A COORDINATED AGENDA FOR MARINE, ENVIRONMENT AND RURAL AFFAIRS SCIENCE (CAMERAS) (2011-2016)

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Science in Support of Marine, Environment, Rural Affairs (MERA) and Related Polices of the Scottish Government: A Coordinated Agenda for Marine, Environment and Rural Affairs Science (CAMERAS) (2011-2016)

1. *The Royal Society of Edinburgh (RSE), as Scotland's National Academy, welcomes the timing of the Scottish Government's initiative for a coordinated agenda (CAMERAS) to help align the scientific activities of those organisations operating in this domain in Scotland. It believes however that the current approach as described in the consultation, if persisted with, represents a missed opportunity to define the high level issues and objectives for environmental and rural affairs science in Scotland. It is important to define and deliver an overall strategy for this sector of science in the context of the wider research needs of Scotland's rural environment and economy, and in the context of Scottish science as a whole. Such a broader and bolder strategy is needed to provide the framework for the Scottish Government to identify policy priorities and for the Scottish science base to respond with the research that will be needed in decades to come. The RSE has made analogous comments in its response to the Scottish Government's proposals for merging RERAD's research institutes.*

2. The consultation document currently contains no clear underlying logic. Although we recognise that the document has been produced to support the Scottish Government's overriding purpose of increasing sustainable economic growth, it does not relate sufficiently to this central objective or to the Scottish Government's objectives of a "Wealthier and Fairer, Healthier, Safer and Stronger, and Smarter Scotland". The document's sole focus is the "Greener" component of that agenda.

3. While the document does attempt to articulate the benefits of collaboration and alignment between existing bodies in the MERA science domain, it does so without a clear, contextual appreciation of the high level issues and priorities. The RSE has therefore drawn together a wide-ranging group of experts from the MERA domain, who have identified the following six strategic science priority areas which we believe should have formed the foci of the consultation document:

    - Energy
    - Education and Knowledge Exchange

- Food and Water
- Environment and Global Change
- Rural Communities
- Biodiversity and Sustainable Use of Natural Resources

4. Having identified the strategic priority areas, the group has identified the contribution each of the priority areas makes to the economic sustainability of Scotland as well as their alignment with the five Strategic Objectives of Wealthier and Fairer, Healthier, Safer and Stronger, Smarter, and Greener. This has been prepared in the form of a matrix and is an example of the sort of structured strategic framework that is required if the science base is to respond to current and emerging challenges. Given the short timeframe within which this has been done, we would hope this approach could be developed further by others, including in-depth economic, sociological and technological analyses. This exercise also highlights wider problems in the consultation process in general. It would have been more appropriate if there had been an early stage, wide-ranging stakeholder workshop involving participants from the science base, scientific NDPBs, and Agencies of the Scottish Government to identity strategic science priority areas.

5. The approach taken by the RSE in this response has been to identify and elaborate on the strategic science priority areas that we believe need to be identified, but we have also responded to the twenty-four questions posed in the consultation document with reference to the framework matrix prepared below. We hope that the Scottish Government will be prepared to consider the wider issues that our response raises. We would be pleased to discuss these issues further with the Scottish Government; and indeed, if desired, to contribute further to the development of a strategy for this sector of science.

Energy

Increasing Sustainable Economic Growth	*Wealthier & Fairer*	*Healthier*	*Safer & Stronger*	*Smarter*	*Greener*
Develop, with urgency, a robust and realistic energy strategy that utilises a viable diversity of energy sources including renewables, clean technologies for fossil fuels and nuclear power generation Develop a common methodology to assess the relative merits of energy technologies, including full lifetime costs and a carbon audit Maximise Scotland's research, development and demonstration capacity and capability for renewable and low carbon emissions sources of energy Understand mechanisms for changing patterns of energy consumption Develop sustainable bio-energy strategies	Maximise Scotland's research, development and demonstration capacity and capability for renewable and low carbon emissions sources of energy Support local communities to derive economic benefit from renewable and low carbon emissions sources of energy Maintain access to affordable energy for all of society Understand mechanisms for changing patterns of energy consumption	Minimise pollutant outputs of energy generation and use Maintain access to affordable energy for all of society	Develop, with urgency, a robust and realistic energy strategy utilising a viable diversity of energy sources including renewables, clean technologies for fossil fuels and nuclear power generation To ensure security of supply and to benefit from economies of scale the approach should encourage interdependency with the UK, European and global markets. Enhance waste management	Maximise Scotland's research, development and demonstration capacity and capability for renewable and low carbon emissions sources of energy Build technical resilience for the move to the low carbon economy Achieve a balance between energy generation and use and environmental aspects	Maximise Scotland's research, development and demonstration capacity and capability for renewable and low carbon emissions sources of energy Ensure an appropriate balance between the carbon costs of energy extraction and carbon savings Define the environmental trade-offs associated with specific options for energy production Minimise pollutant outputs of energy generation and use Enhance transport systems (both public and private)

based on use of plant-based resources and organic wastes Develop sustainable extraction of hydrocarbons Understand incentives for renewable and low carbon emissions sources of energy					

Education and Knowledge Exchange

Increasing Sustainable Economic Growth	*Wealthier & Fairer*	*Healthier*	*Safer & Stronger*	*Smarter*	*Greener*
Create the conditions for talented people to live, learn, visit, work and remain in Scotland[1] Provide and support an entrepreneurial environment for the exploitation, communication and commercialisation of scientific discoveries and new products/technologies in the MERA areas Improve two-way KE	Establish outreach programmes of interest and relevance to Scottish people and visitors Create participatory process to enhance governance	Establish outreach programmes of interest and relevance to Scottish people and visitors Create participatory process to enhance governance	Establish outreach programmes of interest and relevance to Scottish people and visitors	Establish Scotland as a recognised world leader in the transfer of science into practice, through technology development and knowledge exchange	Educate the public and the relevant industries on the importance of sustainable environments Improve understanding of ecosystem function to enhance ecosystem services for the benefit of all Ensure biodiversity and sustainable ecosystems are on school and university curricula

[1] Scottish Government International Framework 2008

between all providers and users of science in the MERA areas, including all industries in the food chain and environmental/landscape use Understand public attitudes and behaviour Understand how regulation drives innovation Increase engagement of school children with science					

Food and Water

Increasing Sustainable Economic Growth	*Wealthier & Fairer*	*Healthier*	*Safer & Stronger*	*Smarter*	*Greener*
Meet the Scottish Government Food and Drink Strategy target of increasing the value of Scottish industry from £7.3B to £10B by 2017 Underpin sustainable growth of the value and value-added of the Scottish beef, sheep and pig industries	Continue enhancement of the genetic base of Scotland's livestock and fish farming Develop preventive methods (e.g. diagnostics and vaccines) to reduce diseases which adversely affect the economics of farming and the welfare of	Ensure food is free of food-borne pathogens and residues Ensure water is free from pathogens and residues Increase access to high-quality, healthy foods for all of society Provide fish protein	Reduce risk to impact of endemic and exotic diseases and increase community resilience Enhance flood and drought management, mitigation of pollutants	Ensure herd and flock health plans and use of data collections allow farmers to take informed business decisions; analogous procedures for crops	Develop preventive methods for diseases (e.g. diagnostics and vaccines) to reduce use of chemicals and drugs, and unproductive greenhouse gas emissions Breed livestock for production efficiency, and disease

Underpin sustainable growth of the value and value-added of the Scottish dairy sector Underpin sustainable growth of the value and value-added of the Scottish crop sector, including cereals, root crops and vegetables Underpin sustainable growth of the value and value-added of the Scottish fish and shellfish sector including sustainable sea-fisheries Generate exploitable IP for the growth of Scottish Biotech companies Promote the sound scientific basis for the Scottish Brand in food and food products	farmed livestock, fish and shell fish; analogous procedures for farmed crops Improve sustainable use of feed resources in livestock and fish farming Develop novel diagnostics and vaccines for emerging diseases associated with global trade and environmental change, and innovation in methods to restrict the introduction of exotic and epidemic diseases Increase access to high-quality, healthy foods for all of society	and essential oils Improve the nutritional value of, and diversify crops for local markets and export using all available (bio) technologies			resistance; analogous procedures for crops Develop integrated management approaches for sustainable and selected use of fertilizers and agrochemicals

Environment and Global Change

Increasing Sustainable Economic Growth	*Wealthier & Fairer*	*Healthier*	*Safer & Stronger*	*Smarter*	*Greener*
Optimise Scotland's contribution to global food supply whilst	Develop novel diagnostics and vaccines for emerging	Develop novel diagnostics and vaccines for emerging	Horizon scan for emerging and re-emerging crop,	Maintain Scotland's position of influence based on relevant	Develop preventive methods for diseases (e.g. diagnostics and

minimising its global footprint Develop the means to establish market and non-market value of ecosystem goods and services Increase R&D efforts to mitigate and adapt to possible future long-term changes in climate, and actively exploit and export these	diseases associated with global trade and environmental change, and innovation in methods to restrict the introduction of exotic and epidemic diseases Develop the means of dealing with epidemic diseases of agricultural organisms and human populations to minimise socio-economic impact	diseases associated with global trade and environmental change, and innovation in methods to restrict the introduction of exotic and epidemic diseases Understand the environmental risks and benefits of new materials and chemicals Enhance waste management	agricultural animal and human pathogens and toxic pollutants Establish livestock and crop surveillance schemes, include remote sensing	internationally excellent research Increase understanding of the effects of climate change on agricultural, aquaculture and fisheries production	vaccines) to reduce use of chemicals and drugs, and unproductive greenhouse gas emissions Breed livestock for production efficiency, and disease resistance; analogous procedures for crops Increase energy efficiency and reduce carbon footprint of agriculture, aquaculture and fisheries Understand connectivity for biodiversity in the landscape and the potential for amelioration/mitigation

Rural Communities

Increasing Sustainable Economic Growth	*Wealthier & Fairer*	*Healthier*	*Safer & Stronger*	*Smarter*	*Greener*
Capacity for development - Underpinning industries which support local jobs and encourage external investment Develop a national policy framework for rural areas and communities that embraces healthy demographic structure, economic opportunity and environmentally sustainable improvement Embrace greater community participation and cooperation in the provision of essential infrastructure such as housing, education and transport facilities Maximise community resilience by minimising community dislocation due to weather events and flooding	Sustain livestock and fish farming for Scotland's rural communities Encourage economic diversification of rural communities Use research-derived technologies to ensure scalable fit to rural communities' needs Develop strategies for informed access to and enjoyment of Scotland's natural resources, including marine resources, in the rural and urban environment (green spaces)	Minimise risk of zoonotic infections from exposure in the countryside Develop strategies for informed access to and enjoyment of Scotland's natural resources, including marine resources, in the rural and urban environment (green spaces) Sustain jobs and local community infrastructure in rural areas including remote rural areas	Develop regional and local herd, flock and crop, health plans Sustain jobs and local community infrastructure in rural areas including remote rural areas	Encourage economic diversification of rural communities Develop holistic approaches to sustainable consumption	Support local communities to utilise renewable and low carbon emissions sources of energy Enhance transport systems (both public and private) Improve understanding of ecosystem function to enhance ecosystem services for the benefit of all

Biodiversity and Sustainable Use of Natural Resources

Increasing Sustainable Economic Growth	*Wealthier & Fairer*	*Healthier*	*Safer & Stronger*	*Smarter*	*Greener*
Develop the means to establish market and non-market value of landscapes to maintain and enhance ecosystem services and to conserve biodiversity Define the trade-offs between biodiversity effects and economic growth Ensure all fisheries are managed at sustainable levels, without adverse impacts on marine biodiversity Develop mitigation and adaptation strategies for the impacts of climate change on biodiversity, including marine biodiversity	Enhance equity of managed and semi-natural land use across Scotland to sustain diversity of landscapes for wider benefit but especially rural communities Provide sound conceptual and scientifically based integration of productive land use, wildlife management and tourism	Develop strategies for informed access to and enjoyment of Scotland's natural resources, including marine resources, in the rural and urban environment (green spaces) Sustain jobs and local community infrastructure in rural areas including remote rural areas Maintain robust ecosystems and ecosystem services Monitor the marine environment to ensure marine resources have low levels of contaminants that may endanger human health	Maintain robust ecosystems and ecosystem services Develop Models of scenarios of change to inform options for more sustainable natural resource management Increase understanding of threats to biodiversity and potential to ameliorate these Sustain jobs and local community infrastructure in rural areas including remote rural areas	Maintain Scotland's position of influence based on relevant internationally excellent research Promote awareness and understanding of biodiversity issues and of the need to harvest natural resources sustainably Build community capacity and knowledge resources in rural areas Refine indicators and monitoring methods (applies across columns)	Encourage sustainable land use practices Develop crop, grassland and livestock systems designed to optimise both food production and carbon capture Improve understanding of ecosystem function to enhance ecosystem services for the benefit of all Secure the capacity to safeguard Scotland's biodiversity through continued investment in expertise Invest in new technologies to make biodiversity information more widely accessible

Develop scientific strategies for managing significant conflicts between species, including strategies for non-native species Develop quantitative assessments for the economic value of natural heritage Develop science and policies for sustainable soil resources					Invest in new technologies to identify biodiversity e.g. DNA bar-coding

Headline Themes

1. Do you agree that the two broad categories of "Local Responses to Global Change" and "Optimising the Potential of Scotland's Natural Assets" are helpful in providing an overlying structure to the Co-ordinated Agenda?

No, they are helpful but not complete. As we have argued above, we believe the current consultation to be a missed opportunity to determine the future strategic science needs of Scotland. Whilst the document has focussed on some important issues (e.g. global change and natural heritage) there are significant omissions and a distinct lack of strategic detail. As a result, it is not at all clear where the document sits within the bigger picture of the provision and use of science in Scotland.

In the matrix framework the RSE expert group has tried to identify the strategic priority areas (Energy, Education and Knowledge Exchange, Food and Water, Environment and Global Change, Rural Communities, and Biodiversity and Sustainable Use of Natural Resources), including those not articulated in the consultation document, and the contribution that each makes to the Scottish Government purpose of increasing sustainable economic growth and its five supporting strategic objectives.

2. Are the descriptions of these set out in Section 3 (and Annex 3) comprehensive?

Again, No. The "policy" descriptions and examples of the "science" in Section 3 are not comprehensive. As we have indicated in our previous answer and set out in greater detail in the proposed matrix, other high level questions and issues exist and will arise, unforeseen and unpredicted.

CAMERAS covers marine, environment and rural affairs science, and addressing these science / policy areas together will ensure synergy. However, energy research is also critical but seems to be largely outside this funding mechanism (though renewables are mentioned). Stronger links to energy research initiatives elsewhere in Government should be highlighted. There are particular rural issues and opportunities arising from local-scale and national-scale renewable energy projects, these should be recognised.

3. Do these cover the major policy challenges where science can contribute as you see them?

No. Please refer to the responses above as well as the contributions of the strategic science priority areas set out in the RSE framework matrix, above.

4. Are they likely to remain broadly relevant over the longer time horizon (well beyond the 2016 focus of this Coordinated Agenda)?

We consider that all the priority scientific areas outlined in the matrix will remain important to Scotland and much of the rest of the world for the foreseeable future and at least until 2050.

5. Do you agree with the description of support for the National Capability Theme set out in Section 3 (and Annex 3)?

Yes. One way of ensuring better integration of research expertise across the Research Institutes and Universities would be to make available funding areas that require joint bids / partnerships / consortia across Scottish Universities and Scottish Research Institutes. The "centres of excellence/one stop shops" (page 9) on specific issues/themes could produce virtual institutes that would encourage collaboration, with examples to be found in the pooling exercises in the Universities and the Thematic Programmes in the Research Institutes, but embracing both the Universities and Research Institutes. The success of such virtual institutes depends on an appropriate funding mechanism that establishes a level playing field for all the relevant scientists regardless of their affiliation.

6. What facilities, resources and data do you think are important for Scotland to maintain?

This question exemplifies one of the weaknesses of the current approach to this consultation exercise. As we have advocated above, strong consideration should be given to defining and delivering an overall strategy for environmental and rural affairs science in the context of the wider research needs of Scotland's rural environment and economy, and in the context of Scottish science as a whole. Such a strategy is needed to provide the framework for what facilities, resources, and data should be maintained and developed, and where wholly new initiatives are required.

7. Are there other resources that Scotland needs to acquire to support future policy development?

Please see our response to the previous question.

Policy Issues

8. Have we correctly identified the key policy issues and the associated scientific opportunities in Section 3?

Although there is a great deal of uncertainty surrounding the potential effects and impacts of climate change, we agree that it seems inevitable that impacts will occur over the coming decades. However, in the consultation document the primary focus seems to be on "potentially harmful" impacts. It should be recognised that there could also be beneficial impacts of climate change for Scotland (e.g. more exotic and greater out-of-season crop production for a more varied, healthy diet using a wider variety of locally produced fruits and vegetables) and opportunities to exploit such impacts. Increased drought in many continents may increase the need for Scotland and the UK's reliance on

home-produced food especially that which is derived from livestock which utilise grazing land. Positive facets do not appear to be recognised or even considered in the current proposals.

9. Are there additional issues that should be included?

Following on from the previous response, it is paramount that there is a rigorous analysis of the true costs and benefits of various options, including full (carbon) life-cycle costs, the stage of technological development, and their ability to deliver as expected. In its Report into *Energy Issues for Scotland*, the RSE recommended that due to a lack of robust procedures for assessing energy technologies, and the frequent lack of objectivity in such assessments, that a common methodology should be developed to assess the relative merits of energy technologies. Factors such as the state of the technology, infrastructure requirements, security of supply, carbon benefit, environmental effects, cost to the consumer, as well as full lifetime costs should be considered. This type of robust methodology could be applied to other sectors.

10. What do you think will be the most important influences on Scotland's future in the Marine, Environment, Rural Affairs and related areas?

At this point we would wish to refer to the strategic science priorities identified in our matrix framework:

- Energy
- Education and Knowledge Exchange
- Food and Water
- Environment and Global Change
- Rural Communities
- Biodiversity and Sustainable Use of Natural Resources

However, in the immediate term, the current recession of unpredictable length and depth, will be a primary influence.

11. Why do you think these are important?

The reasons are self explanatory. However, for completeness, we would highlight the fact that globally humanity faces huge challenges in addressing the pressures caused by a growing population of increasing affluence and aspiration and by the finite limitations of the world's resources and the adverse atmospheric and climatic effects of their use. We believe that Scotland must seek to address the impacts and opportunities of this global situation and its economic, environmental and societal consequences by making full use of its resources, including its scientific and technological resources and the innovation and enterprise of its people.

12. Are there other scientific opportunities which should be highlighted?

It is crucial that government recognises the importance of “win-win” options that deliver on more than one of the strategic priority areas. Currently the administrative boundaries by which government manages its business can result in a lack of policy connectivity and policy contradiction and, as such, it is much more difficult to determine “win-win” options.

Scientific understanding and the technologies that derive from it, have changed, are changing and will continue to change the way we live. As such it is imperative that all are stakeholders in the scientific venture. Scientists need to engage with fellow citizens and policy makers in explaining the potentials and limitations of their science, whilst recognising the critical importance of social values in determining how scientific understanding should be used. Governments and bodies in civic society need to collaborate constructively in creating the frame within which these interactions can occur. If these processes fail, there is every prospect that the scientific creativity and understanding that is increasingly required to cope with issues such as climate change, energy technologies, stem cell technologies, nanotechnology, genetically modified organisms etc., will not be exploited, that we will fail to realise the potential that science offers the economy and in support of public policy, and that we will be indecisive and ineffectual in the face of the many challenges that confront us.

The Science

13. What existing areas of Scottish based scientific expertise should be maintained to contribute evidence to key policy issues?

Scotland is strong in research in agriculture, forestry and land use, in marine science and fisheries, and in environmental science. These strengths should be nurtured. Application of scientific knowledge needs to be improved by better education and by improving engagement with our social science base. While education may not be within the current CAMERAS remit, we have identified it in the matrix framework as a strategic science priority area. As we have advocated in our answer to question 12, scientists need to engage with fellow citizens and policy makers in explaining the potentials and limitations of their science, whilst recognising the critical importance of social values in determining how scientific understanding should be used. The social sciences should be more routinely engaged to understand better how business, universities, government agencies and research institutions can interact more effectively and how public values can be included in the formation and implementation of policy. The RSE’s recent response to the DIUS consultation on *A Vision for Science and Society* focuses on this interplay in greater detail.

In the last decade, there has been a dramatic improvement in the efficiency and drive of the Scottish universities and institutes to connect with business. They have used their technical excellence as a major attractor for research-intensive inward investment, have created an increasing number of spin-out and start-up companies and attracted much international talent to Scotland. In our view, however, it will be difficult to make much further progress without

developing something that has long been absent in Scotland, a much stronger pull from business that elsewhere is the dominant mechanism for economic exploitation of the science base. This is a central strategic issue that the Scottish Government must address. In order to address the issue of low levels of investment in R&D by Scottish business and its failure to exploit the excellence of the science base, the RSE has set up a business-led Business Forum.

14. How clear is the relationship between the scientific areas and the key policy issues?

As indicated at the outset, we believe that the current approach as described in the consultation, if persisted with, represents a missed opportunity to define the high level issues and objectives for environmental and rural affairs science in Scotland. It is important to define and deliver an overall strategy for this sector of science in the context of the wider research needs of Scotland's rural environment and economy, and in the context of Scottish science as a whole. Such a broader and bolder strategy is needed to provide the framework for the Scottish Government to identify policy priorities and for the Scottish science base to respond with the research that will be needed.

Science should not be driven by 'key policy issues' that may be short-term in nature and subject to radical change with, for example, a change of administration.

15. In which areas of science can we continue to make use of expertise supported elsewhere e.g. at the UK, EU and international levels?

The RSE considers this to be a very important issue. Project-based funding in universities is largely derived from UK Research Councils, which also fund many specialist institutes. They play a central role in stimulating and funding major UK-wide consortia in which Scottish institutions have been highly successful. It is vital that Scotland remains an integral part of the UK science base. This integration offsets one of the problems of small countries in research, in that they cannot be internationally competitive in all sectors of research and in the businesses that rely on it. A large-scale system has greater capacity to maintain research diversity and thereby the flexibility to pursue new directions; to make available otherwise unaffordable opportunities to its most competitive groups; and to stimulate excellence through its openness to competition and the wider horizons that it offers.

Beyond the UK there are currently important moves within Europe to strengthen and re-launch the "European Research Area", in which Europe becomes a common market for research. There is every prospect that within the decade, the major funding for basic research in Europe and for early stage development of key platform technologies could be allocated at the European level. Preparing to engage much more closely at a European level should be an important strategic objective for Scotland, with the promotion of more structured relationships with European universities and research centres.

16. In the time frame for CAMERAS (2011-2016) what new emerging areas of science are likely to mature and become available for more general use or application?

We draw attention to the matrix framework.

In particular it is likely that there will be improved environmental modelling, with explicit indications of the (un)certainty of the outcomes. Many plant and animal biotechnologies have already advanced to application over the past 20 years. Further developments are inevitable over the timeframe of CAMERAS.

17. Do we have the expertise available to be able to use these new opportunities?

Yes – but we could strengthen the areas in which we already lead (see response to question 13).

18. In which areas does Scotland need to be self reliant?

Science is a worldwide enterprise but Scotland must have sufficient resources and expertise to be able to contribute to and draw on the wider international resources. For example, in environmental science, ecology, animal science, biotechnology, genetics and other fields there are large worldwide science communities but the technological application and exploitation of knowledge and understanding in economic, environmental and social problems in Scotland have specific regional and local dimensions and dynamics.

Please also see response to question 15.

Delivery

19. Knowledge Exchange is essential for scientific activity to achieve impact. Do you agree that KE should be an explicit and integral aspect of the delivery of this Coordinated Agenda?

Yes, in the matrix framework we have identified education and knowledge exchange as a strategic science priority and illustrated the contribution that it can make to the Scottish Government's overarching purpose of increasing sustainable economic growth and its five strategic objectives.

Please also see our response to question 13.

20. How can we continue to improve the integration of evidence from a diverse range of sources into forms that are accessible to end users?

In its response to the IUSS Parliamentary Committee on *Putting Science and Engineering at the Heart of Government Policy*, the RSE recognised that a major problem lies in the extent to which scientific understanding has extended to so many diverse issues. Science is now such a powerful and

pervasive source of understanding that there are few areas of government policy to which it does not apply. At the same time, far more scientific knowledge exists outwith the ready reach of Government than within it, where the direct STEM support for policy within Government is relatively small. In many areas, direct support has diminished, whereas the range of expertise needed to underpin policy has greatly expanded. In Scotland, the post of Chief Scientific Adviser to the Scottish Government has been established, supported by a Scottish Science Advisory Council; but, as yet, scientific advice is not as pervasively available within the Scottish Government as it needs to be.

There is a serious need to enlist support for public policy from the wider science base, particularly from the universities, which contain enormous resources and unique ranges of competence and therefore a unique capacity to address complex cross-discipline issues. “Centres of excellence/one stop shops” could be used to facilitate this. Government needs to analyse and prioritise its needs more rigorously and to reach out more effectively to the universities. Universities need to recognise and reward the importance of this activity, and both need to discuss the funding basis that would enable this development.

It is highly questionable whether the conventional process of consultation about a proposed policy is adequate to the need. In far too many cases, the underlying technical basis of consultation papers is flawed. In some, through persistence, it is possible to achieve some reverse engineering, but in many cases we suspect that the purpose of consultation is simply to claim that it has occurred. It would be far better if Government were able to create imaginative mechanisms that would entrain high levels of expertise from the start. In our opening statements to this response, we indicated that it would have been more appropriate if there had been an early stage, wide-ranging stakeholder workshop involving participants from the science base, scientific NDPBs, and Agencies of the Scottish Government to identity the strategic science priority areas. We hope that the matrix framework outlined, provides an example of the potential outputs that may be harnessed by such an approach. This framework was created within a short timeframe and could be used as a prototype for further consideration by the scientific communities and by policy makers.

21. How can we reconcile the requirement for science to be responsive and flexible to short term demands while at the same time ensuring that longer term strategic research continues to progress our knowledge and understanding?

As we set out in our introduction to this response, the current approach represents a missed opportunity to define the high level issues and objectives for environmental and rural affairs science in Scotland, and to define and deliver an overall strategy for this sector of science in the context of the wider research needs of Scotland’s rural environment and economy, and in the context of Scottish science as a whole. Such a strategy, which should recognise the functions of research, is needed to provide the framework for

the Scottish Government to identify policy priorities and for the Scottish science base to respond with the research that will be needed.

In its response to the Scottish Government's proposals for merging RERAD's research institutes, the RSE set out the following attributes of an effective research base in the domain of land and marine management needs:

- **Basic research** that explores the fundamentals of relevant phenomena, that provides the fundamental underpinning for current issues, that is sufficiently broadly-based to adapt to emergent issues, and is of sufficient quality to ensure that Scotland is able to benefit from its international links and from external funding.
- **Strategic research** that focuses on specific, often long-term issues of importance to Scotland.
- **Knowledge transfer functions** that have three foci:
  - an outreach function able readily and accessibly to provide advice to the users and managers of the Scottish land and marine environment;
  - commercialisation of new products and processes;
  - contractual services, including internationally.
- **Policy–driven research** and involvement in the policy creation process.
- **Statutory function** fulfilment.

22. How can we ensure that the 2 way flow of knowledge from science to policy and from policy to the academic community is optimised?

In its response to the IUSS Parliamentary Committee on *Putting Science and Engineering at the Heart of Government Policy*, the RSE identified this as an area requiring significant strengthening. The government has political, social and economic objectives that it wishes to pursue that reflect the dynamics of political debate. The STEM community has no special locus in determining these priorities, although scientists may be heavily involved as individuals. The primary role of the STEM community is to provide evidence about matters of governmental concern (e.g. the psychological impacts of cannabis), to identify issues that require a governmental response (e.g. the probability of severe climate change), or evidence of the options that could underlie policy decisions about how to respond to such issues (e.g. low emissions energy generation options). Such involvement by the STEM community may be quite fundamental to the eventual policy, but it is for Government to determine what that policy should be, according to their political objectives, not the STEM community. Science is concerned to understand the working of nature, it is for society to determine how that understanding should be used.

The question for Government is no longer whether the input of the STEM community to policy formation is necessary, it is clearly vital, but how best that input can be achieved. The RSE's response on *Putting Science and Engineering at the Heart of Government Policy*, provides greater detail on the current system through which government formulates science and engineering policy.

Please see our response to question 20.

23. Are there alternative structures/systems or new approaches/organisations that could enhance these flows?

Please see our responses to questions 5 and 20.

24. Are there science delivery models which could provide examples of good practice for Scotland to follow?

With regard to government enlisting support for public policy from the wider science base, we have already referred to the limitations of the conventional process of consultation. It would be far better if Government were able to create imaginative mechanisms that would entrain high levels of expertise from the start. The relationship between the US Government and the National Academy of Sciences would be worth inspection in this regard.

Additional Information and References

In responding to this consultation the Society would like to draw attention to the following Royal Society of Edinburgh responses which are of relevance to this subject:

- The Royal Society of Edinburgh's *Inquiry into Energy Issues for Scotland* (June 2006)
- The Royal Society of Edinburgh's submission to the Scottish Government, *On Delivering More Effective Government: Proposed Government Institute/Commission Mergers* (April 2008)
- The Royal Society of Edinburgh's *Inquiry into the Future of Scotland's Hills and Islands* (September 2008)
- The Royal Society of Edinburgh's submission to *The Interim Report of the Joint Future Thinking Taskforce on Universities* (September 2008)
- The Royal Society of Edinburgh's submission to the Commission on Scottish Devolution, *Review of the Experience of Devolution in Scotland* (September 2008)
- The Royal Society of Edinburgh's submission to DIUS, *A Vision for Science and Society* (October 2008)
- The Royal Society of Edinburgh's submission to IUSS Committee inquiry, *Putting Science and Engineering at the Heart of Government Policy* (January 2009)
- The Royal Society of Edinburgh's submission to the Scottish Parliament's Transport, Infrastructure and Climate Change Committee, *Climate Change (Scotland) Bill* (February 2009)
- The Royal Society of Edinburgh's briefing paper for the Debate in the Scottish Parliament on *Science for Scotland* (March 2009)

Any enquiries about this submission and others should be addressed to the RSE's Consultations Officer, Mr William Hardie
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Responses are published on the RSE website (www.royalsoced.org.uk)

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