A toolkit to determine policy-relevant biodiversity data

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1. INTRODUCTION

Biodiversity data[1] mobilization is the process by which information about biodiversity is captured, digitized and published to become globally discoverable, freely accessible and easily consumable. Sharing data in this manner is of critical importance to biodiversity research and natural resource management.[2, 3] Indeed, the success of efforts to address critical global issues – such as food security, invasive alien species, deforestation, land degradation, the spread of diseases, and marine productivity – depends largely on the availability of relevant, reliable biodiversity data.

The imperative to share biodiversity data is recognised by the 193 Parties to the Convention on Biological Diversity (CBD), specifically, in Article 17 of the Convention, which states:

The Contracting Parties shall facilitate the exchange of information, from all publicly available sources, relevant to the conservation and sustainable use of biological diversity, taking into account the special needs of developing countries… Such exchange of information shall… where feasible, include repatriation of information.[4]

According to the CBD Executive Secretary, Braulio Ferreira de Souza Dias, the Aichi Targets – a set of 20 global targets for reducing the direct pressures on biodiversity and improving its status by 2015 or 2020 – are in danger of being missed because of inadequate availability and accessibility data. Meeting Aichi Target 19, concerning the enhancement of data-sharing, may therefore be regarded as a prerequisite to meeting the other targets.[5]

In this respect, organisations such as the Global Biodiversity Information Facility (GBIF) – established in 2001 – are working with governments and data-holding institutions across the world to create the infrastructure, systems, tools and networks necessary to progress towards a vision of "free and open access to biodiversity data".[6]

Whilst millions of biodiversity data records have been mobilized in recent years, the nature of these efforts has been predominantly opportunistic, focusing on low-hanging fruits that can be readily published, rather than data of strategic importance to research, policy and decision-making.[7] According to GBIF, "progress in global biodiversity data discovery and mobilization is linear, geographically uneven, and opportunistic… generally within the comfort zones of the data custodians and publishers... there are

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[1] For the purposes of this toolkit, 'biodiversity data' is understood to concern mainly species occurrence records.
[2] Chapman, A.D. *Uses of Primary Species-Occurrence Data, version 1.0*. (Copenhagen, Denmark: Global Biodiversity Information Facility, 2005) at p.4.
[3] Pyke, G.H. and Ehrlich, P.R. *Biological collections and ecological/environmental research: a review, some observations and a look to the future.* 85 BIOGICAL REVIEWS 247 (2010).
[4] Article 17, Convention on Biological Diversity, Rio de Janeiro, 5 Jun. 1992, 1760 UNTS 79, *reprinted in* 31 ILM 818 (entered into force 29 Dec. 1993).
[5] Padma, T. *Biodiversity data gaps 'need bridging' to meet global targets*, (11 Oct. 2012) <http://www.scidev.net/global/climate-change/news/biodiversity-data-gaps-need-bridging-to-meet-global-targets.html> (accessed: 27 Jan. 2014).
[6] GBIF. *Free and open access to biodiversity data*, (undated) <www.gbif.org> (accessed: 1 Feb. 2014).
[7] Vollmar, A., Macklin, J. A., and Ford, L.S. *Natural history specimen digitization: challenges and concerns*, 7 J. BIODIVERSITY INFORMATICS 93 (2010).

few, if any, specific demand-driven and deterministic data discovery and mobilization strategies amongst data publishers."[8] However, in recent years, GBIF has placed renewed focus on mobilizing data to meet the needs of end users. Many applications of biodiversity are documented on the GBIF website.

With current resource allocation, and socio-political and scientific priorities, it may not be possible to mobilize all of the world's biodiversity data.[9] Some degree of selectiveness should therefore be exercised when deciding which data to mobilize. Limited conservation resources should not be squandered on mobilizing data without policy or decision-making relevance.[10] If such strategic value cannot be demonstrated then a vicious cycle may arise, whereby donors become increasingly reluctant to support biodiversity data mobilization activities, opting instead to support alternative projects with more tangible outcomes.

Conversely, if biodiversity data mobilization is undertaken in a more strategic and purpose-driven manner, geared towards informing important policy decisions (either directly or via further analyses), then such value will become apparent and donors may respond positively by consolidating their support. Thus ensuring policy-relevance and strategic value of data mobilization activities will increase the potential for attracting financial and human resources to support further data mobilization activities creating a virtuous cycle.[11] Figure 1 illustrates the concepts of vicious and virtuous cycles.

[8] Chavan, V.S., Sood, R.K., and Arino, A.H. GBIF. *Best practice guide for 'Data Discovery and Publishing Strategy and Action Plans' version 1.0.* (Copenhagen, Denmark: GBIF, 2010) at p.2.
[9] Barents, P., Hamer, M., and Chavan, V.S. *Towards demand-driven publishing: Approaches to the prioritization of digitization of natural history collection data*, 7 BIODIVERSITY INFORMATICS 113 at p. 113 (2010).
[10] In this toolkit, the term, 'policy and decision-making relevant', will be used interchangeably with the abbreviated term, 'policy-relevant'.
[11] *Supra* 8 at p.114

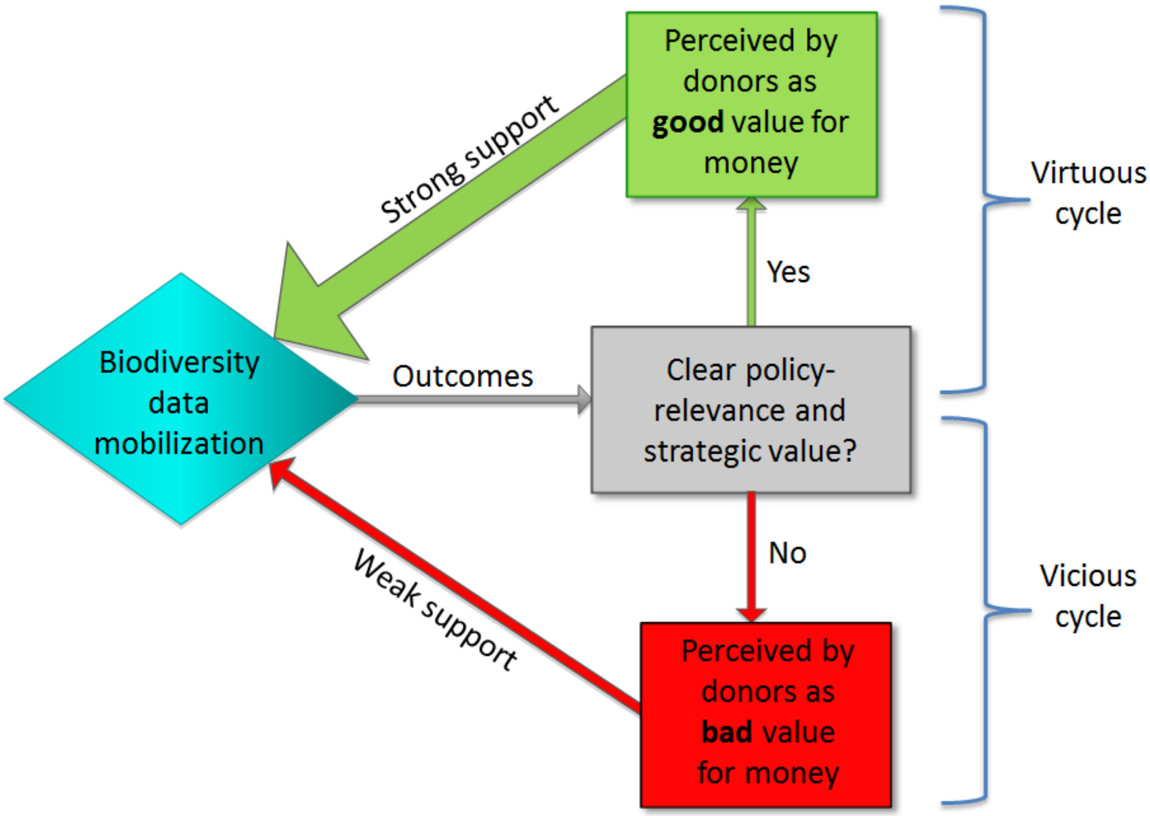

Figure 1. Diagrammatic representation of virtuous and vicious cycles of biodiversity data mobilization.

For several years, the challenge of identifying and mobilizing policy-relevant biodiversity data has been a regular topic of discussion within the GBIF Africa Regional Group – a network of African biodiversity informaticians affiliated to GBIF – which meets annually to share experiences, enhance collective capacity, and coordinate activities (see figure 2). The GBIF Secretariat encourages its members to develop their own "Data Discovery & Publishing Strategies and Action Plans" and it has, in this vain, produced a set of 'how-to' guidelines.[12] Such strategies and action plans can help to focus data mobilization efforts on desired outcomes which better meeting the needs of policy and decision makers.

[12] *Supra* 8

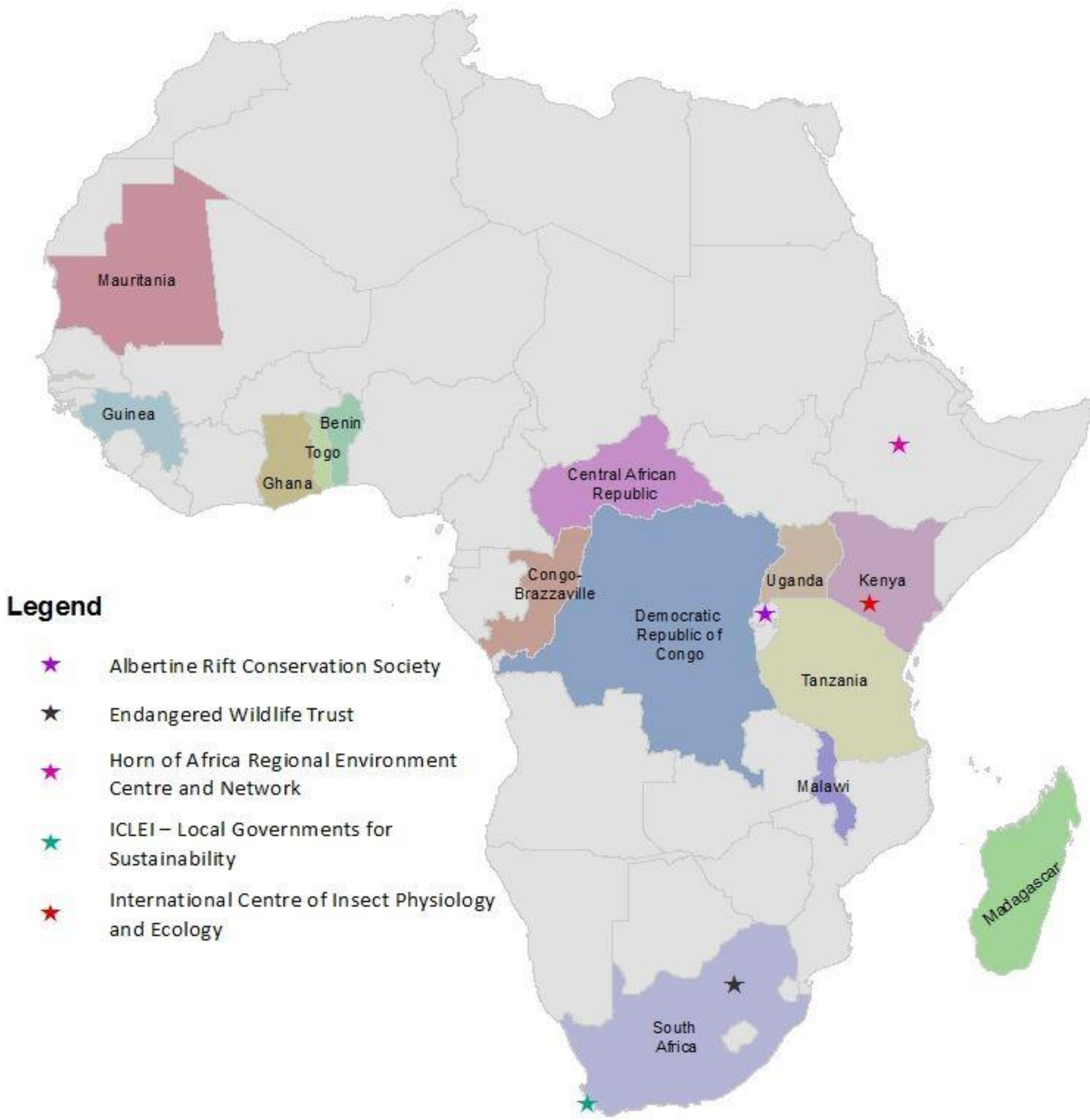

Figure 2. Map of GBIF Participants in Africa as of January 2016 (image credit: SANBI).

As a member of the GBIF Africa Regional Group, the South African National Biodiversity Institute (SANBI) received a grant of USD 250,000 from the JRS Biodiversity Foundation to implement a project in collaboration with its African partners, entitled, *Mobilizing policy and decision-making relevant biodiversity data*. The project ran from October 2013 to December 2016. The overarching aim of the project was to develop a Biodiversity Data Mobilization Strategy for GBIF African members, whilst enhancing regional capacity and collaboration in biodiversity informatics. The key objectives were to:

i) Define priority policy-relevant biodiversity data;
ii) Conduct a gap analysis of priority biodiversity data (i.e. check availability);

iii) Create an inventory of data-holding institutions;
iv) Foster collaboration and data-sharing between institutions;
v) Develop appropriate online support tools; and
vi) Disseminate lessons of the project (e.g. by developing academic curriculum and training materials).

The present document is a toolkit prepared in partial fulfilment of the first objective. It is designed to assist African biodiversity informaticians in identifying and prioritizing biodiversity data for mobilization, with a focus on policy- and decision-making relevance, strategic value and knowledge applications. It is envisaged that the primary users will comprise biodiversity informaticians, data managers, scientists, and researchers. However, certain policymakers who, for instance, must decide on the allocation of political, institutional and financial support to biodiversity informatics may use this toolkit as a guide to priority-setting. It is also envisaged that the methodologies contained in this toolkit will be used to inform activities in a second phase of the aforementioned JRS-funded project due to commence in mid to late 2016.

The development of this toolkit was undertaken in close collaboration with members of the GBIF Secretariat and GBIF Africa Regional Group. The toolkit provides a number of different methods to identify and prioritize policy and decision-making relevant biodiversity data for mobilization. These methods are distilled from the experiences, suggestions and feedback of the GBIF Africa Regional Group, as well as a literature review entailing the examination of various models concerning the interplay of data, science and policy.

Finally, it should be noted that this toolkit constitutes a living document that may be periodically updated and consolidated as new insights, ideas and materials come to light. This may be achieved through test-bedding, implementing user feedback, and assimilating emerging knowledge and best practices.

2. WHAT IS POLICY-RELEVANT BIODIVERSITY DATA?

In order to define policy and decision-making relevant biodiversity data, it is necessary to consider a number of preliminary questions. What is policy? Who are policy makers? What is the policy making process and how can science influence it? What is evidence-based/-informed policy and how what is policy-relevance? This subsection will seek to answer these questions.

2.1. What is policy?

Policy affects all of us in our daily lives. The term has many definitions. Burger defines it as "a set of interrelated decisions taken by a political actor or group of actors concerning the selection of goals and the means of achieving them within a specified situation where these decisions should, in principle, be within the power of these actors to achieve."[13] Nakamura & Smallwood define it "as a set of instructions from policymakers to policy-implementers that spell out both goals and the means for achieving those goals."[14] Meanwhile Hogwood & Gunn offer a broader definition of policy: a label for a field of activity, an expression of general purpose or desired state of affairs, specific proposals, decisions of government, formal authorization, a programme, output, outcome, a theory or model, and a process.[15]

According to Guba, "one can safely conclude that the term policy is not defined in any uniform way". He identifies eight uses of the term:[16]

i) Policy is an assertion of intents or goals.
ii) Policy is the accumulated standing decisions of a governing body… within its sphere of authority.
iii) Policy is a guide to discretionary action.
iv) Policy is a strategy undertaken to solve or ameliorate a problem.
v) Policy is sanctioned behaviour, formally… or informally through expectations and acceptance established over (sanctified by) time.
vi) Policy is a norm of conduct characterized by consistency and regularity in some substantive action area.
vii) Policy is the output of the policymaking system.
viii) Policy is the effect of the policymaking and policy-implementing system as it is experienced by the client.

Furthermore, Guba notes that "the particular definition assumed by the policy analyst determines the kinds of policy questions that are asked,… data that are collected, the sources of data…, the methodology… used, and… the policy products that emerge."[17]

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[13] Burger, R.H. Information policy: A framework for evaluation and policy research (Norwood, USA: Ablex, 1993) at p.7.
[14] Nakamura, R.T. and Smallwood, F. The politics of policy implementation (New York, USA: St. Martin's, 1980) at p.31.
[15] Hogwood, B.W. and Gunn, L.A. Policy analysis for the real world (Oxford, UK: Oxford University Press, 1984) at pp.13-19.
[16] Guba, E.G. *The effects of definitions of policy on the nature and outcomes of policy analysis*, 42(2) EDUCATIONAL LEADERSHIP 63 at pp.63-65 (1984).

A common thread of these definitions is the chain of causation between initial conditions and future consequences. Policies are thus designed to solve problems by guiding decisions and actions towards desired outcomes.

For the purpose of this toolkit, a shorter, narrower working definition of policy is posited:

A course or principle of action adopted or proposed by government with a view to solving real world problems.

Additionally, for the purpose of this toolkit, decision-making is considered to be a component of policy making.

2.2. Who are policymakers?

In seeking to understand policy relevance, it is helpful to examine the characteristics of policymakers, especially in comparison with scientists (including biodiversity informaticians). Scientists may generate considerable volumes of biodiversity data and/or act as intermediaries between data providers and policymakers. Policymakers and scientists generally work under very different demands, constraints and reward systems.

Scientists and policymakers often level criticism at each other: scientists are accused of being out of touch, irrelevant and impractical; whereas policymakers are accused of "ignoring, under-utilizing or misinterpreting research findings when formulating or implementing policy."[18] Roux *et al.* suggest that such bidirectional criticism is an acknowledgement of their mutual dependence![19]

For scientists, performance is usually measured as the production and impact factor (citation rates) of peer-reviewed publications, the positive contribution made to their organisation's reputation, and the amount of external funding they can raise to support research activities. In the scientific community, job security is often project-dependent, which encourages scientists to seek long term funding for projects. In pursuit of novel findings, for which they receive most recognition among their peers, scientists tend to become highly specialised. In general, they receive relatively little recognition or reward for influencing industry practice or public debate.

Policymakers work in a very different environment. In most governments, power is distributed in a hierarchy and the careers of policymakers are dependent on advancing policies and programmes that reflect the broader manifesto of the government. According to Gibbons *et al.*, "there are a broader range of competing interests and stakeholders that policymakers need to consider when providing

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[17] *Supra* 15 at p.70

[18] Gibbons, P., Zammit, C., Youngentob, K., Possingham, H.P., Lindenmayer, D.B., Bekessy, S., Burgman, M., Colyvan, M., Considine, M., Felton, A., Hobbs, R.J., Hurley, K., McAlpine, C., McCarthy, M.A., Moore, J., Robinson, D., Salt, D. and Wintle, B. *Some practical suggestions for improving engagement between researchers and policy-makers in natural resource management* 9(3) ECOLOGICAL MANAGEMENT & RESTORATION 182 at p.182 (2008).

[19] Roux, D.J., Rogers, K.H., Biggs, H.C., Ashton, P.J. and Sergeant, A. *Bridging the science-management divide: moving from unidirectional knowledge transfer to knowledge interfacing and sharing*, 11(1):4 ECOLOGY AND SOCIETY 1 at p.10 (2006).

advice to government than typically considered by researchers." Time frames can also be critical for policymakers, who must often make decisions quickly in the absence of certainty. Figure 3 summarizes and compares the key motivations of researchers (or scientists) and policymakers.

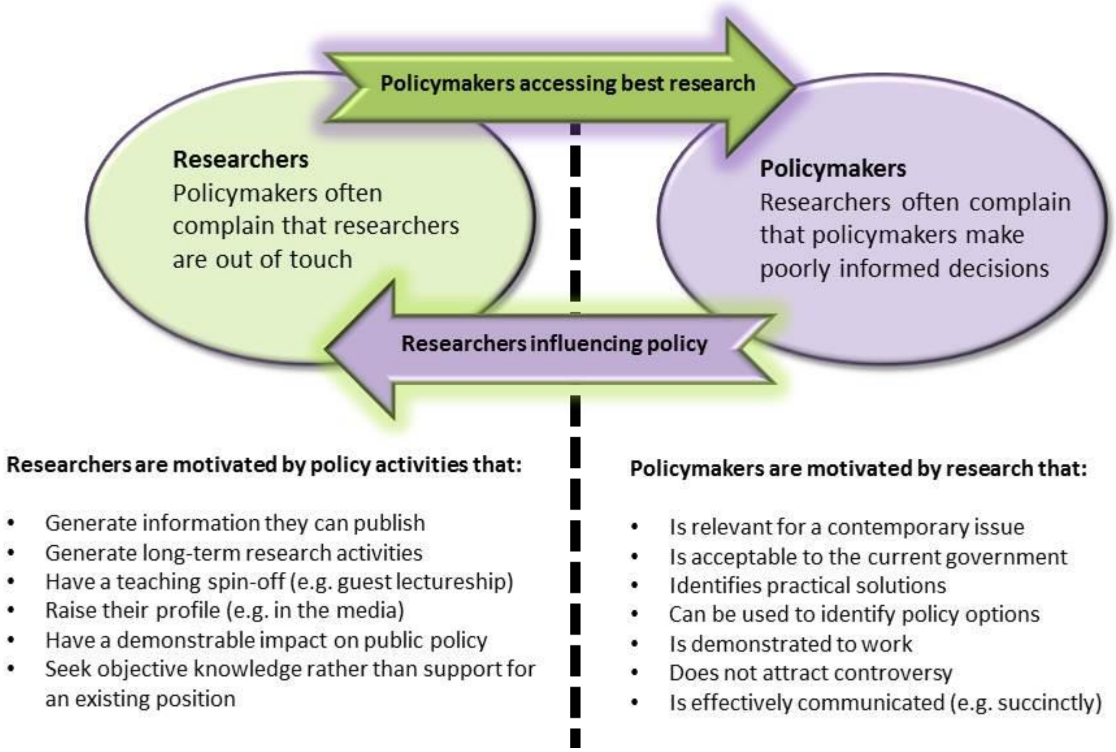

Figure 3. A comparison of the key motivations of researchers and policymakers (adapted from Gibbons *et al.* 2008).

2.3. The policy process

The development and implementation of policy are not single outcomes or events, but are actually part of a cyclical process, moving from agenda-setting to implementation, monitoring and evaluation. There is a subtle distinction between law and policy. Whilst the former are typically passed by a legislative body, approved by an executive branch and enforced/interpreted by a judicial system, the latter are usually created by individual agencies and enforced/interpreted through internal channels, albeit within a legal framework.

This 'policy process' is driven by "an interplay of institutions, ideas and interests".[20] Given the substantial influence of policy on matters concerning special interest groups (e.g. commercial activity, environmental health and public service delivery), the policy process is hotly contested and complicated. For scientists to effectively engage in the policy process, they must understand its dynamics and players.

[20] John, P. Analysing Public Policy (London, UK: Cassell 1998) at p.59.

Figure 4 provides a deceptively simple representation of the policy making process. When one considers the plethora of different institutions and their various channels of interaction and influence, the picture is far more complex, as is depicted in figure 5.

Figure 4. A simplified representation of the policy making process.

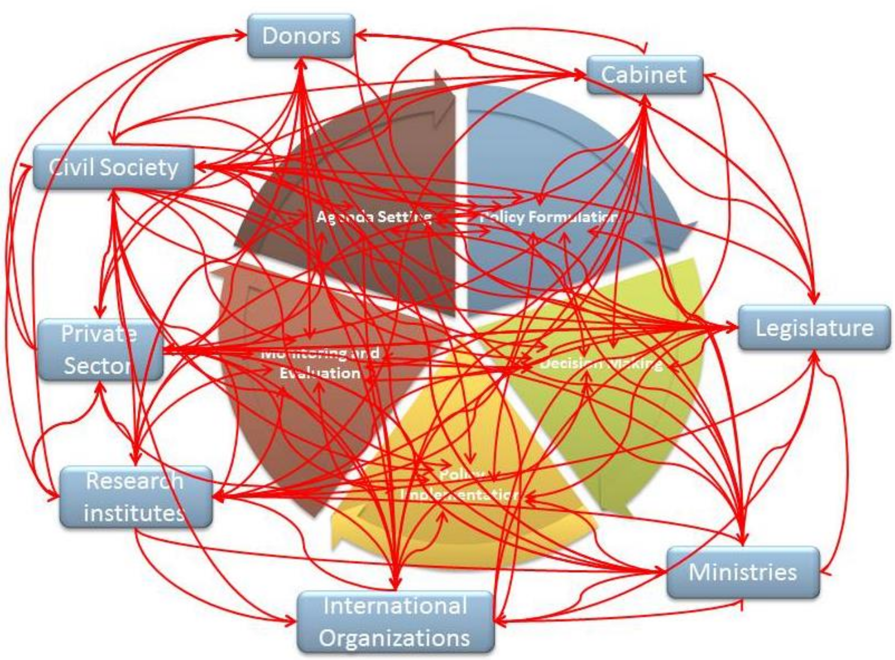

Figure 5. A representation of the policy making process including the interplay of institutions, ideas and interests. The red lines depict the formal and informal channels of influence and are presented here only to highlight the complexity of system.

2.4. How can science influence policy?

There are many ways in which scientific evidence, by inference of biodiversity data, can be taken up into policy and practice and several models exist to illustrate this.

The recently-formed Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES) – which is set to become the world's "leading intergovernmental body for assessing the state of the planet's biodiversity, its ecosystems and the essential services they provide to society" – is committed to the mobilization of policy-relevant biodiversity data with a view to addressing knowledge gaps and informing policy formulation.[21] Figure 6 provides an adapted representation of the science-policy interface that IPBES is seeking to establish. It entails scientists communicating information and evidence to the policymakers who in turn provide feedback to the scientists, articulating a demand for further information.

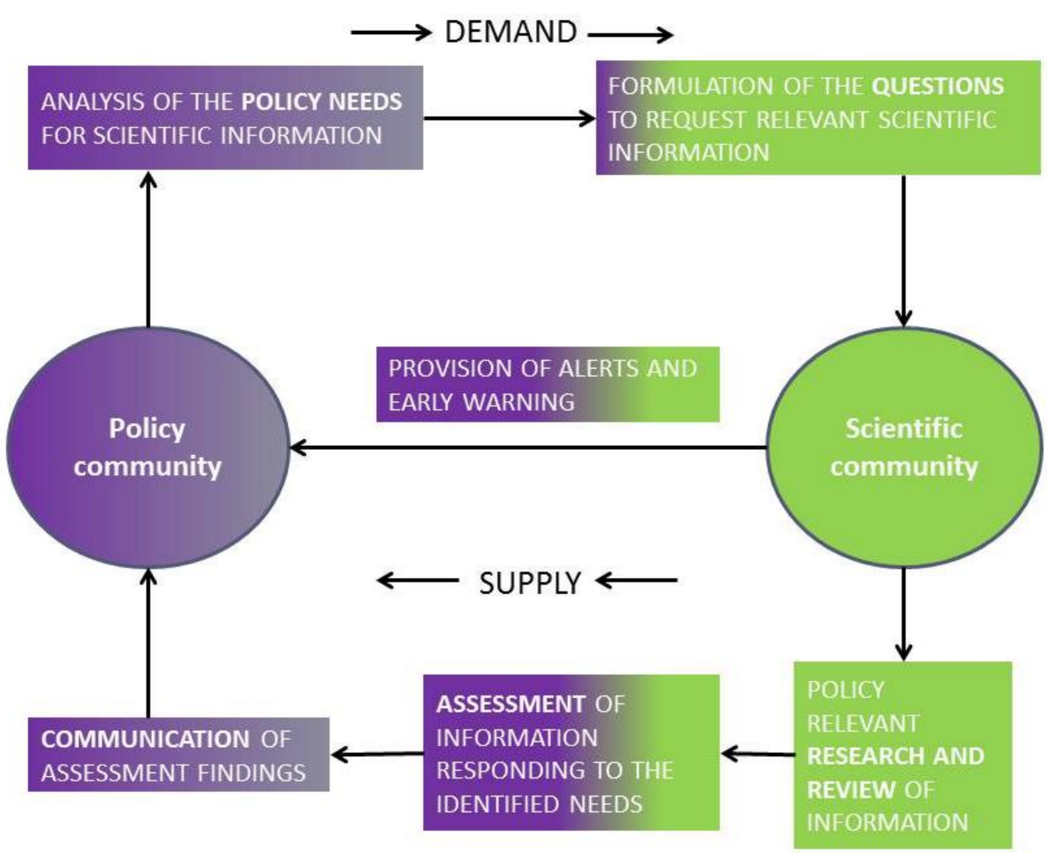

Figure 6. The science-policy interface according to IPBES.

Aside from this model provided by IPBES, there are several other theoretical ways in which science can influence policy. These are addressed as follows:

[21] IPBES. *About IPBES* (undated) <http://www.ipbes.net/about-ipbes.html> (accessed: 2 Feb. 2014).

- ***Engineering model:*** This model sees the relationship between science and policy as rational and sequential. It presumes that results of good research influence policy in a direct, immediate and linear fashion. This is however, rarely seen in practice.[22]
- ***Enlightenment model:*** The relationship between science and policy is seen as indirect, often hidden and rarely logical, predictable or neat. Scientific research contributes to the enlightenment of policymakers, by fostering new ways of thinking rather than solutions to specific problems. There may be a long lag time between the production of science and its impact on policy.[23]
- ***Strategic model:*** Governments and powerful interest groups use science in entirely political ways to advance their own interests and positions. To this end, they cherry-pick desirable research evidence and may even attempt to delay decision-making by commissioning additional research.[24]
- ***Elective affinity model:*** This model holds that policymakers are most likely to consider scientific evidence, if they have somehow contributed to the research process, if the timing of the release of the evidence suits the decision-making process, and if the implications of the evidence align with the core values of the policymakers.[25]
- ***Two communities model:*** Scientists and policymakers come from very different cultures with different ideas about what is important and how the world works. To influence policymakers, scientists must understand and overcome these differences.[26]
- ***Advocacy coalition model:*** A group distinguished by a set of beliefs, norms and resources, agrees on fundamental policy goals and proactively collaborates across disciplines and sectors in pursuit of those goals.[27]

These and other models are elaborated further by Buse *et al*.[28]

2.5. Evidence-based/informed policy

In the late 1990s, a movement called for *evidence-based policy*, with proponents insisting that research evidence be given primary consideration in the formulation of policy.[29] Another school of thought coined and advocated the more modest goal of *evidence-informed policy*, defined as "the integration of

[22] Buse, K., May, N. and Walt, G. Making health policy. (Glasgow, UK: Bell and Bain, 2005) at pp.173-174.
[23] *Ibid* at p.180
[24] Weiss, C.H. *The many meanings of research utilization*. 39 PUBLIC ADMINISTRATION REVIEW 426 at p.426 (1979).
[25] Short, S. *Elective affinities: research and health policy development*. In: Gardner, H. (ed.) Health Policy in Australia (South Melbourne, Australia: Oxford University Press Australia and New Zealand, 1997).
[26] *Supra* at p.175
[27] *Ibid* at p.173
[28] *Ibid*
[29] *Ibid* at p.171

experience, judgement and expertise with the best available external evidence from systematic research.[30] Both movements are regarded as a reaction to policymaking based on convictions.

Today's proponents of evidence-based/informed policy have made great strides in proposing ways to improve the information base for policymaking. However, improved information does not automatically result in improved policymaking because evidence and information are not the same. According to Majone, evidence is "information selected from the available stock and introduced at a specific point in the argument in order to persuade a particular audience of the truth or falsity of a statement."[31] It is important to discern between problems of availability (information) from problems of fit for purpose (evidence). The latter is a subset of the former. An evidence problem arises when very little of the available information stock is considered in policy formulation, or when the information that is considered in support of a policy decision is unpersuasive.[32] Informed, evidence-based policymaking requires not only information, but evidence. With respect to biodiversity data, evidence would constitute a portion of the total biodiversity data stock, which is accessible, reliable, and relevant and has a clear application and practical use (i.e. actionable data).

It is an insightful exercise for scientists to consider how much of the information they generate serves to justify or contend a policy argument; how effectively they are producing evidence that supports good policymaking.

2.6. What is policy-relevance?

The United Nations Environment Programme (UNEP) defines the term, policy-relevance, as "the degree of applicability and practicality of the [information]… for decision-makers and recommendations to policymaking processes, taking into consideration national, regional and global priorities."[33] According to Wolf, policy-relevance "is underpinned and informed… by well-conceived approaches to generating research solutions…" and "is not an automatic by-product of good research". It results from "an effective blending of researchers' awareness of policy decision needs and decision makers' awareness of a knowledge base that bears on their decisions."[34]

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[30] Davies, P.T. *What is evidence-based education?* 47 BRITISH JOURNAL OF EDUCATIONAL STUDIES 108 (1999).

[31] Majone, G. Evidence, Argument, and Persuasion in the Policy Process (New Haven, USA: Yale University Press, 1989) at p.10.

[32] Shulock, N. *The paradox of policy analysis: If it is not used, why do we produce so much of it?* 18(2) JOURNAL OF POLICY ANALYSIS AND MANAGEMENT 226 (1999).

[33] UNEP. *Guidelines for ensuring Scientific Credibility and Policy Relevance of the GEO-5 Assessment* (undated) <http://www.unep.org/GEO/pdfs/geo5/ANNEX12_GEO-5_Guidelines_Scientific_Credibility-Policy_Relevance.pdf> (accessed 1 Feb. 2014).

[34] Wolf, A. *Research strategies for policy relevance*, 23 SOCIAL POLICY JOURNAL OF NEW ZEALAND 65 at pp.67-68 (2004).

Gardner *et al.* offer criteria for assessing the policy-relevance of biodiversity research (understood to include biodiversity data mobilization):[35]

- **A tenable connection between the research and its policy application**. There should be a clear link to relevant "national or regional policy statements, legislative frameworks or management plans… Specific national and/or regional policies and plans that stand to benefit from application of the research results should be identified". These might include multilateral environmental agreements, national biodiversity strategies and action plans (NBSAPs), and even policy applications in other sectors.
- **Identified end-users.** This should include statements from anticipated end-users (policymakers), expressing specific demands for certain research to be undertaken and describing how the results of such research would be useful. The end-users should be engaged in the process of designing the research, specifying outputs and interpreting results.

In seeking to characterise such policy-relevant data, the GBIF Africa Group has fashioned a more detailed set of criteria. Specifically, they agreed that the mobilisation of policy-relevant biodiversity data should:

i) Serve to better inform policy and decision-making, either directly or via further analysis;
ii) Result in discernible improvements in policy and decision-making;
iii) Contribute towards broader socio-economic development priorities;
iv) Be scientifically justifiable and defensible;
v) Support national priorities vis-à-vis biodiversity conservation and research (assuming that such priorities are themselves posited with broader socio-economic relevance).

Additionally, they suggested that preference should be given to data mobilisation that:

i) Serves to complete otherwise-incomplete data sets, thereby improving utility in research;
ii) Necessitates inter-institutional cooperation, thereby strengthening networks.

Biodiversity data which meets the above criteria may qualify as the special subset of information that constitutes 'evidence'. In essence, such biodiversity must be accessible, reliable, relevant and actionable.

[35] Gardner S., Stott, A. and Vindimian, E. *How to assess policy relevance in research projects: BiodivERsA report*, (undated) <www.biodiversa.org/254/download> (accessed: 1 Feb. 2014).

3. EXAMPLE APPLICATIONS OF BIODIVERSITY DATA

Insofar as Africa is concerned, these uses and applications of biodiversity data pertain to important social, environmental and economic development issues such as public health, food security, invasive alien species, tourism, energy and climate change (see figure 7). Biodiversity data is essential for evidence-based policy and decision-making.

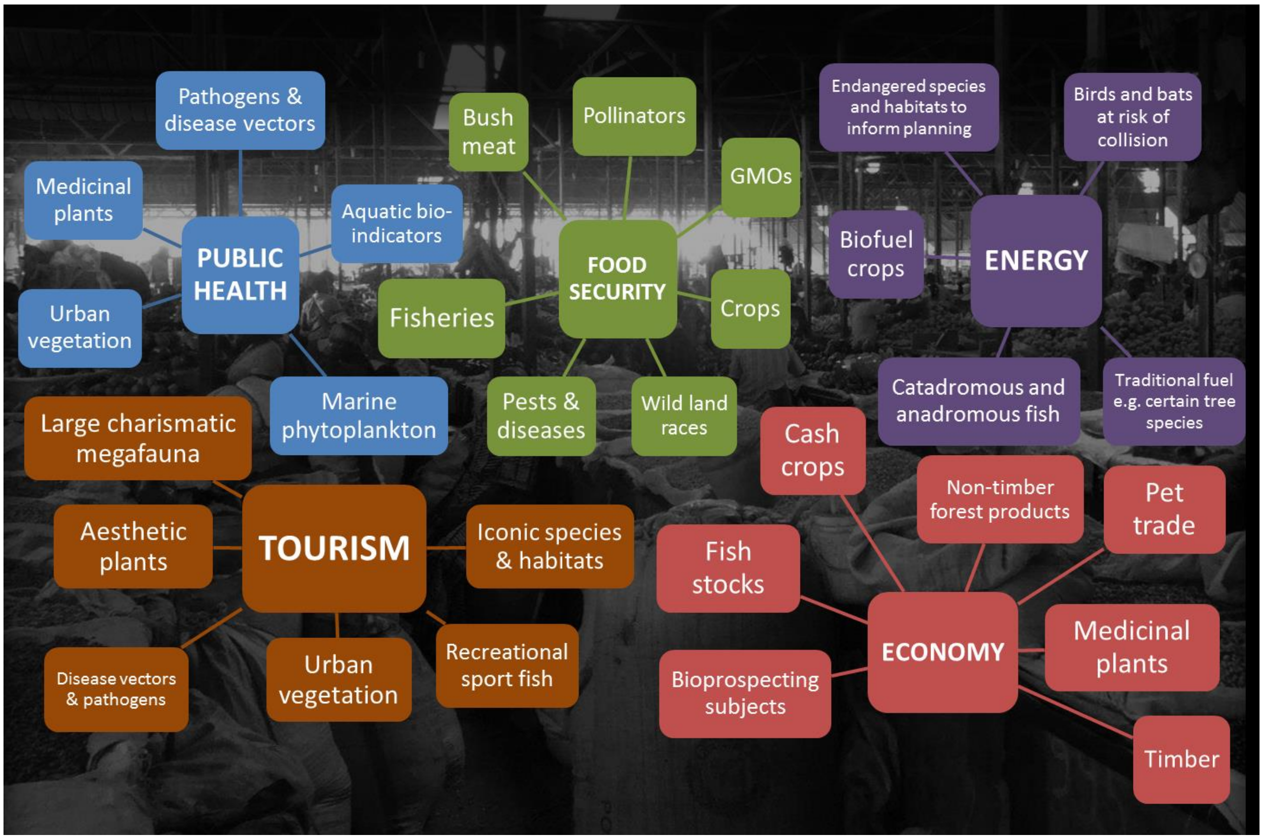

Figure 7. Mind map depicting the breadth of development issues requiring biodiversity data for informed policy and decision-making (image credit: SANBI).

The GBIF website lists documents a number of case studies illustrating various applications of biodiversity data to research and policymaking. The following subsections comprise a selection of examples which may be accredited to GBIF.

3.1. Public health: Mapping the niche of Ebola host animals

A research team from the United Kingdom, the United States and Canada mapped the areas of Africa potentially at risk from outbreaks of the Ebola virus, based on the environmental niche of bat species believed to act as reservoir hosts of the disease.[36]

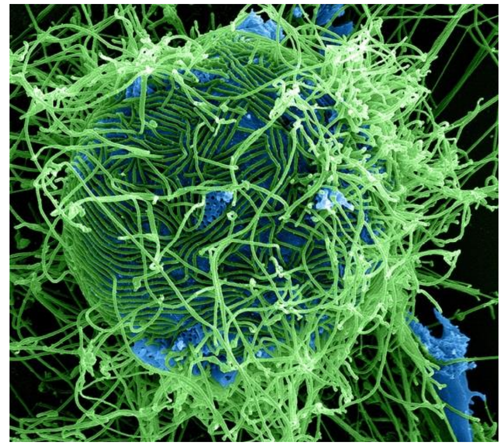

Figure 8. Colorized scanning electron micrograph of filamentous Ebola virus (image credit: NIAID).

While human outbreaks such as the one currently affecting West Africa are very rare, the study identified at-risk areas covering 22 countries in Central and West Africa, with a combined human population of 22 million.

The research published in the eLife online journal modelled the zoonotic niche of the virus using occurrence data accessed through GBIF.org for three bat species, the hammer-headed bat (*Hypsignathus monstrosus*), little collared fruit bat (*Myonycteris torquata*) and Franquet's epauletted fruit bat (*Epomops franqueti*), identified as the most likely candidates to be reservoir species associated with transmission to humans.

The authors argue that better knowledge of the areas potentially at risk from the disease will help to prioritise surveillance for Ebola virus outbreaks, and improve the diagnostic capacity in the countries identified.

3.2. Food security: Conserving genetic diversity of crops in West Africa

This study by a team from Benin, China and the United Kingdom aimed to draw up a list of priority plants to conserve in Benin, based on their importance as wild relatives of the crops used by local people for food, livestock fodder, medicines and other purposes.[37]

Figure 9. Farmers in Nigeria (image credit: Mike Blyth).

An inventory of crop wild relatives (CWR) was compiled using a variety of sources, including records from major herbaria and gene banks worldwide, accessed online through GBIF. Using a series of criteria to rank their importance, the study identified 20 priority crop wild relatives for active conservation.

[36] Pigott, David M et al. "Mapping the Zoonotic Niche of Ebola Virus Disease in Africa." Ed. Prabhat Jha. *eLife* 3 (2014): e04395. *PMC*. Web. 28 Jan. 2016.
[37] Idohou, R. *et al.*, 2013. National inventory and prioritization of crop wild relatives: case study for Benin. 60:34 *Genetic Resources and Crop Evolution* 1337-1352.

3.3. Invasive alien species: Building national watch lists for invasive alien species

A research team from GBIF's partners in the South African National Biodiversity Institute (SANBI) developed a simple methodology for drawing up a 'watch list' that countries can use to identify those alien species most likely to pose a substantial threat of invasion.[38]

Figure 10. The beautiful *Lantana camara* is one of many invasive alien species spreading across Africa (image credit: Maxwildcat).

The team, led by Katelyn Faulkner, drew up a watch list for South Africa using three predictors of invasion success: history of invasion, environmental suitability and propagule pressure. For the study, the researchers downloaded more than 20 million occurrence records from GBIF.org for 884 species in the Global Invasive Species Database. They used these records to assess how many species were likely to establish themselves successfully in South Africa, based on the similarity between the environmental conditions in South Africa and those in regions where the species have been observed.

Trade and tourism data were also used to assess the likelihood of alien species arriving in South Africa from regions where they currently occur. From this, the researchers identified 400 species as potential invaders for South Africa. The authors argue that this technique could be used in any region as an initial assessment of key threats, and could be an important step in developing biosecurity schemes for resource-poor regions.

[38] Faulkner, K. T., Robertson, M. P., Rouget, M., & Wilson, J. R. U. (2014). A simple, rapid methodology for developing invasive species watch lists. 179 *Biological Conservation* 25–32.

4. DETERMINING PRIORITY POLICY-RELEVANT BIODIVERSITY DATA

In seeking to determine policy-relevant biodiversity data, a number of different approaches can be taken. This section outlines four approaches, providing an explanation of each as well as details of their respective resource requirements, advantages and shortcomings. When devising these approaches, the GBIF Africa Regional Group was consulted. The group described the approaches as complementary and best taken together. They suggested that any given user should choose the best mix of approaches for his or her specific situation, taking into account the resources available and the degree of accuracy required. Moreover, they suggested that all approaches should be undertaken in collaboration with the relevant GBIF Heads of Delegations (HoDs) who should also be called upon to assist with lobbying and fundraising to support data mobilisation activities.

4.1. Approach I: Refer to explicit stipulations of data needs

In most countries, policy-relevant biodiversity data can be quickly determined by checking existing, readily-available studies, reports, plans and strategies for explicit indications of data gaps and needs. Potentially enlightening sources include National Biodiversity Assessments (NBAs), National Biodiversity Strategies and Action Plans (NBSAPs), Red List reports, national CBD reports, conservation management plans, and various other country-specific materials.

If these sources do not articulate data gaps and needs, they should at least give indications of species, habitats, ecosystems and geographical areas that are of special national concern. This special concern may be attributed to the important role that these ecological resources play in sustaining or disrupting flows of ecosystem services to society. It is self-evident that biodiversity data pertaining to these ecological resources of special concern is policy-relevant.

Species of special concern might include threatened, endangered or endemic species; harvested species (e.g. medicinal, rare food crops, genetically modified organisms); pests, diseases and disease vectors; and invasive alien species. Habitats, ecosystems and geographical areas of special concern might include specific wetlands, forests, biodiversity hotspots, protected areas and transition zones. Figure 11 illustrates how different sources may be used to identify policy-relevant biodiversity data.

This method has the advantage of being relatively quick and resource-efficient. A single person with a desktop and internet access can readily acquire this information without having to engage stakeholders or policymakers. The disadvantage of this approach is that the available sources may provide only case-specific indications of policy-relevant data and thus fail to provide a comprehensive overview of the data required. Additionally, where policy-relevant biodiversity data is determined on the basis of ecological resources of special concern, there is scope for human error and no means of verification. As such, this approach may be regarded as the ‘quick and easy’ first step in determining policy-relevant biodiversity data.

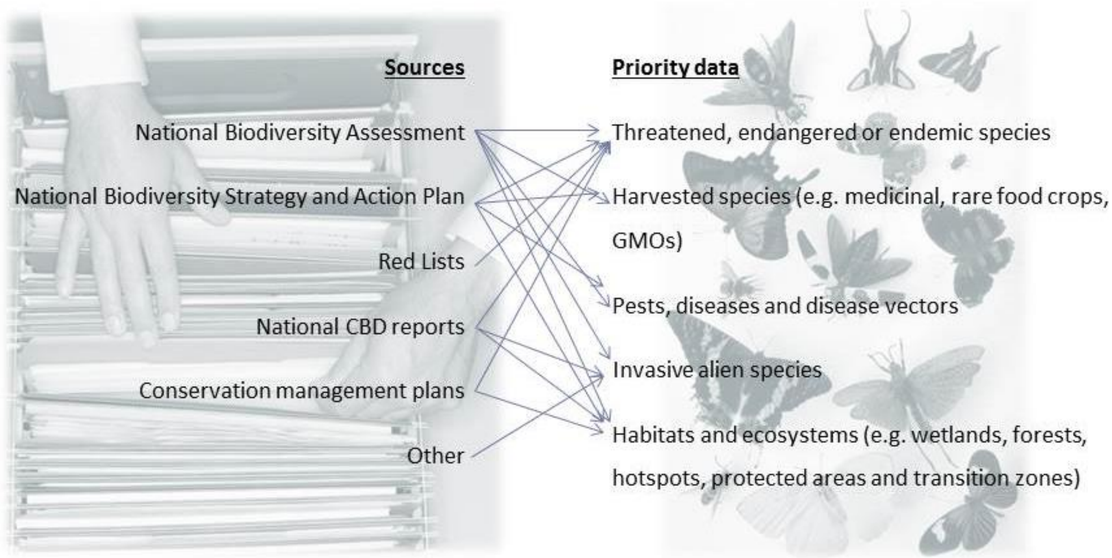

Figure 11. Diagram showing how various sources can provide indications of priority biodiversity data.

4.2. Approach II: Infer implicit, non-stipulated data needs

Biodiversity and ecosystem services underpin human well-being and are therefore of relevance to virtually all policy areas. For example, economic policies must consider the trade of biological products and commodities like timber, food, and medicine; agricultural policies must safeguard pollinators and crop diversity, and ensure the careful management of genetically modified organisms (GMOs); health policies must take into account the behaviour of pathogens and disease vectors; water policies must address the hydrological impacts of invasive alien species and provide for the assessment of water quality in rivers, lakes and wetlands using biological indicators; urban planning policies must ensure the equitable provision of green public spaces and trees which exert a cooling effect and confer multiple health benefits to citizens.

Moreover, many policies may have significant intended and unintended consequences for biodiversity: increasing agricultural production may result in elevated levels of agrochemical pollution and the conversion of natural habitat into farmland; expanding road infrastructure may fragment habitats and induce urbanization in previously inaccessible areas; and eradicating certain disease vectors may require the widespread application of ecologically-harmful insecticides.

Thus biodiversity is connected to a broad spectrum of policy areas, directly and indirectly. Biodiversity data plays an important role in helping us to identify and understand these connections with a view to supporting informed, evidence-based policymaking.

By examining national policy goals and understanding their connection with the environment, one can 'work backwards' to identify the type of biodiversity data that is most relevant to the concerned goal(s). If changes in the diversity, distribution and abundance of the biodiversity concerned would have significant implications for the policy area or vice versa, then data on that biodiversity is 'policy-relevant'.

Given that governments deal with a plethora of typically complex policy areas, it may be unfeasible to examine the relationship of biodiversity with all policies. It is therefore recommended that an initial screening be conducted for a broad set of flagship policies. Greater attention can then be afforded to the policy areas showing the strongest connection to biodiversity. Indications of policies may be found in National Development Plans (or equivalent), sector-specific development strategies, and political manifestos. Additionally, it may be useful to examine a country's regional and international commitments for important clues on policy-relevant biodiversity data. For instance, the Aichi Biodiversity Targets, Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES) and Reducing Emissions from Deforestation and Forest Degradation (REDD).

This approach – hypothetical examples of which are provided in table 1 – has the advantage of being comprehensive insofar as a broader spectrum of policy areas is considered. However, it is also resource intensive, requiring careful and time-consuming examination of a country's policy framework. It also requires an understanding of the various direct and indirect ways in which biodiversity affects, and is affected by, social and economic issues.

Table 1. Hypothetical examples showing how biodiversity data demands can be inferred from policy goals by considering potential research implications.

Policy area	Policy goal	Potential research implications	Inferred data demands
Health	Eradicate certain diseases	Understand the status, trends and behaviour of diseases	Pathogens and disease vectors
	Improve quality of drinking water	Monitor water quality to determine effectiveness of policy interventions	Aquatic biodindicators
	Improve health of marine environment	Detect early warning signs of red tides	Phytoplankton e.g. dinoflagellates
	Ensure long-term survival of medicinal plants	Chart medicinal plants and monitor harvesting pressure	Medicinal plants
	Boost mental and physical public health	Map green infrastructure in cities to assess equitability of distribution	Urban vegetation
	Combat heat-waves	Map urban green infrastructure in cities to mitigate the urban heat island effect	Urban trees
Agriculture	Boost production	Monitor distribution of GMOs to gauge invasion threat and support production analysis	GMOs
	Strengthen resilience of food system	Assess crop and livestock diversity, chart wild land races and monitor critical pollinators	Crops, wild land races and pollinators
	Reduce pest outbreaks	Monitor status, trends and behaviour of pests and diseases	Virulent pests and diseases
Fisheries	Ensure sustainability of fisheries	Monitor abundance, diversity, distribution and average size of seafood species	Seafood species
Economy	Sustainable growth	Monitor depletion and replenishment of natural resource commodities	Timber trees, non-timber forest products, cash crops, fish stocks, etc.
Tourism	Promote natural beauty	Monitor iconic species and habitats known to attract tourists	Iconic species and species in iconic habitats
Environmental	Curb biodiversity loss	Assess ecosystem health monitor threatened and endangered species	Indicator species, and threatened and endangered species
	Reduce poaching	Understand the status and trends poached species	Poached species
	Tackle illegal wildlife trade	Identify specimens retrieved at customs and monitor species	Illegally harvested and traded species
	Reduce forest degradation	Assess and monitor diversity, distribution and abundance of species	Indicator species and insects
	Protect priority biodiversity areas	Assess conservation status of species within and around protected areas	Species in protected areas and transition zones
	Combat invasive alien species	Determine introduction nodes, spread rate, and efficacy of interventions	Invasive alien species
Energy	Increase wind-power	Identify important migratory routes and monitor collisions with birds and bats	Birds and bats at risk of collision
	Increase biofuels	Monitor distribution of biofuel crops	Biofuel crops
	Increase hydropower	Determine effectiveness of fish ladders	Catadromous and anadromous fish

4.3. Approach III: Engage and consult stakeholders to determine and verify policy-relevance

The task of improving engagement between policymakers and scientists has received much attention in the literature and is a stated objective of many international initiatives such as IPBES. Scientists, who engage with policymakers, may gain insights into the priorities of government, constraints on policymaking, and forthcoming policies, and thereby be able to anticipate and verify research requirements and data needs.

McGill identifies seven ways in which scientists can undertake policy-relevant, "actionable" science.[39] These are summarized as follows:

i) **Presentation:** Improving presentation is relatively cheap and requires little effort and change on the part of scientists. There are also plenty of NGOs functioning on the boundary of science, whose professional communicators can help to repackage the work of scientists.

ii) **Stakeholder engagement:** Scientists should talk to people who are going to be affected by, or care about, the problems they are addressing. Stakeholder engagement is essential to undertaking policy-relevant science. However there is currently very little training for scientists on how to do this.

iii) **Problem co-definition:** The majority of scientific questions are asked by scientists themselves. However if one wants to deliver useful, policy-relevant science, one ought to ask potential stakeholder constituencies and policymakers what science might be useful to them, just as a business would seek to find out what its customers want. Most science projects change their research questions in fundamental ways in response to stakeholder engagement.

iv) **Specific:** Policymakers and other stakeholders want specific information that is useful to them whereas most scientists are trained to generalize, albeit within their specialist fields of interest. Place-based, organism-based and time-specific research that pragmatically addresses issues on the ground will likely be more policy-relevant than highly general research.

v) **Trans-disciplinary:** It is important to understand the psychology of what motivates people to change, their reward systems and incentives, the economics and policy framework, human dynamics, technology change, etc.

vi) **Post research engagement:** Policy-relevant science requires stakeholder engagement before, during and after the research is conducted. It takes time for research to be interpreted into policy. It is critical that scientists actively engage with stakeholders, especially policymakers, during this stage to ensure that the research is interpreted correctly. This is also important because stakeholders can help with the communication of the research findings, the elimination of scientific jargon, and with distilling what is most relevant to policy.

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[39] McGill, B. (2013). *What it takes to do policy-relevant science* (14 May 2013) <http://dynamicecology.wordpress.com/2013/05/14/what-it-takes-to-do-policy-relevant-science/> (accessed: 2 Feb. 2014).

vii) **Personal relationships:** Successful stakeholder engagement depends on personal relationships build up over time and through informal and formal contacts. If a legislator is going to decide how to vote based on scientific research, they will almost certainly want to know who did the science and trust them.

In summary, McGil suggests that to do policy-relevant research, around 50 % of time should be allocated to stakeholder engagement. This implies a fundamental change in the way science is conducted.

There are some 'pathways to partnership' that may facilitate such engagement. These include improving communication across cultures, incentivizing effective collaboration with appropriate reward systems, ensuring mutual respect and power-sharing rather than a hierarchy and anticipating research needs of policy issues in order for scientists to respond in a timely manner.[40] It is further suggested that scientists should: seek to understand the perspectives of policymakers; be solution-oriented, practical, pragmatic, and persistent; network strategically; and develop a strong general knowledge of the issues concerned.[41]

Gibbons *et al.* stress the need for scientists and policymakers to understand what motivates each other. Scientists "are likely to attract the interest of policymakers if they identify practical solutions that are consistent with the broader philosophy of the elected government (e.g. budget allocated to the task)." Engagement of scientists on the other hand, may be most effectively achieved by ensuring that any project, contract or workshop provides them with the right to publish proceedings and findings.[42]

By enhancing mutual understanding, it will be easier to build close and enduring working relations. As highlighted by McGill above, personal relationships are the key to effective engagement. Successful relations are underpinned by trust in the integrity of individuals and are characterized by "professional candour, balanced opinion and an appreciation of political sensitivities."[43] Scientists who singularly advocate normative or value-laden outcomes may be distrusted by policymakers, just as policymakers who seek scientific support for a predetermined policy position may be distrusted by scientists.

Roux *et al.* suggest that science can best inform policy through the "co-production" of knowledge.[44] This entails collaborative learning between scientists and policymakers through "communities of practice". Over time, the relationship between scientists and policymakers may evolve considerably from "transactional" – where contact is limited to contractual agreements – to a "science-policy partnership" – where mutual trust allows for frequent informal and formal exchanges between scientists and policymakers leading to the co-production of knowledge. Figure 12 illustrates this progression. Roux *et al.* argue that the establishment of these science-policy partnerships would benefit from the improvement of reward systems. Specifically they suggest that stronger incentives and greater

[40] Briggs, S.V. *Integrating policy and science in natural resources: Why so difficult?* 7 ECOLOGICAL MANAGEMENT & RESTORATION 37 (2006).
[41] Pannell D. J. *Effectively communicating economics to policy-makers*, 48 THE AUSTRALIAN JOURNAL OF AGRICULTURE AND RESOURCE ECONOMICS 535 (2004).
[42] *Supra* 17 at p.183
[43] *Supra* 35.
[44] *Supra* 18 at p.16

acknowledgement should be given to tangible outcomes such as new relationships, altered perceptions, and improved behaviours.[45]

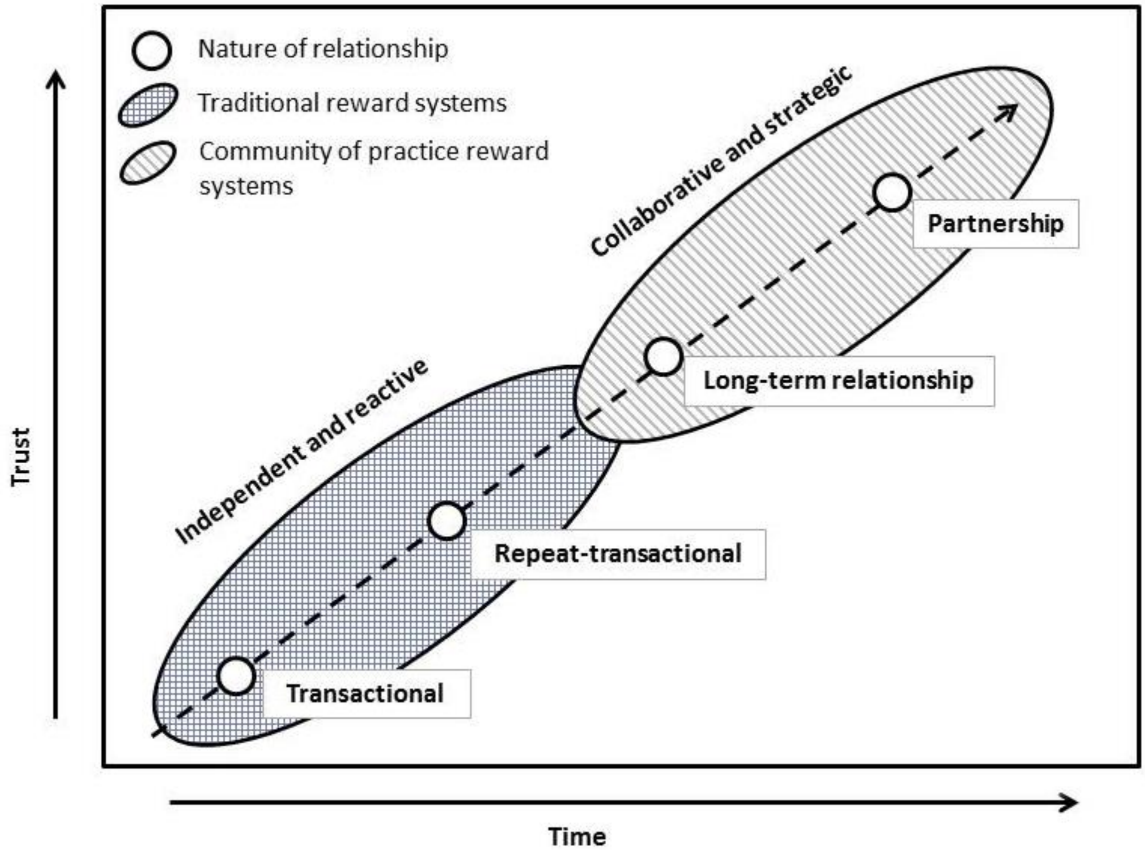

Figure 12. Graph showing the evolution of a relationship between scientists and policymakers over time (adapted from: Roux *et al.* 2006).

Here follows some advice on building and maintaining successful relationships between scientists and policymakers:

i) **Actively disseminate information:** Many scientists operate under "a strategy of hope" that their work will be considered by policymakers, without doing anything to further that goal.[46] Publishing a paper, presenting it at a conference, and posting for public comment do not guarantee uptake by policymakers. Scientists must therefore be proactive in promoting their research findings, which may entail phoning policymakers, setting up meetings and working groups, and arranging field days and tours.

ii) **Communicate effectively:** This is essential to promoting research findings. Pannell offers some general advice for scientists when communicating to policymakers. It is important to

[45] *Ibid* at p.15

[46] Hamel G. and Prahalad C. K. *Strategic intent*, 89 HARVARD BUSINESS REVIEW 63 (1989).

be clear and concise, to present options, to relate any recommendations to policies, and to not tell an audience that they are wrong.[47]

iii) **Maintain relationships:** It cannot be guaranteed that policymakers will correctly interpret and adopt a tool, report, research finding, or recommendation. It is therefore important that scientists maintain close working relationships with policymakers after the initial transfer of knowledge. According to Gibbons *et al.*, "ongoing interaction between researchers and policymakers enables an idea or product to be better understood, tested and refined to meet policy needs."[48]

iv) **Link up:** Spanning boundaries to establish relationships with policymakers from different organisations may be a daunting prospect for scientists. However, there are some methods that might assist in this process. For example, organisations can undertake contact mapping and maintain a database of key researchers and policymakers from different organisations. Additionally, secondments may prove effective in realising the mutual benefits of closer working relations. There are examples of scientists undertaking sabbaticals within government departments although such arrangements may incur bureaucratic hurdles. Less formal and logistically simpler alternatives include the identification of "policy buddies" in government departments who can bridge over the science-policy interface.

v) **Science-policy conferences:** Providing scientists and policymakers an opportunity to come together in an authoritative venue may allow for constructive debates on policy issues and the joint identification of research and data needs. In Australia, scientists, politicians, lobbyists and parliamentary staffers are able to convene at the annual 'Science Meets Parliament' forum.

It may not always be possible for scientists to communicate directly with policymakers. In such cases, there are indirect forms of communication that may prove useful.

Publications: Scientists tend to publish their papers in specialized journals with a view to achieving high 'impact factors' rather than broad readership and accessibility. Additionally, given the sheer volume of new research, policymakers may be overwhelmed when deciding which journal articles to read. In order to better communicate science to policymakers, it is necessary to publish in journals that are accessible to them. Certain journals such as Ecological Management & Restoration target readership from both research and policy spheres, and should be preferred by scientists wishing to ensure the policy-relevance of their research. Additionally, there are some websites and newsletters that attempt to summarize research findings in specific fields. Indeed, some government departments, such as the Canadian Forest Service have developed arms dedicated to interpreting the latest research findings for policymakers.

Proposals: Scientists can be engaged to conduct relevant research through targeted calls for proposals. However, scientists tend to respond to calls from specialized funding organizations rather than policy

[47] *Supra* 37

[48] *Supra* 17 at p.184

and management agencies.[49] Scientists wishing to conduct policy-relevant science may be well-advised to seek funding from such policy and management agencies. In Australia, the Fenner School of Environment and Society hosts an annual conference to which policy and management agencies are invited to present potential post-graduate research projects.

4.4. Approach IV: Mobilize metadata and interpret demand signals

Metadata is data about data (see box 1). It describes how, when and by whom a particular set of data was collected, prepared and formatted, and gives an indication of the content, quality and condition of the dataset. It serves to describe, explain, locate and expose datasets, making them easier to notice, retrieve, use and manage.

There are substantial advantages to authoring and publishing metadata. These include: increased visibility and discovery; stimulation of demand-driven digitization; increased usage and user base; comprehensive tracking of the progress of digitization; early detection of collection risk assessment; enhanced capacity to manage data (technical and financial); improved understanding of the scale and scope of biodiversity data; and easier identification of data gaps.

By rendering datasets visible to potential users without undertaking the laborious task of digitizing and publishing every data record, metadata documents can greatly enhance data discovery in a cost-effective manner. By perusing metadata documents, potential users can readily identify useful datasets. They can then seek to acquire such datasets by filing special requests with the relevant data-holding institution(s). These requests may be construed as demand signals. Although there may be a lag time between the submission of a request and the provision of the data concerned (especially if the data must be digitized), the data-holding institutions may – by way of monitoring demand signals – eventually be able to anticipate requests and direct their data mobilisation efforts accordingly.

Responding in this manner to meet specific, well-defined demands, requires data-holding institutions to be readily contactable, responsive and observant, but will ultimately serve to strengthen the policy-relevance of their data mobilization efforts. Berents *et al.* suggest that demonstrating such policy-relevance will enhance fundraising efforts to support further data mobilization, resulting in a virtuous cycle.[50]

Although this approach has obvious aforementioned advantages, it relies heavily on the assumption that potential data users will be proactive in surveying metadata and submitting requests for datasets. Additionally, it assumes that the potential data users will require the data for policy-relevant reasons, which may not always be the case. As such, this approach may not suffice by itself to precisely determine policy-relevant data, and so should be taken in combination with other approaches.

[49] *Supra* 17 at p.186
[50] *Supra* 8 at p.114

Box 1. Meta data: the essential components

The usefulness of metadata depends largely on the scale and scope of descriptions. Important decisions must be taken on how best to organize and describe the data: a complex task given that data can be organized and described on multiple bases including taxa, projects, collector, ecosystem, size, and digitization extent. Additionally, decisions must be taken on the necessary depth of detail to be included in metadata. Such decisions will be influenced by considerations of the amount of data needing to be described; the availability of human, technical, infrastructural and financial resources; and the target audience. To assist with determining the appropriate scale and scope of metadata documents concerning natural history collection data, Berents *et al.* (2010) provide useful guidance, including criteria and key issues to consider. They hold that the following elements are essential components of any metadata document:

1. List of taxa – preferably to the level of family, but in the case of insects or invertebrates this could be to a higher taxonomic level (e.g. Class or Order) (low granularity) and where possible, also to a lower taxonomic level (Family, Subfamily, Tribe) (higher granularity).
2. List of regions – preferably include biogeographical regions as it would enhance the use of metadata.
3. Temporal scale – granularity depends on the size of the collection and temporal range of collection events (e.g. from 1990-2000).
4. An estimate of the size of the collection - i.e. specify by order of magnitude of 100s, 1000s, or 10000s) (e.g. approximately 1000-2000 specimens).
5. State of accession or curation - e.g. state if the collection is sorted and pinned or not sorted yet, and whether the collection is accessioned into a catalogue book.
6. State of digitization – metadata, extent of digitization (e.g. %), detail of data captured (e.g., taxonomic details only, or locality data, collection data, imaging of each specimen or % of specimens).
7. Type status – How many type specimens v/s non-type specimens.
8. Persistent Identifier (i.e. a unique number or code that unanimously identifies the record) for collection, curator and metadata record itself. Interlinking between these Persistent Identifiers is crucial for easy and efficient discovery.
9. Special significance – e.g. historical or social (productivity and public health), economic or environmental significance of collection.
10. Collection risk assessment: level and description of the potential risk to the collection and reasons for such a risk.

4.5. Comparison of different approaches

To assist in identifying the optimal approach or mix or approaches to employ, the following matrix (table 2) provides a comparison of their respective pros and cons.

Table 2. Comparison of four approaches to determining policy-relevant biodiversity data.

Approach	Pros	Cons
I: Refer to explicit stipulations of data needs	Relatively quick and easy to conduct; Makes use of existing research and 'data gap assessments'.	Potentially subjective; Largely dependent on the accessibility and sensitive to the quality of existing research; Only useful if data gap assessments have already been identified.
II: Infer implicit, non-stipulated data needs	Can be conducted in the absence of data gap assessments; Issue-driven and arguably less prone to bias; Inherently logical.	Hypothetical and technically demanding; Potentially subjective.
III: Engage and consult stakeholders to determine and verify policy-relevance	Highly practical and consensus-driven; By products include building of stakeholder networks; Takes into account a broad range of perspectives; Arguably less prone to personal bias.	Requires extensive consultation; Potentially expensive and time-consuming.
IV: Mobilize metadata and interpret demand signals	Demand-driven and scientifically defensible; Resource efficient as only demanded data is mobilised.	Requires time-consuming monitoring and analysis of data requests.

5. CONCLUSIONS

Central to realising a Green Economy in Africa are the conservation and sustainable use of biodiversity and ecosystem services. This will demand that sufficient volumes of relevant, reliable biodiversity information be timeously delivered to practitioners, scientists and policymakers in readily consumable forms. The collection, collation, digitization, preservation, presentation and dissemination of biodiversity data are therefore of critical importance.

With current resource allocation, and socio-political and scientific priorities, it may not be possible to mobilize all of the world's biodiversity data. Moreover it may not be desirable to do so as only a fraction of biodiversity data is useful to science and policymaking. Thus, some degree of selectiveness should be exercised when deciding which data to mobilize.

To assist with priority-setting for biodiversity data mobilisation, this toolkit proposes four distinct approaches which can be employed individually or together. These include: referring to explicit stipulations of data needs; inferring implicit, non-stipulated data needs; consulting stakeholders; and interpreting demand signals.

By following these approaches, biodiversity data mobilisations activities will better serve the demand of science and policymaking. A stronger evidence base will ultimately enable smarter decision making. Furthermore, by demonstrating such value-for-money, biodiversity data mobilisation activities will likely attract greater financial, technical and political support.

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ANNEX: WHAT SCIENTISTS SHOULD KNOW ABOUT POLICYMAKING

There are common misunderstandings among scientists about how governments make their policy decisions. To help address this issue, Tyler (2013) lists the "top 20 things that scientists need to know about policymaking." These are adapted and summarised as follows:

1. Making policy is really difficult

Scientists flippantly comment on policy decisions as being straight forward and obvious. This is however rarely the case. Public policy is always more complex than it seems, involving a wide range of inputs, complicated interactions with other policies, and varied and unpredictable outcomes. Simple solutions to complex problems are rarer than most people think.

2. No policy will ever be perfect

Whatever the decision, the effects of policy are almost always uneven. For example, any changes to taxes and benefits will leave some people better off and other worse off.

3. Policy makers can be expert too

Scientists often consider themselves as the "experts" who engage with policy makers. However, many policy makers are experts too. Some have excellent research credentials, and frequently they understand the research base well. In other words, if you are a scientist talking to a policy maker, don't assume that you are the only expert in the room.

4. Policy makers are not a homogenous group

"Policy maker" is at least as broad a term as "researcher". It includes civil servants ranging from senior to junior, generalist to specialist, and to those in connected agencies and regional government; it includes politicians in government and opposition; and then there are all the people who might not directly make the decisions, but as advisers can strongly influence them.

5. Policy makers are people too

Policy makers are people who, despite extensive training and the best of intentions, will sometimes make bad decisions and get things wrong. Also, they may – like scientists – choose to act in their own interest.

6. Policy decisions are subject to extensive scrutiny

This is why, like science – which mitigates human nature insofar as it is possible with the principles of academic rigour and peer review – policy is regulated by professional guidelines, a variety of checks and balances, and scrutiny that comes from a wide range of institutions and angles.

7. Starting policies from scratch is very rarely an option

When policy makers consult scientists, they are usually looking for solutions that can evolve from within the existing ecosystem. This rule applies in a lot of policy areas, from infrastructure to education.

8. There is more to policy than scientific evidence

Policies are not made in isolation. First there is a starting point in current policy, and there are usually some complex interactions between policies at different regional scales: local, national and international. Law, economics, politics and public opinion are all important factors; scientific evidence is only part of the picture that a policy maker has to consider. Most of the major policy areas that consistently draw opprobrium from scientists are far more complicated than just scientific evidence.

9. Economics and law are top dogs in policy advice

When it comes to advice sought by policy makers, economics and law are top dogs. Scientific evidence comes further down the pecking order. Whether or not this is the best way to make policy is not the point, it is just a statement of how things work in practice.

10. Public opinion matters

Many of the most important public policy decisions are made by people who were directly elected, and most of the rest are taken by people who work for them. In a democracy, public opinion is a critical component of the policy process. The public is directly involved in many planning decisions and virtually all policy areas are heavily influenced by public opinion.

11. Policy makers do understand uncertainty

It is commonly asserted by scientists that policy makers prefer to be given information that is certain, as they do not understand uncertainty. On the contrary: politicians are surrounded by and constantly make formal and informal assessments of uncertainty (for example, when considering polling information) and civil servants are often expert at drawing up policy options with incomplete information.

12. Parliament and government are different

In most countries, the distinction between parliament and government is profound. Parliament – the legislature – debates public issues, makes laws and scrutinises government. Government – the executive – is led by select members of parliament and is responsible for designing and implementing policy. Parliament comprises all Members of Parliament (MPs) and has a relatively small support staff. Government comprises a small selection of MPs and has a relatively large support staff.

13. Policy and politics are not the same

Policy is mostly about the design and implementation of a particular intervention, determined by government. Politics is about how the decision was made, as debated by ministers, the cabinet, and the party leadership.

14. Most governments have credible science advisory systems in place

Nowadays, it is common for government departments to have highly-qualified scientific advisers. Additionally, scientists are usually well represented in working groups, advisory bodies and expert panels affiliated with the government and involved in its policymaking processes.

15. Policy and science operate on different timescales

When policy makers say that they need information soon, they mean within days or weeks, not months. If scientists want to engage with policy they need to be able to work to policy makers' schedule. Asking policy makers to work to a slower timetable will result in them going elsewhere for advice. Needless to say, any such advice should be given as concisely as possible.

16. Be wary of policy cycles

There are many flow charts depicting "the policy cycle". They usually start with an idea, move through a sequence of research, design, implementation and evaluation, which then feeds back into the start of the cycle. Fine in theory, but in practice it is a lot more complicated and case-specific.

17. The art of making policy is a developing science

We live in exciting times for policy making. Various initiatives for better governance are under way, including ones for opening up the policy making process, and others for building evaluation into policy implementation. Research evidence is of course playing a key role.

18. 'Science policy' isn't a thing

When policy makers talk about "science policy", they are usually talking about policies for things like research funding, universities and innovation policy. Researchers additionally use "science policy" to talk about the use of research evidence to help deliver better policies in a wide range of areas. It is helpful to distinguish between "policy for science" on the one hand, and "science for policy" on the other.

19. Policy makers aren't always interested in science per se

On the whole, policy makers are only interested in research evidence that can inform their policy making. They are not interested in philosophical conversations such as "what constitutes evidence". Policy makers care about research evidence insofar as it helps them to make better decisions.

20. 'We need more research' is the wrong answer

Policy decisions usually need to be made pretty quickly, and asking for more time and money to conduct research is unlikely to go down well. Policy makers have to make decisions with incomplete information (see #11) so they may exhibit frustration with researchers who are unable to offer an opinion without first obtaining funding for a multi-year research programme.