sectoral perspectives (e.g., academia, think tanks, NGOs, government).	Workshop participant list indicates diverse sectors and disciplines (see **Section 2**).

1.4 REPORT STRUCTURE

In this report, we first characterise workshop participants (**Section 2**), before proceeding to present the results of workshop activities exploring the UN Sustainable Development Goals (**Section 3**) and potential activities to support their delivery (**Section 4**). We finish by documenting the initial results of an exercise aiming to understand participants' perspectives on what makes a positive science-for-development partnership (**Section 5**). We outline next steps in **Section 6**.

The Official Development Assistance (ODA) programme of the BGS will use this workshop information to inform future project planning and research development in eastern Africa. All workshop participants will receive a copy of this report.

2 Workshop Participants

2.1 OVERVIEW

Over the course of the two-day workshop, BGS engaged with 26 participants from 14 different organisations (22 participants from 10 organisations based in Zambia, 2 participants from 2 organisations in Malawi, and 2 participants from 2 organisations in Zimbabwe). Participants were recruited via emails to existing contacts, a search of relevant organisations in Zambia, and through word-of-mouth. Twenty-two of the workshop participants were based in Zambia, two participants were based in Malawi, and two participants were based in Zimbabwe. Some organisations or individuals attending the workshop operate internationally, engaged in research and/or activities in the wider eastern Africa region and beyond. **Table 1** gives a summary of participating organisations, with information on the organisation's purpose and activities. Information was collected through a simple survey completed by participants, and from organisational websites (where available).

Table 1. *Participating Organisations*

Sector	Organisation	Groups	Description of Work and Research Activities
Academia	University of Zambia	Geology	Training in the exploration, exploitation, processing and utilisation of raw materials, and training for careers in environmental management, water resources and pollution control programmes. www.mines.unza.zm/?page_id=114
		Humanities and Social Sciences	Contributes to national human resource capacity building in a broad-range of social science and humanities disciplines. The School has eleven departments, including development studies, economics, and political and administrative studies. www.humanities.unza.zm/
		Agricultural Sciences	Offers degrees in animal science, crop science, agro-economics, soil science, food science and human nutrition. www.agric.unza.zm/
	Zambian Open University	Geography	Engaged in research on climate change (resilience, adaptation and mitigation strategies). Many geographical topics are taught, including hazards and disasters, hydrology, geology, energy, food security and water resources. Department has a meteorological station. www.zaou.ac.zm/

Sector	Organisation	Groups	Description of Work and Research Activities
	Copperbelt University (Zambia)	Biological Sciences	Engaged in research on microbial ecology of extreme environments, looking at the effects of mining on health and environment nanoparticle biosafety. www.cbu.ac.zm/index.php/schools/mathematics-and-natural-sciences
		Chemistry	Engaged in research on water and sanitation, looking at the risks to water associated with mining-related pollution. www.cbu.ac.zm/index.php/schools/mathematics-and-natural-sciences
	Lilongwe University of Agriculture and Natural Resources (Malawi)	Faculty of Agriculture	Focused on research and teaching related to agronomy, soil science, agricultural sciences, environmental science, natural resources, soil and water management, and pollution sciences. www.bunda.luanar.mw/luanar/faculty_agriculture.php
	University of Zimbabwe	Soil Science Department	Aims to develop quality research, teaching and training in soil science, bio-resources and environmental engineering and management in Zimbabwe, southern Africa and beyond. Topics include soil chemistry, soil physics, environmental management, water analytics, post-harvest and land reclamation. www.uz.ac.zw/index.php/soil-agric-eng-dept
Government	Ministry of Agriculture and Cooperatives (Zambia)	Zambia Agricultural Research Institute	The overall objective of the department is to provide a high quality, appropriate and cost effective service to farmers, generating and adapting crop, soil and plant protection technologies. Engaged in research on agriculture, soil and water management, plant protection and farming systems. Information disseminated to various key stakeholders. www.zari.gov.zm/
	Ministry of Health (Zambia)	Public Health	Responsible for developing and implementing programs and projects aimed at preventing, controlling and eliminating diseases in order to promote health and prolong life. www.moh.gov.zm/
	BGR (Federal Institute for Geosciences and Natural Resources, Germany)	Technical Cooperation (Groundwater)	Committed to sustainable use of natural resources and protection of the human habitat. Advise ministries and the European Community and act as partners in industry and science. Their technical cooperation programme in Zambia includes work on Groundwater Resources Management (GReSP). www.tinyurl.com/y8zxjjgv

Sector	Organisation	Groups	Description of Work and Research Activities
	Ministry of Agriculture, Mechanization and Irrigation Development (Zimbabwe)	Chemistry and Soil Research Institute, Department of Research and Specialist Services	Aim to be a centre of excellence in agricultural research leading to the generation of cutting-edge technologies and promotion of high quality regulatory and advisory services. Conducts research for agricultural technology development and providing regulatory dissemination and specialist services on all livestock and crops, except tobacco, tea and sugarcane. Example research topics include soil nutrition, soil fertility management, soil microbiology, pedological surveys, and environmental impact assessments. www.drss.gov.zw/
	Ministry of Agriculture, Irrigation and Water Development (Malawi)	Agricultural Research Services	Focus on agricultural research and technology transfer, climate change and soil and water management. www.agriculture.gov.mw/index.php/agriculture-research
Private Sector	Basa Agro (Zambia)		A private sector organisation working to recruit famers to value addition programmes (e.g., mills and expelling oil).
	Zambian Sustainable Environmental Solutions Ltd.		*No information available.*
	BioGas Energy Solutions (Zambia)		*No information available.*
	Association of Zambian Mineral Exploration Companies		Engage on themes of mineral exploration and legislation, acting as a liaison between government and mining companies, and giving assistance with small-scale exploration. www.azmec.co.zm/

2.2 EXISTING NETWORKS AND COLLABORATIONS

Following brief introductions from representatives of each of the organisations in **Table 1**, four multi-sectoral groups were established. Each group was tasked with identifying where existing collaborations exist, and describing the nature and strength of these relationships. **Figure 1** synthesises this mapping exercise. The four network diagrams in **Figure 1** give a preliminary understanding of existing and absent collaborations in each of the four groups, with further research needed to understand the detailed nature of these. We note that additional collaborations may exist not captured in these diagrams (for example, between organisations in different groups).

2.3 EXAMPLE PATHWAYS TO IMPACT

The final exercise in this section was a group discussion around three different scenarios, and appropriate pathways to impact:

i. Two groups considered approaches to connect new research to policy-makers, informing policy development, and ensuring effective policy implementation,
ii. Assimilating data and promoting a new geodata portal, and
iii. Integrating perspectives from local communities into a new research programme.

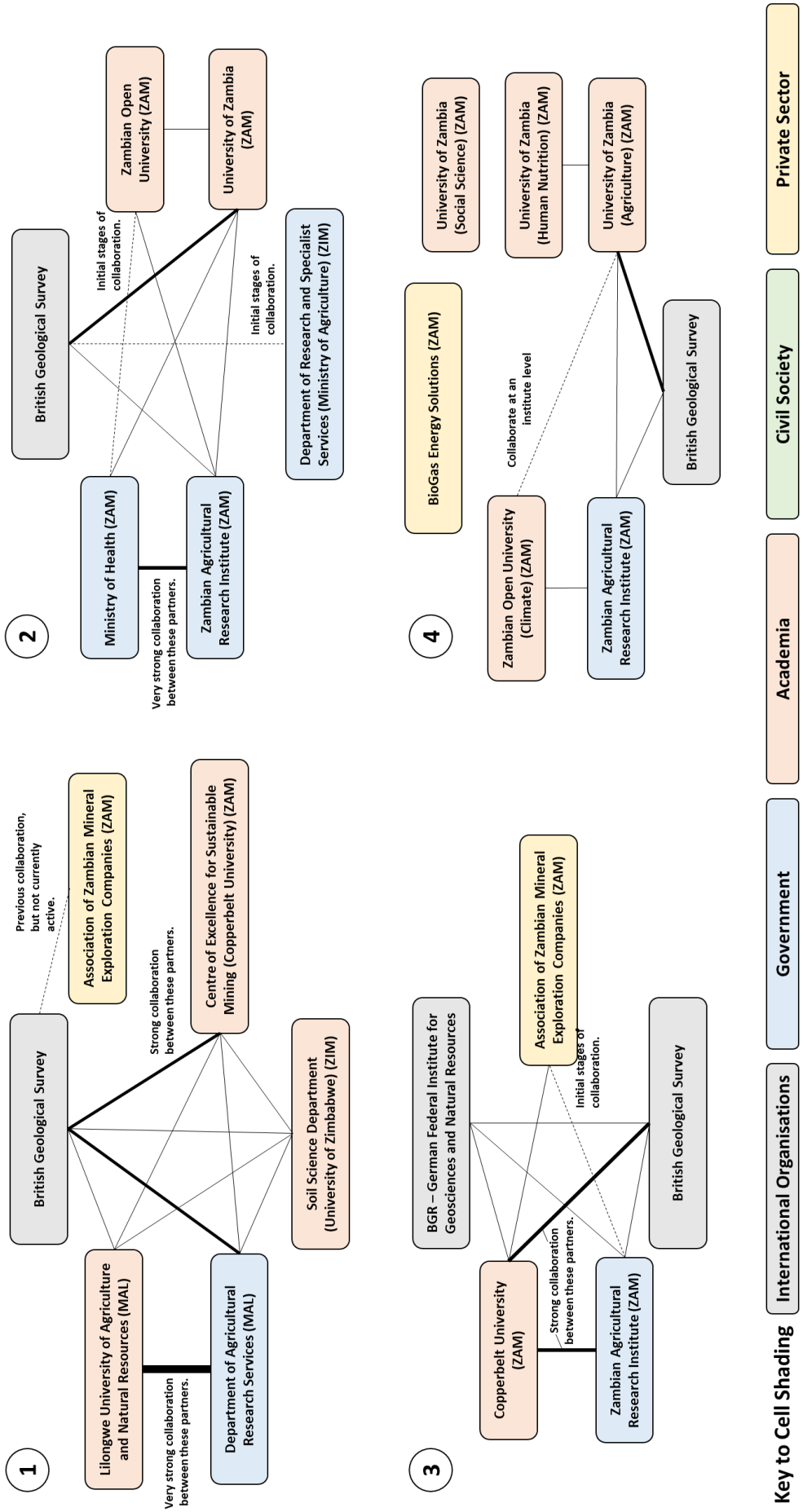

Figure 1. Mapping Existing Collaborations. *A schematic to show the extent of existing collaborations between organisations represented at the workshop, divided into four multi-sectoral groups. Cell shading indicates the sectors represented, and line thickness indicates the relative strength of collaborations (determined by participants).*

Each group considered the organisations and collaborations that are necessary for their scenario to be successful. Groups considered which collaborations already exist and are mature, and which new collaborations need to be developed. Potential barriers to prevent collaborations were also discussed. These discussions provided a rich source of information on pathways to development impact in the particular political and social context of Zambia, although parallels with Zimbabwe and Malawi were also noted.

From Research to Policy

Two teams considered the uptake of research into policy, using examples of food security in Malawi and mine pollution in Zambia. A key observation made across both groups is that *responsibility for socio-environmental issues stretches across multiple ministries.* Tackling socio-environmental issues (e.g., ensuring access to sufficient, continuous, nutritious food) will require integrated approaches, with policy coherence across ministries. For example, the Ministry of Agriculture is responsible for food security whereas the Ministry of Health is responsible for food nutrition. Research into mining pollution would be of interest to the Zambian Environmental Management Agency, the Ministry of Mines, the Ministry of Health, and the Ministry of Water, Sanitation and Environmental Protection. Applied research will likely require involvement of stakeholders from multiple organisations, with communication of research results to policy makers in multiple ministries. Discussions also indicated that there is currently a lack of research uptake by policy makers. Policy is often politically driven, rather than science driven. It is not always consultative (bottom up), with scientists (the knowledge holders) recommending actions.

Assimilating Data and Promoting a Geodata Portal

The accessibility and management of data was an important theme of previous workshops (e.g., see Gill *et al.,* 2017). This exercise encouraged participants to discuss the stakeholders and processes involved in the assimilation of relevant data into an open portal, and its promotion to relevant users. In addition to finance being required at all stages, the group noted the following stages and considerations:

- *Data collection.* Improvements in equipment are needed to help collect sufficient and reliable data.
- *Data formats.* Data needs to be in digital formats, but this is currently not always the case. There needs to be negotiation with stakeholders for improved open-access data.
- *Data management and quality assurance.*
- *Accessibility (to data and data products).* Databases, and maps derived from data, will need to be placed online. Education initiatives to support users to access and benefit from this data will also be needed.
- *Publicising data portals.* This can be done by conferences, workshops and social media, seeking to engage relevant specialists and ministries.

Integrating perspectives from local communities

Recognising the frequent need to engage with local communities when undertaking science-for-development, this scenario explored relevant stakeholders and processes in a Zambian context. The group noted the importance of collaborating with *civil society*, as they have good links with local community groups. They can help to mobilise communities to actively engage in activities, and provide support to research uptake. Within communities, political and religious community leaders have an important role, and can help to mobilise the broader community. They act as key bridges between relevant national ministries (e.g., Ministry of Community Development) and the wider community. Women are also an important group to engage with, often having household responsibilities that would help to inform research. Regional and district governments may provide extension services, (e.g., community liaison officers) who can help to connect universities to stakeholders.

3 Prioritising the UN Sustainable Development Goals

The Sustainable Development Goals (SDGs) are an ambitious set of 17 goals and 169 targets, agreed by members of the United Nations in September 2015. Over a 15-year timeframe (2015–2030), the SDGs aim to: (i) eradicate global poverty, (ii) end unsustainable consumption patterns, and (iii) facilitate sustained and inclusive economic growth, social development, and environmental protection (United Nations, 2017).

This workshop used activities to determine stakeholder perspectives on development priorities in eastern Africa, using the SDGs as a reference tool. Activities were then used to help identify areas where Earth and environmental science could make a significant contribution to sustainable development.

Participants first shared their individual perspectives on high priority SDGs using a matrix worksheet (**Section 3.1**). Small groups then discussed the SDGs, coming to a consensus on their relative importance and the highest priority SDGs in an eastern African context (**Section 3.2**). Participants also documented specific challenges associated with priority SDGs (**Section 3.3**) and identified themes that they believe Earth and environmental science could make the biggest contribution to delivering, as well as stating what that science may be (**Section 3.4**). These results are discussed in the context of development needs assessment (**Section 3.5**).

3.1 INDIVIDUAL PERSPECTIVES ON PRIORITY SDGS

3.1.1 Overview and Method

Using a blank matrix (**Figure 2**), participants were asked to identify (i) four SDGs that they consider to be of highest importance in an eastern African context, and (ii) four SDGs that they consider to be of highest importance in a Zambian/Malawian/Zimbabwean context (depending on their nationality). Participants were encouraged to do this individually, ensuring that every workshop participant had their perspectives recorded.

3.1.2 Results

20 participants submitted completed worksheets for this exercise, with 15 (75%) of these including information on eastern Africa and Zambia, 2 (10%) including information on eastern Africa and Malawi, 1 (5%) including information on eastern Africa and Zimbabwe, 1 (5%) including information only relating to Zimbabwe, and 1 (5%) being void due to it being incorrectly completed. **Figure 3** shows the results of this exercise for eastern Africa and Zambia. Numbers in the columns labelled 1st, 2nd, 3rd and 4th relate to the number of participants selecting the SDG as a priority. The column labelled '*Weighted Total*' sums the number of participants in each column, applying a weighting depending on whether participants selected it as their 1st, 2nd… choice. The formula expressed in **Equation 1** outlines this weighting. Orange shading is used in **Figure 3** to help visualise the relative *Weighted Total* values.

$$Weighted\ Total = 4[n_{1st}] + 3[n_{2nd}] + 2[n_{3rd}] + 1[n_{4th}] \qquad \textbf{Equation 1}$$

Please place one tick in each column!

			Eastern Africa [Place one tick per column]					Zambia [Place one tick per column]			
			1st	2nd	3rd	4th		1st	2nd	3rd	4th
Sustainable Development Goals (SDGs)	Partnerships for the Goals	Strengthen the means of implementation and revitalize the global partnership for sustainable development.									
	Protect the Planet	Take urgent action to combat climate change and its impacts.									
	Good Health	Ensure healthy lives and promote well-being for all at all ages.									
	Reduced Inequalities	Reduce inequality within and among countries.									
	Gender Equality	Achieve gender equality and empower all women and girls.									
	Peace & Justice	Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels.									
	Sustainable Cities & Communities	Make cities and human settlements inclusive, safe, resilient and sustainable.									
	Good Jobs & Economic Growth	Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all.									
	Innovation & Infrastructure	Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation.									
	Quality Education	Ensure inclusive and equitable quality education and promote life-long learning opportunities for all.									
	Clean Energy	Ensure access to affordable, reliable, sustainable, and modern energy for all.									
	Responsible Consumption	Ensure sustainable consumption and production patterns.									
	No Hunger	End hunger, achieve food security and improved nutrition, and promote sustainable agriculture.									
	Life Below Water	Conserve and sustainably use the oceans, seas and marine resources for sustainable development.									
	Life on Land	Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss.									
	Clean Water & Sanitation	Ensure availability and sustainable management of water and sanitation for all.									
	No Poverty	End poverty in all its forms everywhere.									

Figure 2. Workshop Matrix. *A blank workshop matrix, used by participants to express their perspectives on high priority SDGs in Eastern Africa and Zambia/Malawi/Zimbabwe.*

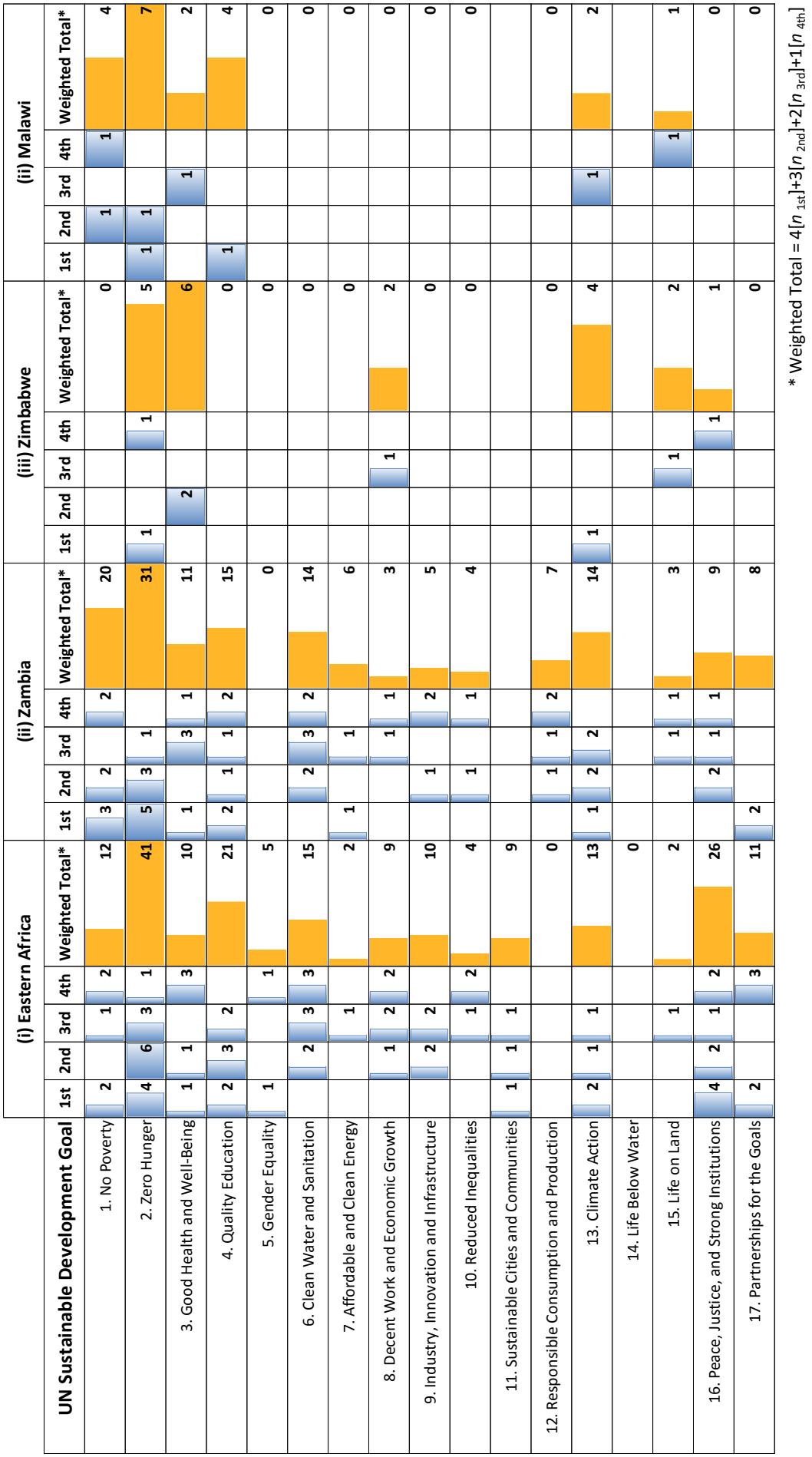

Figure 3. Sum of Individual Perspectives on Priority SDGs. *A synthesis of 19 perspectives on the SDGs (**Figure 2**), with the 'Weighted Total' determined as expressed in **Equation 1**. Shading is used to visualise priority SDGs.*

Using **Figure 3**, we can identify the SDGs with the highest *Weighted Total* (WT) values. This is indicative of the group collectively considering the SDG to be a high development priority.

Eastern Africa. **Zero Hunger** (SDG 2, WT=41) emerges as being the highest development priority, followed by **Peace, Justice and Strong Institutions** (SDG 16, WT=26), **Quality Education** (SDG 4, WT=21), **Clean Water and Sanitation** (SDG 6, WT=15), and **Climate Action** (SDG 13, WT=13). Together these five SDGs represent the first choice (highest priority) SDG of 63% of participants, and 55% of all possible selections.

Zambia. **Zero Hunger** (SDG 2, WT=31) again emerges as the highest development priority, **No Poverty** (SDG 1, WT=20), **Quality Education** (SDG 4, WT=15), and **Clean Water and Sanitation** (SDG 6) and **Climate Action** (SDG 13) both having a WT=14. Together these five SDGs represent the first choice (highest priority) SDG of 69% of participants, and 53% of all possible selections.

Zimbabwe. **Good Health and Wellbeing** (SDG 3, WT=6), **Zero Hunger** (SDG 2, WT=5), and **Climate Action** (SDG 13, WT=4) were identified as being priorities by the two Zimbabweans represented.

Malawi. **Zero Hunger** (SDG 2, WT=7), **No Poverty** (SDG 1, WT=4), and **Quality Education** (SDG 4, WT=4) were identified as being priorities by the two Malawians represented.

These results are a reflection of the expertise and experience of those attending the workshop, with perspectives from at least 14 diverse organisations included. We discuss these results in **Section 3.5**.

3.2 GROUP PERSPECTIVES ON PRIORITY SDGS

3.2.1 Overview and Method

Another insight into development objectives in eastern Africa was documented by asking small groups of participants to discuss and form a consensus on SDG priorities. Mixed-sector groups determined the four SDGs that they believed to be of greatest importance in eastern Africa. Group discussions were prolonged and dynamic, with groups critically examining why they (and others) considered key SDGs more relevant and important than other SDGs (**Figure 4**).

Figure 4. Discussing the UN Sustainable Development Goals. *Following dynamic discussions, groups selected the four SDGs they believed to be of highest priority in eastern Africa.*

3.2.2 Results

Following small group discussions, each group had 10 voting stickers to allocate to their four priority SDGs. Voting was undertaken by placing stickers on appropriate SDG posters, with the 10 stickers being allocated in the proportion best suited to the group conclusion (e.g., 4-3-2-1, 3-3-2-2, or 4-2-2-2 were all allowed). The distribution of group votes is presented in **Table 2**, with different colours used to represent the four groups. From **Table 2**, we note that the SDGs ranked highest are **Quality Education** (SDG 4, 10 votes), **No Poverty** (SDG 1, 7 votes), **Clean Water and Sanitation** (SDG 6, 5 votes), **Zero Hunger** (SDG 2, 4 votes) and **Good Health and Wellbeing** (SDG 3, 4 votes). Together these five SDGs represent 30 of 40 (75%) possible votes.

These results differ from those presented in **Section 3.1** in both the order of the SDGs and the spread of votes. After opportunity for detailed group discussion, where participants had to justify their prioritisation of key SDGs, groups converged on a smaller range of priority SDGs than in **Section 3.1**. When summing individual perspectives (**Section 3.1**), the top five SDGs represented 55% of all possible votes, whereas the results in this section show the top five SDGs representing 75% of all possible votes.

Table 2. *Group Prioritisation of the UN Sustainable Development Goals. Different colours (red, blue, green and purple) are indicative of different groups voting choices.*

SDG	Summary	Votes
1	No Poverty	7
2	Zero Hunger	4
3	Good Health and Well-Being	4
4	Quality Education	10
5	Gender Equality	2
6	Clean Water and Sanitation	5
7	Affordable and Clean Energy	0
8	Decent Work and Economic Growth	3
9	Industry, Innovation and Infrastructure	2
10	Reduced Inequalities	0
11	Sustainable Cities and Communities	2
12	Responsible Consumption and Production	0
13	Climate Action	1
14	Life Below Water	0
15	Life on Land	0
16	Peace, Justice, and Strong Institutions	0
17	Partnerships for the Goals	0

This second exercise allowed the capture of narrative on why certain SDGs were prioritised over others. One group examined **interactions between the SDGs**, and considered which interventions would have the greatest impact on a spread of relevant SDGs. Improving access to quality education (SDG 4), for example, was noted to underpin the delivery of many of the other SDGs. Other groups considered **hierarchies of need** to determine top priorities. For example, tackling hunger, improving health and ensuring access to education and clean water and sanitation (so called ‘basic needs’) underpin economic growth, tackling poverty, and reducing inequality. A summary of comments justifying the selection of specific SDGs is provided in **Table 3**.

***Table 3**. Summary of comments justifying selection of priority SDGs.*

SDG	Summary	Votes	Justification for Selection
4	Quality Education	10	Education is critical, and links to innovation and infrastructure. It improves access to jobs, which enables investment in health. When you are educated, you develop critical thinking skills, and are able to make informed choices.
1	No Poverty	7	Other goals are dependent on ending poverty. If the population have no money, then they cannot gain access to healthcare and education. Poverty results in environmental degradation.
6	Clean Water and Sanitation	5	Other goals are dependent on ensuring access to clean water and sanitation.
2	Zero Hunger	4	*None stated.*
3	Good Health and Well-Being	4	Health links to clean water and sanitation.
8	Decent Work and Economic Growth	3	Jobs and economic growth provide security for families and communities.
5	Gender Equality	2	This will improve access to facilities for half the population.
9	Industry, Innovation and Infrastructure	2	Fundamental to economic growth.
11	Sustainable Cities and Communities	2	Need sustainability of cities to ensure continuation of development progress.
13	Climate Action	2	Climate links to food security, which depends on the effective tackling of climate change.

Emerging themes are the interconnectedness of the SDGs, and differences between resources needed immediately for survival (i.e., short-term development) and activities relating to long-term sustainable development. These results are further discussed in **Section 3.5**.

3.3 CHARACTERISING SPECIFIC CHALLENGES

This exercise asked individuals and groups to add notes to SDG posters on specific challenges in eastern Africa associated with priority UN Sustainable Development Goals. **Table 4** outlines the challenges identified for each SDG. While groups were encouraged to focus on priority SDGs (see **Section 3.2**), they were free to add comments on specific challenges to any of the SDG posters.

***Table 4**. Specific challenges in eastern Africa associated with the UN Sustainable Development Goals (SDGs).*

SDG	Summary	Specific Challenges
1	No Poverty	Job opportunities for new graduates; impact of droughts and floods; desertification in Western Province; lack of quality education; dependence on traditional ways of making money, and the need to consider preparing people for entrepreneurial careers in modern unconventional areas; lack of enabling environment to support farming; limited access to good/improved technologies by smallholder farmers and high costs; less meals per day and no balanced diet; resilience to climate shocks and natural hazards; malnutrition in under 5s and adults; lack of key nutrients (Vitamin A).

SDG	Summary	Specific Challenges
2	Zero Hunger	Poor farming methods and irrigation, causing soil degradation; loss of workforces due to disease; not enough use of irrigation for small-scale agriculture; food security is hard for many families – especially in rural areas – due to climate change, will need to look at local crops for genetic solutions; high input costs of fertilisers and seeds in production; lack of access to markets; hidden hunger, need for good nutrition and better quality and diversity of food; lack of food and people skipping meals or going without food altogether; rising populations; soil degradation and erosion; new pests and crop diseases; dry spells and droughts; low agricultural productivity; rural to urban migration results in a loss of labour; animal nutrition; market prices are too low (economics).
3	Good Health and Well-Being	Lack of access to quality health facilities; insufficient numbers of medical personnel like doctors; lack of facilities and personnel in rural areas; lack of good knowledge and habits in nutrition (junk food); hidden hunger; access to healthcare; lack of clean water causing disease; lack of proper access to health services in rural areas; few clinics; few doctors; lack of drugs; poor health infrastructure; unavailable drugs; rising rates of disease (e.g., AIDS and cancer); unexploited local nutritional diversity; access to nutritional and health information.
4	Quality Education	Not enough qualified teaching staff; not enough funds allocated to education (all levels, including vocational); poor reading culture; lack of proper libraries; lack of infrastructure for formal schools; need for proper science educational capabilities; access to tertiary and vocational education; research and development within tertiary education; funding for infrastructure; too few schools and teachers; need for skills development; girls dropping out due to lack of adequate sanitation facilities, lack of study materials such as books.
5	Gender Equality	Under-representation of women in responsible positions; female children disadvantaged by culture and society; deserves renewed attention especially in the governance of our countries; involvement of women's perspectives is necessary for prosperity; females are dropping out of higher education; archaic traditions and lack of deliberate policies to promote female child education.
6	Clean Water and Sanitation	Untreated water; distance to water sources; drilling not regulated; unplanned city expansion; use of agrochemicals; unmatched provision of water to infrastructure (housing); contamination with faecal matter; unregulated pit latrines and septic tanks; groundwater contamination from mining; lack of access to clean water in urban areas; lack of sanitation impacts on access to education for girls; on site sanitation causing contamination; regulation of groundwater resources; large scale and industry abstraction of groundwater is unregulated; contamination with sewage; lack of understanding, data and knowledge of water resources in Zambia; pollution of water (and soils) from mine tailings; water is untreated and long distances from homes; growing irrigation could threaten water resources and cause pollution if not managed well; conflicting demands on water resources (e.g., industry vs. residential); lack of laws that give people the right to access water.
7	Affordable and Clean Energy	Power is not stable; common to lose power; greater need for shift to sustainable energy sources; lack of institutional support for renewables; lack of technical skills for renewables; lack of human resources for renewables; poor awareness of renewables potential; lack of alternative energy sources for rural households; identification of appropriate technology energy options.

SDG	Summary	Specific Challenges
8	Decent Work and Economic Growth	Little prioritisation of occupational health and safety; corruption that sways policies to suit individuals; women spending too much time collecting water and having no time for economic activities.
9	Industry, Innovation and Infrastructure	Lack of access to markets due to no good roads; lack of access to required infrastructure to facilitate growth in innovation; lack of industries; few jobs related to improving infrastructure.
10	Reduced Inequalities	*None stated.*
11	Sustainable Cities and Communities	Unplanned settlements; rural to urban migration; land encroachments; unplanned cities; no roads; no electricity; limited knowledge on sustainable industrialisation; lack of coordinated planning; unplanned cities with urban sprawls (slums).
12	Responsible Consumption and Production	Too much plastic waste and not enough action on this; lack of proper recycling centres; deforestation for charcoal production.
13	Climate Action	Deforestation; open burning; lack of awareness of communities about climate change and the impacts of certain actions on the environment.
14	Life Below Water	No interest in aquaculture.
15	Life on Land	Biological degradation; deforestation; loss of productive agricultural land and connections between this and food security.
16	Peace, Justice, and Strong Institutions	*None stated.*
17	Partnerships for the Goals	Lack of proper linkages; lack of funding and time for proactive development of partnerships.

Comments presented in **Table 4** (together with the information in **Section 3.4**) were a starting point for designing Earth and environmental science activities to support the delivery of the SDGs (**Section 4**). Further discussion of these challenges, in the context of other results in this section, is included in **Section 3.5**.

3.4 EARTH AND ENVIRONMENTAL SCIENCE

In addition to identifying priority SDGs in eastern Africa (**Sections 3.1**–**3.2**) and specific challenges associated with these (**Section 3.3**), participants were then asked to reflect on where Earth and environmental science can make the greatest contribution to development impact. Many of the SDGs require geological research and practice. Each workshop participant was given four voting stickers to place on the SDG posters they considered had a high requirement for Earth and environmental science research. The distribution of votes can be seen in **Table 5**.

From **Table 5**, we note that the SDGs ranked highest in terms of a role for Earth and environmental science are **Climate Action** (SDG 13, 12 votes), **Clean Water and Sanitation** (SDG 6, 10 votes), **Zero Hunger** (SDG 2, 9 votes), and **Good Health and Wellbeing** (SDG 3), **Affordable and Clean Energy** (SDG 7), and **Life on Land** (SDG 15), each with 8 votes. Together these six SDGs represent 69% of all possible votes.

In addition to voting, participants added further notes to SDG posters on specific ways in which Earth and environmental science cam support the delivery of the SDG in eastern Africa. **Table 6** outlines these areas of Earth/environmental science input for each SDG. Further discussion of these results is included in **Section 3.5**.

Table 5. Earth and environmental science and the SDGs in eastern Africa. *Sum of individual perspectives on where Earth and environmental science can have the biggest development impact in eastern Africa.*

SDG	Summary	Votes
1	No Poverty	3
2	Zero Hunger	9
3	Good Health and Well-Being	8
4	Quality Education	3
5	Gender Equality	0
6	Clean Water and Sanitation	10
7	Affordable and Clean Energy	8
8	Decent Work and Economic Growth	0
9	Industry, Innovation and Infrastructure	7
10	Reduced Inequalities	0
11	Sustainable Cities and Communities	5
12	Responsible Consumption and Production	4
13	Climate Action	12
14	Life Below Water	0
15	Life on Land	8
16	Peace, Justice, and Strong Institutions	0
17	Partnerships for the Goals	3

Table 6*. Potential Earth and environmental science inputs required to support the delivery of the UN Sustainable Development Goals (SDGs) in eastern Africa.*

SDG	Summary	Potential Earth and Environmental Science Inputs
1	No Poverty	Use of science to support cheaper and sustainable livelihoods; reduction of hunger.
2	Zero Hunger	Sustainable agriculture; increase crop yields through crop resistant seeds; assessment of environmental pollution due to animal waste; improving nutrition and food security through research; technologies to increase crop yields while maintaining high environmental standards; soil mapping; research into natural fertilisers; micronutrient rich food crops; development of rural infrastructure development.
3	Good Health and Well-Being	Research into micronutrient deficiencies.
4	Quality Education	Embedding of contemporary Earth science ideas into education, to help improve public reactions to issues such as climate change.
5	Gender Equality	*None stated.*
6	Clean Water and Sanitation	Monitoring and understanding of groundwater; understand health risks from contaminated ground and surface water; identify and access clean/quality water; regulation of groundwater drilling in Lusaka; integration of hydrogeological and GIS skills; understanding of water and soil contamination to reduce pollution; improve sanitation facilities; guidelines for groundwater protection zones; natural geologic contaminants; groundwater education; research into efficient irrigation.

SDG	Summary	Potential Earth and Environmental Science Inputs
7	Affordable and Clean Energy	Exploration of geothermal energy; carbon capture and storage; advocate for greener growth economics; energy storage; solar pumping; bioenergy and competition for land/food with crops.
8	Decent Work and Economic Growth	*None stated.*
9	Industry, Innovation and Infrastructure	Innovation in development minerals can create wealth and jobs for society, including products for construction; environmental considerations for infrastructure development.
10	Reduced Inequalities	*None stated.*
11	Sustainable Cities and Communities	National planning; integration of urban planning information into geological survey work; mapping of areas with poor drainage to avoid construction of settlements; understanding of links between sub-surface and surface water to support drainage and flood management.
12	Responsible Consumption and Production	Identify resources; reduce environmental pollution and related ailments; improve recycling of resources through understanding of raw materials; improved technologies in the mining sector; planned resource use to support future generations.
13	Climate Action	Impacts of climate change on agriculture, poverty and disasters; understanding of climate dynamics to help manage changes; predicting/mitigating/adapting to climate change; building resilience to disasters; help switch to low carbon energy; sustainable land management; understanding of science to support decision making; research on efficient crop varieties to survive in water-stressed environments; evidence for past climates; help develop climate records using groundwater as a proxy; potential for droughts; research into traditional practices that may help with climate change resilience.
14	Life Below Water	*None stated.*
15	Life on Land	Provide evidence and ways of sustaining land resources; sustainable agriculture and crop production; methods to reduce soil degradation; manage land resources for sustainable productivity; understanding of groundwater and potential contamination pathways; prevention of water pollution; prevention of soil pollution;
16	Peace, Justice, and Strong Institutions	*None stated.*
17	Partnerships for the Goals	*None stated.*

3.5 DISCUSSION AND LIMITATIONS

3.5.1 Summary of Key Observations

From **Sections 3.1**–**3.4**, we can make the following observations and conclusions:

- **Priority SDGs**

  Across both prioritisation exercises (**Sections 3.1** and **3.2**), SDGs consistently selected as being of high importance (ranked in the top five) in eastern African were **Zero Hunger** (SDG 2), **Quality Education** (SDG 4), and **Clean Water and Sanitation** (SDG 6). When focusing on Zambia (in contrast to eastern Africa), these three SDGs were again included in the top five. The highest priority SDG using the method in **Section 3.1** was **Zero Hunger** (SDG 2), with the highest priority SDG using the method in **Section 3.2** being **Quality Education** (SDG 4).

- **Consistency of Results**

  The results presented in (**Section 3.1**) differ significantly from those arising from the group discussion exercise (**Section 3.2**). This is indicative of people changing their mind after reflecting on the group discussion. The group discussions provided an opportunity for participants to confront their pre-existing ideas of principal development priorities with information from other sectors and disciplines. This resulted in **Quality Education** (SDG 4) rising from third to first, with votes from all four groups. **No Poverty** (SDG 1) rose from sixth to second in the group rankings, being allocated a high share of votes by two groups. In contrast, **Peace, Justice and Strong Institutions** (SDG 16) was ranked second in **Section 3.1**, but this received no votes in the group exercise, **Section 3.2**. **Zero Hunger** (SDG 2) was initially ranked first; with approximately 57% more votes than the second placed SDG. This may be a function of many participants coming from an agriculture research and policy background. After group discussion, this was ranked joint 4th, and only selected by one of four small groups.

- **Interconnectedness of SDGs**

  During the group discussions (**Section 3.2**), an emerging theme was the interconnectedness of the SDGs. For example, actions to support one SDG could help reinforce or support another. Participants highlighted how **Quality Education** (SDG 4) can help improve access to **Decent Work and Economic Growth** (SDG 8), **End Poverty** (SDG 1), and reduce inequalities (e.g., SDG 5 and SDG 10). Development interventions or research projects could feasibly support multiple SDGs. For example, projects related to agriculture could relate to SDGs on poverty, food, water, and climate. In their discussions, many groups were considering which SDGs were focal points, and would support the implementation of other SDGs.

- **Immediate vs. Long-Term Development**

  Many of the SDGs identified in **Sections 3.1** and **3.2** as being high-priority SDGs are 'basic needs' and critical for survival (e.g., food and water). These are likely to be of immediate importance to participants; necessary for daily survival. Both immediate (humanitarian) and long-term (development) solutions are required to address these 'basic needs'. Additional exercises could be developed for future workshops that ask participants to consider priority challenges in 10, 20 and 50-years from now. This would encourage participants to think beyond the current development landscape, and reflect on long-term development.

- **Earth and Environmental Science**

  In the context of eastern Africa, SDGs ranking highest in terms of a role for Earth and environmental science (**Section 3.4**) were **Climate Action** (SDG 13), **Clean Water and Sanitation** (SDG 6), **Zero Hunger** (SDG 2), and **Life on Land** (SDG 15), **Affordable and Clean Energy** (SDG 7), and **Good Health and Wellbeing** (SDG 3).

- **Overlap of Priority and Science Needs**

  SDGs identified as being both a high priority and having a significant role for Earth and environmental science (**Sections 3.1**, **3.2** and **3.4**) were therefore **Clean Water and Sanitation** (SDG 6), **Zero Hunger** (SDG 2), and **Good Health and Wellbeing** (SDG 3).

The information gathered during this two-day workshop provides additional context to the implementation of the UN Sustainable Development Goals, and other records of development priorities. For example, the African Agenda 2063 and Zambia Vision 2030 offer regional and national scale visions for sustainable development. The latter includes three broad objectives of economic growth and wealth creation, social investment and human development, and creating and enabling an environment for sustainable social economic development. Relevant themes for these three objectives, taken from the Zambia Vision 2030 document, are included within **Table 7**.

***Table 7**. Themes within the 'Zambia Vision 2030' development strategy.*

Objective	Key Themes
Economic growth and wealth creation	Agriculture, land, tourism, manufacturing, mining, infrastructure, energy, science and technology, information and communications technology, and employment and labour.
Social investment and human development	Education and skills development, health, food and nutrition, housing and settlements, water and sanitation, social protection, and arts and culture.
Creating and enabling an environment for sustainable social economic development	Macro-economy, governance systems, foreign relations, information services, public safety, population dynamics, HIV/AIDS, gender, and the environment and natural resources.

The priorities identified and discussed by participants through **Section 3** map on to these themes. In **Sections 3.3** and **3.4**, we provide additional context about the specific challenges associated with them, and the role of Earth and environmental science in tackling these challenges.

3.5.2 Uncertainties and Limitations

The perspectives discussed through **Section 3** are a function of the sectors, disciplines, personal expertise, and experience of individuals attending the workshop. While a high diversity of sectors and disciplines were present, some key groups were under-represented. For example, while agricultural scientists were well represented, there were fewer participants from other environmental sciences (e.g., economic geology, hydrogeology) and broader disciplines (e.g., political economy, social and economic sciences) present. There was also limited diversity in terms of nationality, with 85% of the participants being from Zambia. Additional perspectives from participants from Malawi and Zimbabwe (15% of participants) were included in all workshop exercises. These perspectives can be confronted with other perspectives gathered beyond Zambia to explore if there is a regional consensus on development priorities, challenges and solutions.

4 Thematic Working Groups

The information collected in **Section 3** was used to establish three thematic working groups at the end of the first day of the workshop. Three themes were proposed by the workshop participants, and used throughout the second day of the workshop. The themes, and the reasons for their inclusion, were:

Food Security and Nutrition — *Focus on SDGs 2, 3* and *15*. Zero hunger ranked highly in individual expressions of development priorities (**Figure 3**) and the group prioritisation (**Table 2**). It also received a high ranking when considering how Earth and environmental science can help deliver sustainable development (**Table 5**).

Clean Water and Sanitation — *Focus on SDG 6.* This SDG was repeatedly emphasised to be of high importance (**Figure 3**) and (**Table 2**), with a significant role for Earth science (**Table 5**). Multiple complex challenges were identified (**Table 4**), with links between SDG 6 and health, education, and gender equality emphasised.

Energy and Climate Change — *Focus on SDGs 7* and *13.* While access to clean energy and tackling climate change ranked low in terms of eastern African development priorities

(**Figure 3** and **Table 2**), climate action was a priority for Zambia (**Figure 3**). Both clean energy and tackling climate change were emphasised to be areas where Earth scientists could make an important contribution (**Table 5**). Links between climate change and high-priority development goals (e.g., water, food, poverty) were also highlighted. This theme, therefore, reflected a group desire to explore how improving energy access and tackling climate change can support the delivery of a broader range of SDGs.

Each working group was also asked to recognise the importance of **Quality Education** (SDG 4) and tackling **Poverty** (SDG 1), given the emphasis placed on these goals during earlier exercises (**Section 3.2**).

4.1 METHODS

A modified theory of change approach was used to help frame the group discussions. An example of this process is shown in **Figure 5**, with each step highlighted and described.

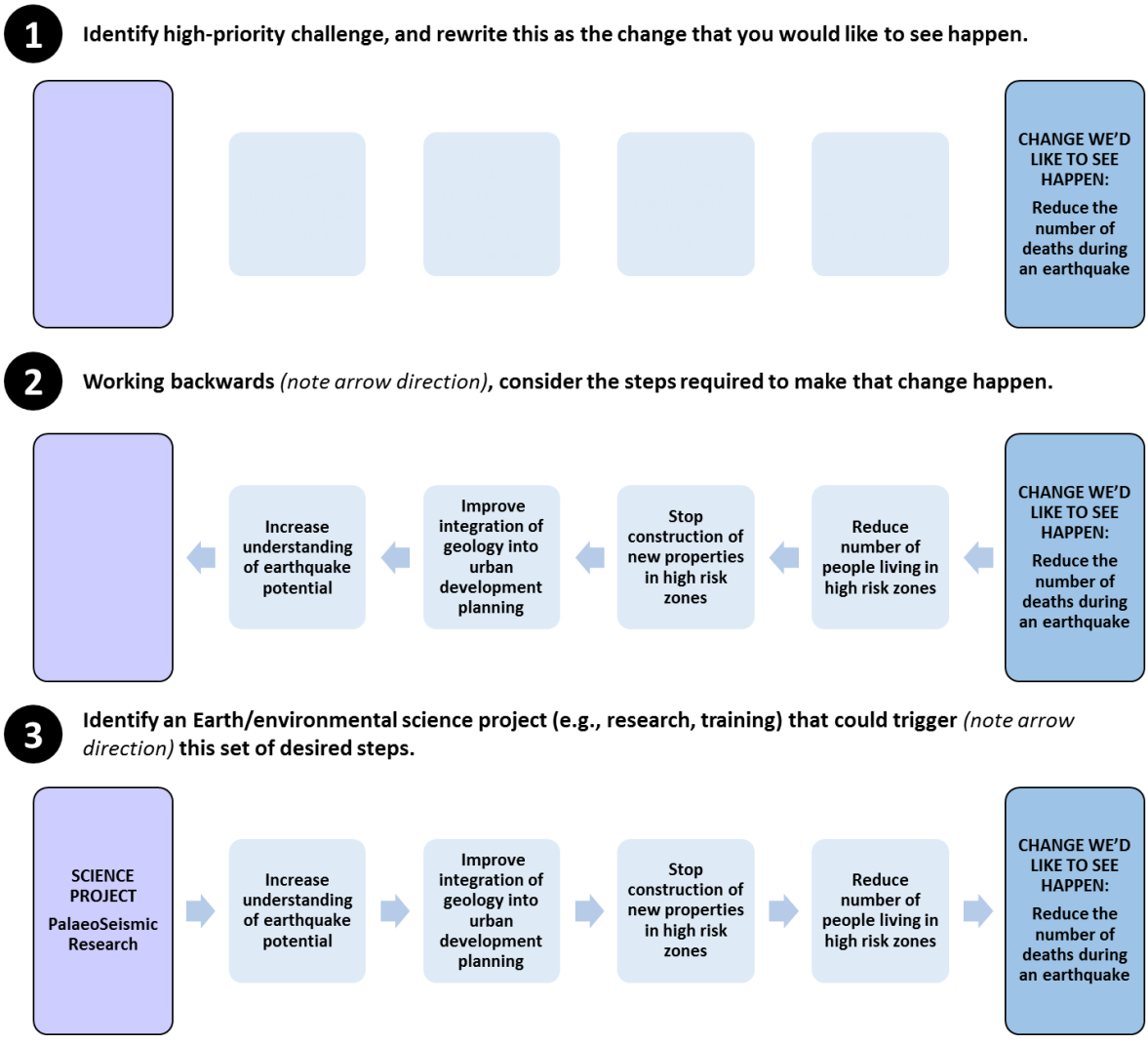

Figure 5. Identifying Earth/environmental science projects to support development priorities. *An example of a simple 'Theory of Change' approach to identifying science interventions to help address high priority development challenges.*

Groups were encouraged to consider the steps required to bring about a change before determining what Earth/environmental science research, capacity building or innovation was required. This process is outlined below.

- Groups initially reviewed specific challenges (**Section 3.3**) related to their working group, considering which challenges were the greatest priority. High priority challenges were rephrased as a positive change (e.g., a challenge of 'contaminated water', would be 'reduce contamination of water sources').
- Groups considered the steps required to make that change happen. Groups worked backwards, aiming to come up with three to five steps that characterised the 'project' to 'impact' pathway.
- Groups then determined and planned Earth and environmental science interventions to trigger this chain of steps.

The approach presented in **Figure 5** is a simplified theory of change approach, and as such includes a number of limitations. The actual change pathways may be non-linear, involving multiple branches. The approach used in the workshop, however, encouraged groups to focus on one potential chain of events in detail. Furthermore, the change pathway may differ from one region or discipline to another, but ideas were integrated from our diverse participants into one generic change pathway. We used this approach to emphasise the importance of understanding context and desired development objectives prior to designing environmental science projects.

We present a summary of the discussions in each working group in **Sections 4.2–4.4**. These summaries are based on notes taken by members of each group and the feedback presented during summary sessions. The notes below, therefore, offer a record of the conversations had by groups but these conversations have not been edited or checked to remove errors.

4.2 FOOD SECURITY AND NUTRITION

This group included contributions from: University of Zambia, Zambia Agricultural Research Institute, Basa Agro Co., Lilongwe University of Agriculture and Natural Resources, Ministry of Agriculture, Irrigation and Water Development (Malawi), Chemistry and Soil Research Institute (Zimbabwe), and the British Geological Survey.

Figure 6. Food security and nutrition thematic group. *Exploring the science, innovation and technologies required to tackle micronutrient deficiencies in eastern Africa.*

Access to sufficient and nutritious food (SDG 2) was the focus of this thematic group, integrating perspectives from diverse organisations in Zambia, Zimbabwe, and Malawi. The group started by reviewing the challenges associated with this goal (outlined in **Table 4**) and identified the

reduction of micronutrient deficiencies as being a high priority challenge and soil degradation as a secondary challenge.

In addition to ensuring there is sufficient food, it should also be nutritious. Poor plant and animal nutrition can result in nutrient deficiencies in humans, with associated health implications.

Starting with the objective of reducing micronutrient deficiencies in humans, this group identified the key change steps that could help to realise this. These steps are outlined in **Figure 7**, showing the progression from *research* (e.g., how widespread are micronutrient deficiencies), to *policy* (e.g., improved agricultural management practices, to *changes in practice* (e.g., improved nutrient supply to crops, increased dietary diversity). In addition to research being a specific component of this chain of change steps, there is also an ongoing need for research and development to support the progression from one step to the next.

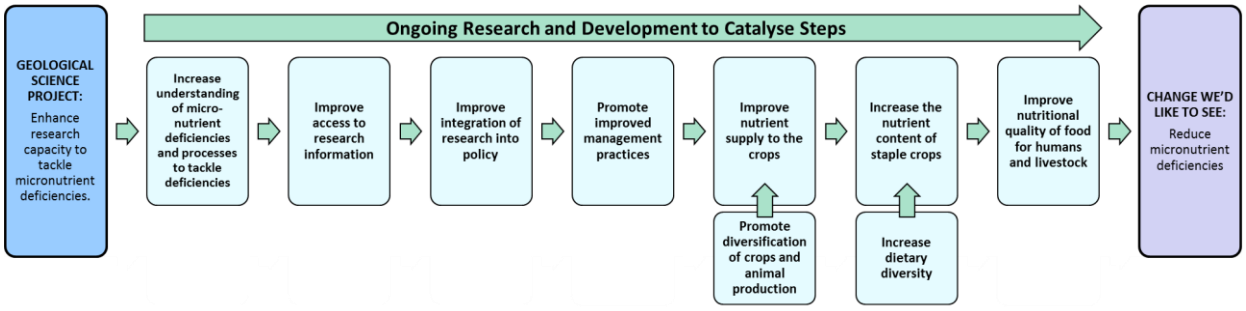

Figure 7. Reducing micronutrient deficiencies. *A simple overview of how enhanced research capacity building could help to improve nutrition in eastern Africa.*

The primary activity initiating this set of change steps is a programme of capacity building to enhance research on micronutrient deficiencies in eastern Africa (particularly Zambia, Zimbabwe and Malawi). Research is enhanced by improved (i) baseline data, (ii) access to data, and (iii) training and development. A programme integrating these steps would enable the research community to identify data gaps, conduct more comprehensive analyses, and develop innovative research programmes to understand micronutrient deficiencies and approaches to address this challenge.

- ***Baseline Data.*** Climate, soil, livestock, plant/crop types, and indigenous genetic resource data would provide a useful underpinning framework for exploring food security in general, and micronutrient deficiencies in particular. Further socio-economic information would also be needed, including population and health data.
- ***Data Access.*** The data outlined above could be included within an open-access information portal. This would display available data from across the region (brought together from currently disparate locations), and help the research community identify information gaps so that further data collection can be targeted. The integration of diverse data sets, and ability to view spatial distributions at scales ranging from local to regional, would allow more complex analyses than are currently possible.
- ***Training and Development.*** Areas for focused researcher training include data management, sampling design (statistics), physiology, genetics, and nutrition. Targeted support could help to strengthen the skills and capacities of researches to collect the data and use the data portal described above.

Building on this capacity building, a research project was proposed looking at the use of geospatial data to understand the effects of diverse management practices on livestock and the subsequent food chain. This would include management practices such as bio-fortification, soil improvement and feeding trials, considering how they affect the health of indigenous livestock (e.g., chickens) in Zambia. Livestock, such as chickens, is a primary source of protein for much of the population,

important economically, and a good indicators species for disease (e.g., oesophageal cancer). Improving the health of livestock could support improved human health.

The group briefly examined issues around soil degradation, and soil improvement technologies. They noted the diverse range of input required (e.g., soil chemistry, soil physics and soil biology), with important interactions and the need to examine this topic in an integrated way. They identified nutrient depletion as an important area for future research, which would ideally lead to new and affordable technologies to support soil improvement. Research and technology development would need to be done alongside farmers so that they understand how such technologies can help them, with research and technology combining together to result in improved welfare at the household level.

4.3 CLEAN WATER AND SANITATION

This group included contributions from: Zambian Open University, Ministry of Health (Zambia), BGR, University of Zimbabwe, Zambia Agricultural Research Institute, Copperbelt University, University of Zambia, and the British Geological Survey.

Information on water (e.g., how much groundwater is there, is pollution occurring) is necessary for the delivery of SDG 6, but is also needed to underpin other SDGs. For example, expansion of agriculture to ensure zero hunger (SDG 2) will require water resources but also means an increase in fertiliser use. This information could be at borehole (i.e., fine resolution) or regional (i.e., coarse resolution) scale, each with associated advantages and disadvantages.

Figure 8. Clean water and sanitation thematic group. *Exploring the science, innovation and technologies required to tackle specific challenges relating to clean water and sanitation (SDG 6).*

An overarching challenge is the lack of public water supply and sanitation infrastructure. Investment is needed to increase both infrastructure networks. Specific challenges relating to SDG 6 in Zambia (see **Section 3**) were initially grouped into themes of **regulation**, **pollution and contamination**, **access to water**, and **interactions between water and sanitation facilities**. Underpinning these challenges is the lack of up-to-date water resources data. Where data exists, it may be old or contains gaps limiting its use. High priority specific challenges included:

- ***Water pollution.*** This has many causes, including both natural geological pollutants (e.g., iron, fluoride, arsenic, salts) and anthropogenic activity (e.g., mining, agriculture, sanitation). The overall change objective associated with this challenge is *'reduce water pollution'*.
- ***Lack of effective regulation and management of water resources.*** The group noted the lack of a legal framework for regulation & protection of water resources. There is a growth in the number of boreholes drilled for personal use, particularly in Lusaka. Drilling is often

unregulated, with weak water management structures in place to monitor water quantity and quality. A legal framework is in the process of being prepared; ensuring its implementation will be important. The overall change objective associated with this challenge is to *'improve regulation and management of water resources'*.

A theory of change for reducing water pollution helped to identify enhancing the capacity of key stakeholders and organisational structures as a key intervention. **Figure 9** shows the steps by which this intervention would help to reduce water pollution.

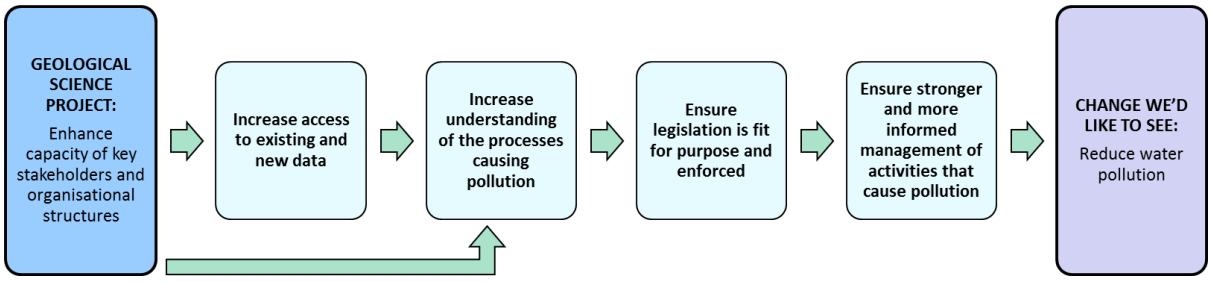

Figure 9. Reducing water pollution. *A simple overview of how enhanced capacity building of key stakeholders could help to reduce water pollution in Zambia.*

This chain of steps suggests that enhanced capacity of key stakeholders and organisational structures will increase access to existing and new data, which would subsequently increase understanding of processes causing pollution. By understanding the processes causing pollution, legislation can be developed that is fit for purpose and enforced. Stronger legislation will result in better, and more informed management of the activities that cause pollution, and ultimately reduce pollution. This is a simplistic representation of a complex chain, with key assumptions being that enhanced process understanding is a key input to the formation of legislation, and that a more informed management would take the decisions necessary to reduce pollution.

Key stakeholders identified included those responsible for water management and monitoring, and those contributing to water pollution. Examples include: national, regional and local governments; Water Resources Management Authority (WARMA); Zambian Environmental Management Agency; National Water Supply and Sanitation Council (NWASCO); Zambia Bureau of Standards (ZABS); Department of Water Resources Development (DWRD); agricultural sectors (including small scale famers); industry; mining organisations; individuals with septic tanks; sanitation companies; borehole drillers; academic researchers; geological survey; communities; water users associations; health committees; and traditional leaders.

Key areas for capacity building include: financial (accessing and managing funds and sustaining income); transport; infrastructure; monitoring stations and the collection of data; laboratories, information technology; improved water treatment systems; human resources; and education. Given the small group largely consisted of those with a science and research background, the group focused on capacity building relating to **laboratories** and **data collection**.

Laboratories. In Zambia, there are too few laboratories, the equipment is not diverse enough, and consumables can be hard to access and afford. There are not sufficient staff to run these laboratories, and existing staff may lack the necessary training. Actions to address this lack of laboratory capacity all require financial investment. Capital investment (e.g., new laboratories and equipment) is necessary but difficult to secure. Investment in training is more feasible, and could include enhancements to the academic training of those working in laboratories, as well as in-service training courses, or continued professional development. Examples of courses include potability analysis, and training on specific research parameters (e.g., pesticides, organics).

Data Collection and Monitoring, Data Management, and Data Transfer. Samples are collected and supplied to laboratories in Zambia by a range of stakeholders, including those in government, academia and the private sector. Challenges in the collection of data for monitoring of the

environment, management of data, and transfer of data to others (e.g., laboratories) result in reduced data quality and utility. For example, there are not enough people trained to do fieldwork, a lack of equipment and financial challenges that limit access to transport and fuel. The frequency at which data is collected is often not sufficient, and the data that is collected may not be of good enough quality. Procedures to manage this data are lacking, as is the necessary metadata on sampling sites. Staff need improved access to health and safety training and equipment, and must be qualified and motivated to work well. These challenges could be addressed through training, access to enhanced field and health and safety equipment, and improved procedures on topics such as health and safety, fieldwork and sample collection, and data transfer and management. New technologies (such as apps) were highlighted as having the potential to help improve data management and transfer.

Effective data collection requires agreed common standards, protocols, and templates for different data formats. Water samples are collected by diverse groups (e.g., national government, local government, universities), and therefore common standards and protocols would help to improve data quality assurance. Fit-for-purpose technologies, such as mobile applications (apps), could help disseminate these templates, which are completed when samples are submitted to laboratories for testing. Such a project would need to be incentive driven to encourage people to use the application.

In summary, an emerging theme during this discussion was the importance of ***enhancing the quality assurance of data going into and coming out of laboratories***. Improved templates for different data formats and improved data transfer procedures would strengthen data management and quality assurance in laboratories. Enhancing the data output from laboratories (e.g., through enhanced training) would help to increase access to reliable data, understand research gaps, and develop evidenced process models to understand pollutant sources and pathways.

4.4 ENERGY AND CLIMATE CHANGE

This group included contributions from: BioGas Solutions, Zambian Open University, Zambia Agricultural Research Institute, University of Zambia, Copperbelt University, and the British Geological Survey.

Figure 10. Climate change and energy thematic group. *Exploring the science, innovation and technologies relating to the delivery of SDGs associated with access to clean and affordable energy, and resilience to climate change.*

After evaluating the range of challenges in **Table 4** associated with energy and climate change, this group focused on two priority challenges:

i. Lack of clean and appropriate energy. The first challenge considered by this group related to a lack of clean, reliable and appropriate energy for Zambians. The desired change, therefore, is greater access to clean and appropriate energy in Zambia. This requires a set of steps, as visualised in **Figure 11** and summarised as (i) improved clean energy infrastructure, (ii) increased utilisation of smart and affordable energy, (iii) encouragement to use and participate in clean energy

production, and (iv) an improved understanding of future energy demand and location. The group proposed the collection and communication of geological science data to support sustainable energy development.

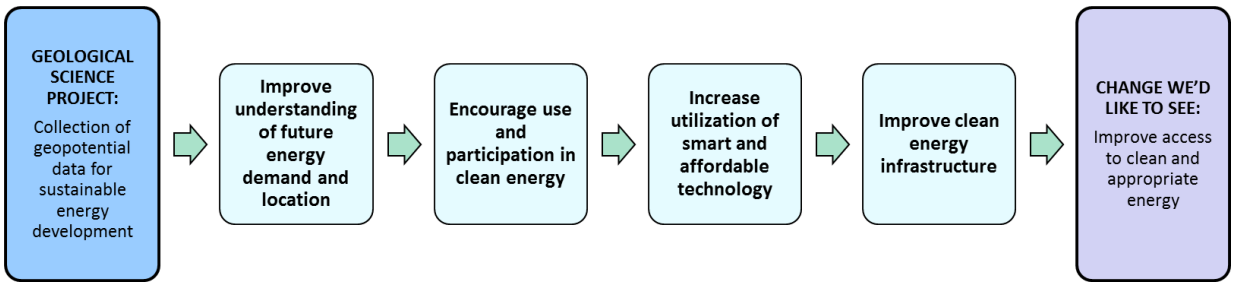

Figure 11. Enhancing access to clean and appropriate energy. *A simple overview of how geological science interventions may help to enhance access to clean and appropriate energy.*

The group identified potential energy technologies to be solar, hydroelectric, geothermal, biogas, wind and nuclear. Technologies would benefit from being locally scaled, providing off-grid energy for the community. The development of any technology would require enhanced Earth and environmental science data. For example, data on ground conditions (geotechnics), maps to visualise seismic risk and maps of geothermal (heat) potential. Data on population growth would also help understand the future nature and scale of demand. The integration of such data would inform decision-making and investments. Partnerships with economists, statisticians, the geological survey, commercial sectors, government ministries, and NGOs would be necessary to deliver this project and catalyse the subsequent change steps. Communities would also need to be involved, with this helping to overcome any resistance to new technologies.

ii. Lack of awareness regarding climate change in rural communities. Information regarding climate change and its impacts is needed by rural communities, helping to strengthen resilience and enhance resource (e.g., food, water) security in the context of a changing climate. The desired change, visualised in **Figure 12**, is therefore enhanced awareness of climate change and its impacts. Stakeholders refer to all community groups within rural villages, working with community leaders, women's groups, youth representatives and appropriate NGO and Government intermediaries.

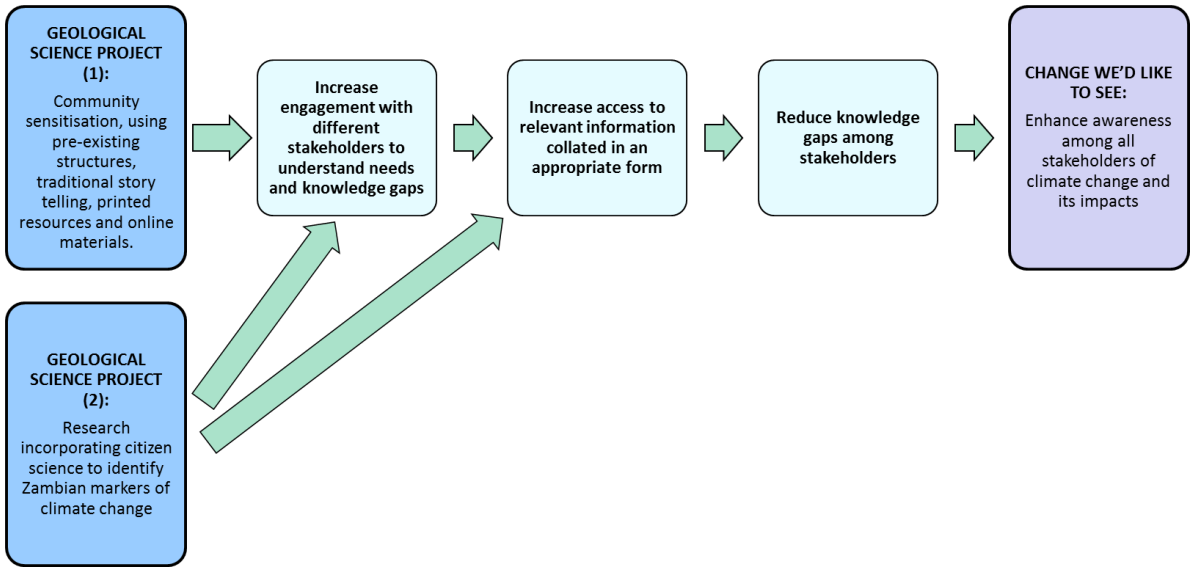

Figure 12. Enhancing awareness of climate change and its impacts. *A simple overview of how geological science interventions may help to enhance awareness of climate change in rural communities.*

To enhance awareness of climate change, there needs to be (i) reductions in knowledge gaps among stakeholders, (ii) increased access to relevant information collated in an appropriate form, and (iii) enhanced engagement with different stakeholders to understand their needs, knowledge, and knowledge gaps. These steps can also be visualised in **Figure 12**.

The group proposed two activities to help increase engagement and access to relevant information. The first activity centred on community sensitisation, taking time to engage with communities (using information collected in **Section 2.3**), and using diverse approaches to communicate information. This includes story telling where literacy is low, printed brochures/websites in other settings, and community interviews to determine perceptions on environmental change. The second activity centred on research to identify Zambian makers of climate change. This, together with the use of a citizen science approach, would help to connect climate change to the lives of Zambian communities, demonstrating its applicability to their context.

4.5 AREAS OF PROJECT OVERLAP

Across the three thematic working groups, two common themes emerged.

- *Data management.* Each group emphasised the collation and integration of data to support future project steps. Groups highlighted the importance of integrating environmental data with socio-economic data (e.g., future population, health). Data is currently in diverse formats and held by disparate organisations. The full potential of this data can only be realised when appropriate data management systems are in place, and data is integrated. This will help to identify where data gaps exist, explore future research questions, and conduct more sophisticated analyses of existing data.
- *Engagement with common stakeholders (e.g., policy makers, local governments, communities).* Across the various projects, the steps to development impact require engagement with relevant national ministries (e.g., water, health, natural resources and tourism, agriculture), local governments (e.g., district and regional governments and extension officers), and community groups.

5 Science-for-Development Partnerships

Using a questionnaire methodology, participants were invited to characterise good *science-for-development* partnerships. Here we note a summary of initial results. Data will be analysed further in the context of additional workshops, and published in a peer-review journal.

In this context, we consider '*science-for-development*' to be research, application and/or communication of science directed towards efforts to tackle poverty, improve economic and human development, manage the natural environment, and reduce risk and increase resilience. Science and research that supports sustainable development may require collaborations that are

i. **International** (i.e., people and organizations from multiple countries),
ii. **Multi-sectoral** (i.e., people from diverse sectors, such as the public and private sectors),
iii. **Multi-disciplinary** (i.e., people from diverse disciplinary backgrounds).

Questionnaires were completed independently by participants, and they were anonymous.

Participants were initially asked to comment on previous experience of *science-for-development* partnerships. They then proceeded to explore what characteristics they think are most important in developing positive and effective partnerships. Fourteen characteristics were presented, with participants asked to rate on a 7-point Likert scale (from *Strongly Agree* to *Strongly Disagree*) how important they believe each factor to be in the formation of positive 'science-for-development' partnerships. One test characteristic (*members of the partnership are all the same*

nationality) was also added to check that participants were evaluating each statement carefully and not simply giving the highest ranking to each statement.

Based on 21 responses, the characteristics of *science-for-development* partnerships ranked as being of most importance are listed below.

1. Sharing of data across the partnership.
2. Access to training and capacity building.
2. Sharing of project outputs across the partnership (e.g., reports, journal articles).
4. Opportunity for all members of the partnership to contribute to project design.
4. Respectful dialogue between members of the partnership.
6. Access to funding/financial resources.
7. Access to expertise of other organizations.
8. Being treated as an equal by other members of the partnership.
8. Frequent e-mail communication between members of the partnership.
10. Understanding of cultural differences across the partnership.
10. Co-authorship of research outputs (e.g., journal articles, reports).
12. Access to facilities of other organizations.
13. Regular face-to-face meetings between members of the partnership.
14. Frequent telephone communication between members of the partnership.
15. Members of the partnership are all the same nationality [*test characteristic*].

The rankings presented above suggest that characteristics associated with **equality** are of greatest importance to participants. Four of the top five ranked characteristics relate to the affirmation of partners as equals in any science-for-development collaboration. For example, ensuring equal access to data generated as part of the partnership (#1) and project outputs (e.g., reports, journal articles) (#2, joint) are highly valued by those questioned, as were opportunities for all members of the partnership to contribute to project design (#4, joint). Other characteristics associated with this 'equality' theme are being treated as an equal by other members of the partnership (#8, joint), and ensuring opportunities for co-authorship of research outputs (#10, joint).

Secondary to these 'equality' values are a set of values relating to **resources** and the resourcing of partners. Access to training and capacity building (#2, joint) was prioritised more than access to funding and financial resources (#6), expertise (#7), or facilities (#12). Finally a set of values can be identified which relate to the partnership **process**. Respectful dialogue (#4, joint) and frequent email communications between partnership members ranked relatively highly (#8, joint).

This preliminary data synthesis can help to inform partnership development in a Zambian context (recognising that four out of the 21 responses were from participants from Malawi and Zimbabwe). These results provide BGS with an understanding of key values to embed within research partnerships, supporting ongoing monitoring and evaluation of whether partnerships remain mutually beneficial. Replication of this research in other countries can help to develop a multi-national perspective on characteristics for effective science-for-development partnerships.

6 Conclusions

6.1 SUMMARY

Through this workshop, and subsequent analysis, we have undertaken, understood and demonstrated the following:

- **Section 2**. Characterised the organisations involved in this workshop, identifying key stakeholders from academia, government, and the private sector. The workshop adopted a bottom-up approach, with those attending demonstrating a high level of enthusiasm, engaging

positively, with a willingness to share their expertise and experiences. Participants developed and enhanced their own networks, with the potential for future collaborative activities.

- **Section 3**. Explored development priorities in eastern Africa and Zambia, and the role of Earth and environmental science in addressing these, identifying quality education, ending poverty, access to clean water and sanitation, ensuring food security, and improving health as recurring priorities. This report allows all workshop participants (including the BGS) to understand development priorities in eastern Africa and Zambia, using the SDGs as a reference tool. The approaches used to understand these priorities demonstrated an interactive pedagogy, and raised awareness of the SDGs as a global development strategy.
- **Section 4**. Summarised the discussions of three working groups, exploring potential ideas relating to food security and nutrition, water and sanitation, and energy and climate change. From these groups we identified thematic projects that could support sustainable development in a Zambian context (with applications to the wider region). For example, emerging from the water and sanitation working group was the idea of developing a mobile application (app) to improve data management and transfer between stakeholders and laboratories. This approach could enhance the quality of data, and help increase understanding of the processes causing water pollution, with the ultimate aim of reducing pollution. At the end of **Section 4** we also highlight some crosscutting project priorities (e.g., data management, engagement with diverse stakeholders). The approaches used to develop projects demonstrated an interactive pedagogy, and raised awareness of a theory of change process by which projects can be determined.
- **Section 5**. Documented the characteristics that workshop participants considered to be of greatest importance in *science-for-development* partnerships, identifying those characteristics associated with equality. For example, equal access to data generated as part of the partnership, project outputs (e.g., reports, journal articles), and opportunities for all members to contribute to project design. All of the activities identified in **Section 4** will require multi-sectoral and multi-disciplinary partnerships.

In the following section, we outline the next steps, to be explored with project partners, which will advance these ideas.

6.2 NEXT STEPS

This workshop report discusses development challenges in eastern Africa (particularly Zambia, with insights into Malawi and Zimbabwe), and presents several ideas where Earth and environmental science will support sustainable development. *We will send this report to all workshop participants, and encourage their active engagement in reflecting on the conclusions and refining the proposed next steps*. Through externally funded activities, BGS staff are actively engaged in work in Zambia, Zimbabwe and Malawi. We will proactively continue discussions with many of those who were present at the workshop, and discuss the following actions to advance and enhance the outputs from this workshop:

i. ***Co-produce project proposals (aims, objectives, background context, pathways to development impact) for ideas generated in this workshop.*** Workshop participants identified a set of potential projects that could be developed through (for example) BGS ODA or GCRF funding. For example, the food security group suggested a comprehensive multinational capacity-building programme that strengthened access to data, and the ability of researchers to use this to complete further analyses on micronutrient deficiencies in eastern Africa. Through meetings with stakeholders in Zambia, Malawi and Zimbabwe, *we will co-produce with in-country colleagues outline proposals for these projects in preparation for relevant funding opportunities.*

ii. ***Bring in stakeholders from additional disciplines***. While the workshop attracted 14 organisations, key groups were missing, particularly those from socio-economic disciplines and civil society. Many of the pathways to development impact identified in

previous sections will need engagement and input from professionals in the socio-economic sciences. Additional engagement was also needed with the minerals sector in Zambia. *We will pro-actively work to build relationships with appropriate civil society groups, socio-economic professionals, and minerals professionals, mapping out potential stakeholders, and seeking enhanced engagement at future workshops.*

iii. ***Connect stakeholders in Zambia, Malawi and Zimbabwe with BGS (and external) expertise relevant to emerging projects.*** Having identified relevant expertise and research/project interests in Zambia, *we will use the extensive BGS network of researcher links from across eastern Africa and the UK to catalyse new interactions.*

iv. ***Explore eastern African priorities by contrasting this workshop with the results of workshops in Tanzania and Kenya***. Having coordinated three workshops in eastern Africa (Kenya, Tanzania and Zambia), we will proceed to contrast the results of these. *We will write and publish a peer-reviewed paper that examines similarities and differences between development priorities across the region, and discuss emerging themes of common interest.*

v. ***Improve our understanding of effective international partnerships to support science-for-development***. During this workshop, we collected data to understand partnership priorities in a Zambian context, with initial perspectives from Zimbabwe and Malawi. *We will supplement this data with semi-structured interviews, and aim to publish a peer-reviewed journal article on science-for-development partnerships.*

Appendix 1 Workshop Programme

The two-day workshop programme is included below, with detail of the sessions planned.

DAY 1 (14 SEPTEMBER 2017)

	Session	Activities	Purpose
08.30-09.00	**Registration & Refreshments**		
09.00-09.45	**Welcome/ Introduction**	• Formal welcome • Welcome from Zambian representative • Context and objectives of the workshop • Overview of the workshop structure/activities • Participants' expectations	
09.45-11.10	**Participant Introductions and Mapping**	**10.00-10.15** Icebreaker **10.15-11.10** Group Activity (Stakeholder Mapping) • **Introductions:** Each person introduces them self (name, where from, organisation, type of activities included in their work, where these activities take place). • **Nodes and Linkages**: Explore sectors, disciplines, collaborations. • **All Together**: Identify how organisations influence each other (i) connect research to a new policy; (ii) approach communities about participating in research; (iii) encourage use of a new data information website.	This exercise acts as an icebreaker, catalyses dialogue between participants, and generates data to support effective stakeholder mapping. It helps all participants know what groups are represented at the workshop, and what work they are doing.
11.10-11.30	**Tea and Coffee Break**		
11.30-12.30	**Plenary Talks (Zambia, Malawi and the UK)** *(10 minutes each, with 5 minutes for questions)*.		Set the scene and give useful context to the SDGs, as well as the work of the British Geological Survey.
12.30-14.00	**Buffet Lunch**		
14.00-15.30	**Regional Development Needs** *(Big picture, high-level problems)*	**14.00-14.10** Session Introduction **14.10-15.30** Sustainable Development Goals • **Individual Exercise.** Populate a matrix with information about priority SDGs. • **Group Exercise.** Rank the SDGs in terms of their relative importance. • **All together.** Identify specific challenges for priority SDGs.	Explore stakeholder perspectives on development priorities, using the Sustainable Development Goals (SDGs) as a reference tool.
15.30-16.00	**Tea and Coffee Break**		
16.00-16.30	**Regional Development Needs** *(Big picture, high-level problems)*	• **All together.** Explore the role of Earth and environmental science by identifying: (i) which SDGs require input from Earth/environmental scientists, and (ii) what that input is?	
16.30-17.00	**Open Discussion and Questions and Answer Session with BGS Team**	An opportunity for comments reflecting on the information discussed in Day 1. Participants can also ask questions to the BGS team about their intentions, experiences and work.	Promote transparency and honest discussion.
17.00-17.15	**Summary**	• Reflection and Summary of Day 1 • Plan for Day 2, including selection of three thematic working groups.	

DAY 2 (15 SEPTEMBER 2017)

	Session	Activities	Purpose
08.30-09.00	**Arrival & Refreshments**		
09.00-09.30	**Welcome/ Recap**	• Recap Objectives • Recap key outputs from Day 1 • Structure Day 2	
09.30-10.00	**Example Project Planning:** *What changes need to happen?*	Session Introduction	
10.00-11.00		Discussion Groups *(themes determined at the end of Day 1).* • **What needs to change?** Groups identify the specific challenges associated with the group theme, and rank these into high/medium/low priority. • **How does change happen?** What are the steps needed for this change to occur?	Explore priority development challenges, and determine what changes need to happen.
11.00-11.20	**Tea and Coffee Break**		
11.20-12.30	**Example Project Planning:** *Earth and Environmental Science Solutions*	• **Earth/environmental science solutions?** Groups work to develop example project outlines that would help to tackle high-priority challenges. • **Who needs to be involved?** Identify those people who need to be involved if the project is going to result in change? • **Where does the funding come from?** Local and International sources of funding for projects	Identify the role of Earth and environmental science in addressing identified challenges, and consider example projects to develop this science.
12.30-14.00	**Buffet Lunch**		
14.00-15.00	**Example Project Planning:** *Group Feedback*	Feedback from group discussions, with time for questions and answers.	
15.00-15.20	**Tea and Coffee Break**		
15.20-16.20	**Building Good Partnerships**	What are the characteristics of good international partnerships? We will explore this theme through: • **Questionnaire** • **Group Discussion Exercise** The data generated may be published (in an anonymous form) and used to inform BGS future planning, enable effective monitoring and evaluation of our partnerships.	Characterise good science-for-development partnerships, from the perspective of workshop participants.
16.20-17.00	**Concluding Remarks**	• Review • Reflections on ways forward • Formal close/thank you • Feedback Forms	

Appendix 2 Workshop Feedback

How would you rate your overall experience as a participant at this workshop?

Very Negative	Fairly Negative	Slightly Negative	Neither	Slightly Positive	Fairly Positive	Very Positive
					4	17

How would you rate each of the following aspects of this workshop? (n =21)

Communication before the Workshop:

Very Negative	Fairly Negative	Slightly Negative	Neither	Slightly Positive	Fairly Positive	Very Positive
			1	1	6	12

Workshop Programme:

Very Negative	Fairly Negative	Slightly Negative	Neither	Slightly Positive	Fairly Positive	Very Positive
				1	7	13

Venue:

Very Negative	Fairly Negative	Slightly Negative	Neither	Slightly Positive	Fairly Positive	Very Positive
					4	17

Catering/Refreshments:

Very Negative	Fairly Negative	Slightly Negative	Neither	Slightly Positive	Fairly Positive	Very Positive
					5	16

Quality of Discussion:

Very Negative	Fairly Negative	Slightly Negative	Neither	Slightly Positive	Fairly Positive	Very Positive
					4	17

Opportunity to Contribute to Activities:

Very Negative	Fairly Negative	Slightly Negative	Neither	Slightly Positive	Fairly Positive	Very Positive
					3	18

Consider your overall experience at this workshop. Please indicate the extent to which you agree/disagree with the following statements (n =21, 1 person did not complete the final three questions):

I received the communication I needed to play an effective part in the workshop.

Strongly Disagree	Disagree	Slightly Disagree	Neither Agree nor Disagree	Slightly Agree	Agree	Strongly Agree
1				2	10	8

I felt comfortable getting involved in the table discussions.

Strongly Disagree	Disagree	Slightly Disagree	Neither Agree nor Disagree	Slightly Agree	Agree	Strongly Agree
					7	14

I felt comfortable getting involved in the larger (whole-workshop) discussions.

Strongly Disagree	Disagree	Slightly Disagree	Neither Agree nor Disagree	Slightly Agree	Agree	Strongly Agree
					10	11

The workshop proceeded at a pace I felt comfortable with.

Strongly Disagree	Disagree	Slightly Disagree	Neither Agree nor Disagree	Slightly Agree	Agree	Strongly Agree
				1	10	10

I understood how each session linked to the objectives of the workshop.

Strongly Disagree	Disagree	Slightly Disagree	Neither Agree nor Disagree	Slightly Agree	Agree	Strongly Agree
				1	7	12

I felt my opinions were valued by other workshop participants.

Strongly Disagree	Disagree	Slightly Disagree	Neither Agree nor Disagree	Slightly Agree	Agree	Strongly Agree
					7	13

I felt my opinions were valued by the workshop facilitators.

Strongly Disagree	Disagree	Slightly Disagree	Neither Agree nor Disagree	Slightly Agree	Agree	Strongly Agree
					8	12

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