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GLOBAL SCIENCE–POLICY INTERFACES RELATED TO AGRIFOOD SYSTEMS: A DESKTOP REVIEW OF STRUCTURES AND COMMON PATTERNS

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ABBREVIATIONS

AHPSR	Alliance for Health Policy and System Research
BO	boundary organization
ECOSOC	Economic and Social Council of the United Nations
FAO	Food and Agriculture Organization of the United Nations
G77	The Group of 77 at the United Nations
GEF/STAP	Scientific and Technical Advisory Panel for the Global Environment Facility
HLPE-FSN	High Level Panel of Experts on Food Security and Nutrition
IPBES	Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services
ICES	International Council for the Exploration of the Seas
IPCC	Intergovernmental Panel on Climate Change
ITPS	Intergovernmental Technical Panel on Soils
JRC	Joint Research Centre
MedECC	Mediterranean Experts on Climate and Environmental Change
Regular Process /REGPROC	Regular Process for Global Reporting and Assessment of the State of the Marine Environment, including Socioeconomic Aspects
SAPEA	Science Advice for Policy by European Academies
SPI	science–policy interface
STI	science, technology and innovation
STS	science and technology studies
UNCCD SPI	Science–Policy Interface of the United Nations Convention to Combat Desertification
UN DOALOS	United Nations Division for Ocean Affairs and the Law of the Sea
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNGA	United Nations General Assembly
SAB	The Scientific Advisory Board of the United Nations Secretary-General
WHO	World Health Organization
WMO	World Meteorological Organization
WTO	World Trade Organization

EXECUTIVE SUMMARY

This desktop review provides information about the structures and patterns common to global science–policy interfaces (SPIs). In this report, SPI is defined as an institutional arrangement, forum, process or organization whose task is to facilitate dialogue between scientists, policymakers and other relevant stakeholders in support of inclusive evidence-based policymaking.

This review aims to: 1) provide a broad overview and comparison of how international SPIs work, 2) identify a set of categories that are relevant to the work of SPIs, 3) present a systematic, comparative analysis based on publicly available data, 4) draw preliminary conclusions based on findings, and 5) suggest further avenues for study.

The review was undertaken to understand the characteristics and functions of SPI activities operating at the global level. Sources of data included academic and grey literatures and a virtual expert workshop. The analytical framework adopted was informed by existing SPI typologies and provides a set of constructs and measures to characterize and compare global SPIs. The framework integrates a rich SPI information environment in a design that is intended for use by a wide range of stakeholders.

The framework includes four major categories: *purpose and origin, scope and governance, co-production structure and process*, and *learning*. For the latter three categories, a summary estimate of complexity, co-production and learning is given, based on publicly available information retrieved by the review team. Descriptions of categories and their subcategories are provided. The review covered twelve global SPIs that concern agrifood systems and two international regional SPIs that each span two continents.

SPIs have various levels of science and policy in their aims and goals, and the majority interact with multiple sectors or policy domains. Many SPIs are supported by public funding or a mix of public and private funding. About half of the SPIs were primarily demand-driven, responding to specific policy requests. Most of the others operated according to a mixed approach, part policy demand-driven and part supply-oriented, providing autonomous advice to policymakers without explicit requests.

Co-production processes between SPIs and stakeholders were identified – some undertake scheduled consultations with stakeholders and others have open stakeholder involvement. Most SPIs appear to have only low levels of communication and outreach, make little effort to disseminate their work, and limit inclusion of varied knowledge sources. Goal-oriented learning is evident (e.g. training, capacity building, mentorship and fellowship programmes) and some SPIs engage in reflective learning processes. Comparing overall levels of complexity, co-production and learning across the twelve SPIs, few have high levels of all three: levels of complexity varied, co-production opportunities were low to medium, and most SPIs have low learning levels.

To understand better how different international SPIs operate in addressing the complexities of their tasks, three important findings may require further investigation.

1. **The extent to which the SPI focal domain or issue–area influences design and function**. The variation among SPIs and the absence of clear patterns could be explained by differences in the nature of the domain that are not captured by the current framework, as well as by uneven capacities, resources, interests or limitations of the review.

2. **The overall difficulty for SPIs to engage in co-production and the need to equip them better**. SPIs may have difficulty working with stakeholders to co-produce relevant knowledge. While there is general acceptance that low levels of co-production can influence relevance and impact, co-production can take several forms and SPIs can work in different ways. More work is needed to qualify the diversity of co-production forms, and the intensity of co-production before useful lessons can be formulated into guidance for SPIs.

3. **The relatively scarce information available on how SPIs operate**. Despite their critical role, there is relatively little publicly available information that provides insights into how SPIs operate. This is either due to a deliberate lack of transparency or reflects the general inability of SPIs to present their processes.

Overall, the lack of identifiable patterns among United Nations SPIs provides some evidence of the lack of a shared framework and vision regarding governance, co-production and learning, and their interrelationships. Nevertheless, establishing, agreeing to, and adhering to a transparent framework is critical for SPIs to fulfil their potential and influence decision-making. FAO aims to develop guidance on strengthening agrifood SPIs (at the national level) building on the findings from three efforts: 1) this review, 2) a study on national-level models to support the use of evidence in agrifood policymaking, and 3) an online consultation addressing the question "What are the barriers and opportunities for scientists and other knowledge holders to contribute to informing policy for more efficient, inclusive, resilient and sustainable agrifood systems?".

The overall objective is to expand upon current understanding of SPI design and operations to strengthen science–policy interfaces and build better science- and evidence-based policy processes for agrifood systems.

1 INTRODUCTION

The roles and responsibilities of science in relation to policy in society are dynamic. Knowledge systems should support societal transformations towards sustainability more effectively than is currently the case (Fazey *et al.*, 2020). This function of science[1] is important for agrifood system transformation, a policy arena requiring solutions that go beyond conventional boundaries and take into account different experiences, expertise and values to meet multiple demands. The role of science in agrifood systems extends beyond food production, trade, nutrition and consumption to include justice and human rights, livelihoods, biodiversity conservation and climate change mitigation and adaptation (Canfield *et al.*, 2021; Turnhout *et al.*, 2021; HLPE, 2020; SAPEA, 2020). The multiple dimensions and complexities of agrifood systems highlight the need for inclusion of knowledge from both the academic and non-academic spheres, as well as mechanisms to translate and integrate this knowledge into governance structures and processes (Turnhout *et al.*, 2021).

Interactions between science and policy are important at the national level, where much of the decision-making for agrifood systems takes place, but global-level challenges require different governance. An increasing number of global conventions and regulations have sought to address environmental challenges in a globally integrated way (e.g. the recent Agreement under the United Nations Convention on the Law of the Sea on the Conservation and Sustainable Use of Marine Biological Diversity of Areas beyond National Jurisdiction; UN, 2023) through greater interaction with science. Many conventions depend on global environmental assessments, although improvement is necessary (see e.g. Maas *et al.*, 2021). Within this changing landscape, FAO recently adopted its first Science and Innovation Strategy, which is key to supporting implementation of the FAO Strategic Framework 2022–31 and the 2030 Agenda for Sustainable Development (FAO, 2022a).

The Science and Innovation Strategy includes three interdependent pillars, nine associated outcomes and two enablers. The first pillar on strengthening science and evidence-based decision-making includes *science–policy interfaces for agrifood systems strengthened* as one of its outcomes. FAO has a mandate that includes translating science and innovation into guidance and practical tools. As a facilitator of intergovernmental processes, FAO also provides a neutral platform for discussion and exchange of ideas among countries.

To this end, this review on international science–policy interface (SPI) organizations aims to provide information about the structures and common patterns of global SPIs in preparation of further work on guidance for strengthening science–policy interfaces and effectively building better science- and evidence-based policy processes in the agrifood systems sector.

[1] 'Science' terminology has been adopted for this desktop study due to its general use in the literature. It is acknowledged that 'evidence' (or even the more neutral term of 'information') is a more inclusive term that recognizes the value and importance of diverse forms of knowledge.

The review provides a short overview of the academic literature on the interactions between science, policy and society to illustrate the evolution of thinking on this (Section 2). Subsequently a systematic, comparative examination of international SPIs is undertaken that spans a comprehensive range of policy areas covered by global intergovernmental processes. The work aims to: 1) provide a broad overview and comparison of how international SPIs work, and 2) identify a set of categories that are relevant to science–policy work carried out by these organizations.

The approach and methodology are described in Section 3, the finalized categories are provided in Section 4, and results on the selected SPIs are given in Section 5. Finally, in Section 6, conclusions are drawn based on the findings and several avenues are identified for further investigation into improving international SPIs.

2 OVERVIEW OF THE LITERATURE ON SCIENCE–POLICY INTERFACES

Over recent decades, the term *science–policy interface* has become increasingly evident among organizations of the United Nations (UN). Although various definitions of the term exist,[2] an SPI is generally understood to be an institutional arrangement, forum, process or organization whose task is to facilitate dialogue among scientists, policymakers and other relevant stakeholders in support of inclusive evidence-based policymaking. The rationale for SPIs postulates that solving current global challenges, including environmental and sustainability challenges, requires effective interaction between science and policy. Policy is becoming increasingly evidence-based (Global Commission on Evidence to Address Societal Challenges, 2022). Science is only one of several major sources of evidence (Global Commission on Evidence to Address Societal Challenges, 2022). Local and Indigenous Peoples' knowledge, for instance, is increasingly called upon and included with science (Wheeler and Root-Bernstein, 2020; Tengö *et al.*, 2014) and foresight activities can also be considered (e.g. FAO, 2022b). Several organizations have emerged within the UN to enable science–policy dialogue, including the Intergovernmental Panel on Climate Change (IPCC) and the Intergovernmental Science–Policy Platform on Biodiversity and Ecosystem Services (IPBES).

Different literature streams and frameworks can provide the background needed to articulate and understand similarities and differences, and patterns of convergence and divergence, among global SPIs. One stream focuses on the institutional structure of SPIs and a second targets the social dimension of the interface process by focusing on the modes of involvement of knowledge actors, organizations and networks in global public policies to facilitate policy convergences in areas characterized by knowledge deficits and uncertainty. Other contributions offer explicit recommendations to improve SPI performance. For example, Singh *et al.* (2021) suggested improving the effectiveness of SPIs for food system transformation by boosting coordination, legitimacy, inclusion and knowledge integration across SPIs. Additionally, the governance and institutional theory literatures provide useful insights into structures, functions and mechanisms of SPIs. The literature review, which is summarized here, informed the work for this review, allowing identification of a set of categories useful for analyzing global SPIs.

To bridge science and policy domains, SPIs can operate using different modalities, and display a wide range of mechanisms and governance models. For instance, while many international SPIs perform scientific and knowledge assessments (Haas, 2017; Kowarsch and Jabbour, 2017), they can also be engaged in capacity building (Kowarsch *et al.*, 2016). SPIs, which can operate at different stages of the policymaking process, perform a broad range of functions, from knowledge synthesis to provision of prescriptive recommendations (Van den Hove and Chabason, 2009). SPIs can be categorized according

[2] For instance, Van den Hove (2007) defines SPIs as "social processes which encompass relations between scientists and other actors in the policy process, and which allow for exchanges, co-evolution, and joint construction of knowledge with the aim of enriching decision-making", while Koetz *et al.* (2012) refer to them as "institutional arrangements that reflect cognitive models and provide normative structures, rights, rules and procedures that define and enable the social practice of linking scientific and policy-making processes". More recently, Sarkki *et al.* (2015) defined SPIs as "organizations, initiatives or projects that work at the boundary of science, policy and society to enrich decision making, shape their participants' and audiences' understandings of problems, and so produce outcomes regarding decisions and behaviours". Furthermore, FAO (2022a) defines science–policy interfaces as "mechanisms for organized dialogue between scientists, policymakers and other relevant stakeholders in support of inclusive science-based policymaking" and states that "effective science–policy interfaces are characterized by relevance, legitimacy, transparency, inclusivity, and ongoing and effective dialogue through an appropriate institutional architecture".

to type of function they fulfil, e.g. scientific knowledge generation, scientific knowledge synthesis, scientific knowledge brokerage and science communication (UNDESA, 2021). Due to the numerous functions and tasks carried out by SPIs, it might be more useful to categorize SPIs by organizational features rather than by objectives or functions (Sarkki *et al.*, 2020). Görg *et al.* (2016) showed that SPIs can follow different levels of formalization, ranging from an informal network approach, with a flexible structure and minimal level of formalization, to a platform model based on extended and well-defined institutional structures. Various typologies have also been developed to classify SPI governance models. For instance, Kaaronen (2016) identified six ideal model types: independent, integrated, assignment, nested, adviser and platform. Others have proposed categorizing SPIs based on activity, sector, topic, or association, such as expert groups, agencies, research projects or interest groups (Wagner *et al.*, 2023; Timaeus *et al.*, 2011).

The science and technology studies (STS) literature details perspectives that offer the means to understand SPIs. It identifies three levels for study: 1) the political decision level, including the difficulties involved in applying the results (evidence) produced by science, 2) the transmission level, where the results of science are communicated (problem of interface and communication), and 3) the scientific production level. STS literature provides an account of how science and decision-making interact that extends beyond the linear model of science advice in which experts are supposed to 'speak truth to power'. One of the main assumptions underlying the linear model is that the SPI can be improved by providing more and better epistemic inputs from science to policy. The STS literature has shown the limitations of the linear model due to the increasingly wicked nature of policy challenges that render insufficient the mere aggregation of specialized disciplinary expertise to provide usable knowledge on sustainability transformations (Fernandez and Philippi, 2017; Dedeurwaerdere, forthcoming).

However, the linear model is an enduring feature of SPI arrangements because there are few alternatives – science is held to be essential to policymaking, and policymakers are often reluctant to accept responsibility for improving science–policy interfaces (Maas *et al.*, 2022). Furthermore, it has been suggested that linear model thinking may undermine potentially inclusive knowledge–policy processes unless critical and reflexive approaches that explicitly recognize power and knowledge asymmetries in SPI arrangements are adopted (Wiegleb and Bruns, 2022). In this regard, co-production has emerged as a key concept in evidence-informed policy and practice but means different things according to the nature of the science–policy interface (Bandola-Gill, Arthur, and Ivor Leng, 2022).

The boundary organization (BO) framework offers a conceptualization of co-production. By focusing on achieving usable knowledge, the BO literature advocates better matching of the supply and demand for science in policy through increasing interactions and collaboration among scientists and those who use science to make policy and management decisions (Bandola-Gill, Arthur, and Ivor Leng, 2022; Meadow *et al.*, 2015). SPIs adopt various strategies to manage the boundary between science and policy effectively, but a key aim is to ensure that scientific advice provides policymakers with knowledge that is robust in epistemic and political terms (Lentsch and Weingart, 2011), and is perceived to be salient, credible and legitimate (Cash *et al.*, 2003). In line with this, co-production activity is not limited to boundary management between scientists and policymakers, but, as several authors have insisted, must be expanded to include participation of a broader set of stakeholders. Because the general orientations toward sustainable transformation involve heterogeneous societal values, the knowledge required to address complex challenges must be developed across different communities and knowledge systems to be legitimate and actionable (Bandola-Gill, Arthur, and Ivor Leng, 2022; Dedeurwaerdere, forthcoming).

Brokerage at the SPI (as described by Gluckmann *et al.*, 2021) serves the boundary function to link science and policy bidirectionally. Ideally, it informs policy options but does not determine policy development; it acknowledges that the scientific process and evidence synthesis have a particular set of values embedded in them; and it is aware of the complexities of inference from incomplete evidence, as well as the implications of different options according to different value views.

Overall, the most efficient BOs can mobilize and combine different kinds of knowledge, including, but extending beyond, scientific knowledge, to then generate and communicate knowledge-based alternatives for action at different policy levels.

In addition to specific co-production functions and features of SPIs, the effectiveness of the interaction between science and policy is conditioned by two forms of learning: 1) mutual learning among actors intervening in SPIs, and 2) reflexive learning about the process of mutual reshaping of knowledge and decision-making to facilitate effective governance. It has been reported that studying SPI governance models and arrangements provides greater insight about science–society processes than studying science–policy interaction knowledge synthesis efforts and outputs (Jagannathan *et al.*, 2023). This literature generally sees reflexivity (i.e. learning about its own mode of operations) as a crucial prerequisite to improve the effectiveness, credibility and legitimacy of SPIs. By inviting SPIs to open up and understand the governance of expertise as a matter of political contestation, the STS approach advocates understanding that science–policy governance depends on more than scientific input. SPIs should therefore go beyond the dogma of consensus by embracing pluralism and uncertainty, thus facilitating a shift towards inclusive knowledge-governance interface arrangements (Beck *et al.*, 2014; Turnhout *et al.*, 2021).

Furthermore, there are specific governance challenges for SPIs that operate at international and intergovernmental levels. The relationship between science and policy may be understood differently among countries, just as the definitions and standards for expertise may be contested across cultural and geopolitical divides (Miller, 2001). Such cultural and political diversity is particularly likely to emerge during international negotiations where conflicting intergovernmental epistemologies may hinder SPI functions (De Donà, 2022). Considering this, international and global SPIs should be designed in ways that consider the political features of intergovernmental settings, thus enabling intercultural awareness and dialogue (Hakkarainen *et al.*, 2020).

3 RESEARCH DESIGN, METHODOLOGY AND APPROACH

This review was designed to understand the characteristics and functions of SPI activities and SPIs operating at the global level. Data sources included academic and grey literatures, and a virtual expert workshop. Because the goal of the review was to characterize the landscape of SPIs and effectively communicate similarities, differences and overall patterns, the approach was guided by the literature on SPIs and depended on a qualitative empirical approach to capture the details of SPIs. Additionally, to minimize technical complexity of presentation, an analytical framework was developed that is informed by typologies that exist in the academic literature but which formulates an easily communicated vocabulary of constructs and measures used to characterize and compare global SPIs. The resulting method and approach aim to maximize accessibility to a wide range of stakeholders.

3.1 Data and information sources

The review used two main sources of data and information: 1) a desktop review that included the academic and grey literatures on SPIs and a review of information on specific websites, and 2) an SPI workshop to review and contribute to the approach and interim findings.

3.1.1. Literature review

An expansive review of the SPI literature was conducted to identify academic articles, reports and other sources to study global SPIs. The sources included alternative approaches to capturing and describing the many different types of SPI as well as detailing the work and functioning of specific SPIs. For example, some academic work points to multiple forms of SPI, including expert groups, research projects, state agencies, interest groups and policy processes integrating scientific input (Sarkki *et al.*, 2015, Görg *et al.*, 2016), while others articulate different models: independent, integrated, assignment, nested, advisor and platform (Kaaronen, 2016).

Efforts to build SPI typologies have often focused on national and cross-national levels (Van Enst, 2018; Hegger *et al.*, 2020; Kaaronen, 2016) or on single policy areas (Sarkki *et al.*, 2020; Sundqvist *et al.*, 2018). In this review, a systematic comparative approach was developed that spans a comprehensive range of policy areas in intergovernmental governance. More literature is presented in other parts of this report (e.g. Section 2 and 4.1–4.4).

3.1.2. Expert workshop

A virtual expert workshop was organized to assist in the development of the framework and complement the data collection from a broader range of experts. Invitees had expertise in science and technology studies (STS) and engagement in SPI activities. They were provided with the preliminary framework, a summary of the data collection, and guiding questions for feedback and reflection prior to live virtual interactions (see Annex 1 for the workshop invitation materials and list of participants). The workshop stimulated discussions that led to the refinement of categories and subcategories.

3.1.3. Online data collection

This review relies entirely on secondary data collected using academic and grey literatures as well as web-based materials. The corpus consists of scientific publications on SPIs (mostly collected on Google Scholar, in addition to background knowledge) and institutional reports published on individual SPI websites. These reports include the terms of reference, annual reports, audit reports, brochures and other publications containing information of value to the research. SPI websites also provided basic information on specific SPI activities and the sectors in which they operate. Due to the scope of this desktop review, data published by SPIs on websites and in journal articles were generally accepted as valid. Future work should consider additional data collection approaches, including the collection of primary data.

3.2 Analytical approach

3.2.1. SPI selection

This review focuses mainly on formalized SPIs that operate globally, usually with the UN system. An initial set of SPIs was identified based on the literature and the authors' expertise and knowledge. Because thematic areas associated with agrifood systems were to be covered, the chosen SPIs relate to agriculture (including fisheries), environment, health and development. The set of selected SPIs for the review is presented in Table 1 (the list includes many global SPIs, but is not comprehensive).

While focusing on formalized global SPIs is advantageous because of the extent of information readily accessible on the internet, there is the potential to overlook other international SPIs. Therefore, this review also included two examples of regional SPIs that specifically bridge geographic regions, thereby increasing the scope and relevance of the cases. One is a particularly long-standing SPI (International Council for the Exploration of the Seas – ICES) focused on the North Atlantic Ocean. The other is a very recent SPI focused on the Mediterranean Sea (Mediterranean Experts on Climate and Environmental Change – MedECC), and specifically bridging Europe and Africa. Inclusion of the regional SPIs enriches this study, although they are not representative of all regional SPIs.

Table 1. Selected science–policy interface organizations

FULL TITLE OF THE SPI (ACRONYM)	SECRETARIAT LOCATION	SECRETARIAT UN AFFILIATE	SECTOR	DESCRIPTION OF THE SPI
The High Level Panel of Experts on Food Security and Nutrition (HLPE-FSN)	Rome (Italy)	FAO	Agriculture	HLPE-FSN is the United Nations body for assessing the science related to global food security and nutrition. It is governed by a steering committee of 15 scientific experts in food security and nutrition-related fields. HLPE is hosted by FAO.
Intergovernmental Technical Panel on Soils (ITPS)	Rome (Italy)	FAO	Agriculture	ITPS is a group of 27 soil experts representing all the regions of the world. The main function is to provide scientific and technical advice and guidance on global soil issues to the Global Soil Partnership primarily and to specific requests submitted by global or regional institutions. The ITPS advocates addressing sustainable soil management in different sustainable development agendas.
The Scientific and Technical Advisory Panel for the Global Environment Facility (GEF/STAP)	Washington, DC (United States of America)	UNEP	Environment	STAP provides independent advice to GEF. It is a 7 member group of experts whose goal is to provide scientific and technical advice on GEF policy strategies, programmes and projects. It was established by UNEP.
Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES)	Bonn (Germany)	UNEP	Environment	IPBES has four functions: assessing knowledge, building capacity, strengthening the knowledge foundations, supporting policy. While it is not a UN body, its Secretariat is hosted by UNEP. It currently has 140 member states. Its decision-making body (plenary) meets yearly while the Bureau takes decisions intersessionally. Other bodies include the Secretariat (including technical support units), task forces, multidisciplinary expert panel, stakeholder networks and expert groups.
Science–policy Interface of the United Nations Convention to Combat Desertification (UNCCD SPI)	Bonn (Germany)	UNCCD	Environment	UNCCD SPI was established at COP11 in 2013 to translate scientific findings and assessments into policy-relevant recommendations. It provides peer-reviewed technical reports and science–policy briefs to support policy development. The UNCCD SPI is composed of independent scientists at the global and regional level, as well as policymakers and observers. The work programme is determined by the UNCCD Committee on Science and Technology, which also selects the members.
Regular Process for Global Reporting and Assessment of the State of the Marine Environment, including Socioeconomic Aspects (Regular Process/REGPROC)	New York (United States of America)	UN DOALOS (UN Division for Ocean Affairs and the Law of the Sea)	Environment	REGPROC is an intergovernmental process that reviews environmental, economic and social aspects of the state of the world's oceans. It was set up by and is accountable to the United Nations General Assembly and is overseen by an 'Ad Hoc Working Group of the Whole', composed of Member States, with two Co-Chairs (one from a developing and one from a developed country). It carries out the World Ocean Assessments.
Intergovernmental Panel on Climate Change (IPCC)	Geneva (Switzerland)	WMO	Environment	The IPCC is the UN body for assessing the science related to climate change. Its role is to report on the state of scientific, technical and socioeconomic knowledge on climate change as well as options to reduce the rate at which climate change occurs. It was created in 1988 by the World Meteorological Organization and the UN Environment Programme. It is an organization of UN member states (currently 195 members). Thousands of experts work on assessing the latest publications on climate change.

FULL TITLE OF THE SPI (ACRONYM)	SECRETARIAT LOCATION	SECRETARIAT UN AFFILIATE	SECTOR	DESCRIPTION OF THE SPI
The Scientific Advisory Board of the United Nations Secretary-General (SAB)	Paris (France)	UNESCO	Education	UN-SAB was a panel of experts established by former UN Secretary General Ban Ki-moon, comprising renowned scientists representing various fields of natural, social and human sciences. The central function of the Board was to provide advice on science, technology and innovation (STI) for sustainable development to the UN Secretary General and to executive heads of UN organizations, endeavouring to strengthen the interface between science, policy and society.
Alliance for Health Policy and System Research (AHPSR)	Geneva (Switzerland)	WHO	Health	AHPSR promotes the generation and use of research to strengthen the health systems of low- and middle-income countries. It is hosted by WHO. It has 15 staff members managing 18 programmes and 40 grants a year for research in health policy and systems. It has a scientific and technical board of 6 experts, and a governing board made of 8 stakeholders (funders, leaders, WHO representatives).
International Council for the Exploration of the Seas (ICES)	Copenhagen (Denmark)	NA	Other	ICES is a regional intergovernmental organization for marine science that provides advice for conservation, management and sustainability goals. It is a network of about 6 000 scientists and has 20 member countries around the North Atlantic Ocean. The Council is the principal decision and policymaking body of ICES, and for decisions, resolutions are submitted for approval to the Council, Advisory Committee and/or Science Committee (member countries are represented in all three). Other bodies include steering groups, expert groups, strategic initiatives and a Secretariat.
Mediterranean Experts on Climate and Environmental Change (MedECC)	Marseille (France)	NA	Other	MedECC is a regional open independent international scientific expert network that provides information to decision-makers and the public. It works based on available information and ongoing research. It aims to build a regional SPI on climate and environmental change. It also aims to update and consolidate the best scientific knowledge, contribute to future assessments by e.g. IPCC/IPBES, identify research gaps, and build capacity of scientists from southern and eastern Mediterranean countries.
South Centre	Geneva (Switzerland)	NA	Other	South Centre was founded by a coalition of states of the Global South, mainly part of the G77 group. The SC currently has 55 member states. Its goal is to help developing countries promote their common interests in the international arena. It provides policy-oriented research and technical support to state coalitions at UN institutions. It has observer status in several international organizations, including ECOSOC, WTO and WHO.

3.2.2. Framework development and measurement approach

The framework development was iterative and included three distinct stages: 1) initial framework development, 2) expert feedback and framework revision, and 3) final framework and data validation.

1. Initial framework development

Development of an initial framework of global SPIs was based on the authors' expertise. Categories and subcategories were chosen based on three criteria: a) need for informative comparison, b) potential for the operationalization into measurable indicators, and c) availability of accessible information for all SPIs. The resulting framework comprised a table in which the rows included all SPIs of interest and the columns included all categories and subcategories for comparison.

Once the framework was developed, data were collected on all SPIs from websites and complemented with information from academic and grey literature.

2. Expert feedback and framework revision

An expert workshop was held to gather feedback on the initial framework. The presentation included all components of the initial framework: categories, subcategories, metrics and results. The experts supported the approach and the categories chosen and underlined the complexity of the task. Feedback identified opportunities to include additional SPIs and refine the categories, subcategories and metrics.

In terms of SPIs included in the review, the participants questioned the choice of mainly formalized assessment-based SPIs. There is a risk of ignoring SPIs that are more representative of social science or community-based organizations, which may not fit into the conventional category of SPIs. South Centre was therefore added.

The expert panel also provided suggestions for the overall framework, as well as for specific categories and subcategories. For example, panellists suggested addition of a field to capture existing critiques of an SPI (positive or negative) and to add subcategories for formal evaluation processes, including external evaluations (e.g. audits). Furthermore, workshop participants suggested addition of a subcategory covering the decision structure of the interface and participants agreed that not all SPIs operate on the basis of co-production. Participants also highlighted the difficulty in assessing SPI learning due to lack of transparency. It was considered by the panel that UN SPIs were less able to learn because of their complex structure and path dependency dynamics. Finally, panellists recommended that the review develop a richer description of the categories, subcategories and metrics to elaborate a more nuanced classification.

Based on the expert panel feedback, the authors revised and improved the description of the categories and subcategories, as well as the articulation of the measurement scale for each subcategory. The framework and measurement scale presented in this report represents the final output of this iterative process (see Section 4 for a full presentation of the framework).

3. Final framework and data validation

After revising the framework, new data sources in addition to original data sources were used to characterize each SPI. Scoring used the measurement scale for each category and subcategory to determine the relative strengths of each SPI.

Reliability of the data collected was ensured through an independent review by two authors of the data for each SPI, providing qualitative categorizations according to the final measurement protocol for all subcategories. In all cases, the two sets of results were compared and discussed. In cases where there was no consensus, a third opinion was sought.

4 FRAMEWORK AND MEASUREMENT SCALES

The comparative review of SPIs was conducted based on an analytical framework comprising four categories: *purpose and origin, scope and governance, co-production structure and process, and learning*. Each category includes several subcategories. For the latter three categories, a summary estimate of complexity, co-production and learning is given, based on publicly available information. A description of categories and subcategories is provided. Additionally, a table of categories and metrics is included (Table 2).

4.1. Purpose and origin

This category refers to the stated goal of the SPI and includes three subcategories: *integration of science and policy in aims/goals, institutional origin and date of creation*. The former refers to the extent to which the purpose of the SPI is to integrate science and policy. The latter refers to the roots of the SPI (in particular, whether the SPI originates from the United Nations system).

4.2. Scope and governance

This category refers to complexity of the institutional and governance aspects of the SPI and includes five subcategories: *geographic scope of SPI products, sector(s), funding source, decision-making structure, and diversity of outputs*.

- ***Geographic scope of SPI products*** – geographical scale for which the SPI produces outputs (coded as global or regional).

- ***Sector(s)*** – whether the SPI addresses a single or multiple sectors. The sector(s) is identified based on the UN organization(s) with which the SPI interacts. Sectors include agriculture, environment, health and development (coded as either single or multiple sectors).

- ***Funding source*** – whether the SPI is financed publicly, privately or by a mix of both.

- ***Decision-making structure*** – whether the decision-making process of the SPI follows a demand-driven, supply-driven or mixed approach. Demand-driven SPIs respond primarily to policy needs based on scientific evidence. Supply-driven SPIs respond to scientific developments and synthesize/adapt it for policy. SPIs that are credible, legitimate and relevant are those that maintain a balance between scientific supply and policy demand (Sarkki et al., 2015).

- ***Output complexity*** – a combination of output variation and policy audience variation. Output variation is measured as either limited (few types of output) or numerous (various output forms, e.g. reports, policy briefs, recommendations). Audience variation refers to the complexity of the policy-relevant audiences targeted for the outputs, ranging from narrow to expansive. As complexity increases, SPIs can include a broader range of potential decision-makers as targets for their outputs. Variation across these two audience-output dimensions results in four measurement groupings: limited-narrow, numerous-narrow, limited-expansive and numerous-expansive.

4.3. Co-production structure and process

This category refers to the features and dynamics of the SPI in terms of the participatory modes of knowledge production (Turnhout *et al.*, 2020). The chosen conceptualization of co-production includes the relationship between science and policy, and between science and other knowledge system holders. SPIs with a high degree of co-production – especially SPIs that include a large variety of stakeholders beyond scientists and policymakers (e.g. practitioners, local/indigenous knowledge holders) – can foster strong, close and dynamic interplay among science, policy and society. An inclusive co-production process, albeit less predictable and potentially complex, can lead to enhanced legitimacy and effectiveness of SPIs (Maas *et al.*, 2022). This category comprises five subcategories: *openness to stakeholders, type of co-production process, communication and outreach, level of knowledge-source inclusion, and diversity of mechanisms for achieving goals*.

- ***Openness to stakeholders*** – the degree of openness of the SPI in terms of cooperation with stakeholders in a narrow intergovernmental sense, including all those outside member states, international organization bureaucracies and scientist/expert members of SPIs, measured on a three-point scale. An elite SPI does not include external stakeholders and a selective SPI indicates greater openness of selected stakeholders. A universal SPI refers to SPIs that are open universally to all stakeholders.

- ***Type of co-production process*** – the nature of the co-production processes between SPIs and stakeholders, ranging from consultative to immersive (Carter et al., 2019). Consultative is more controlled and formalized and immersive is less structured and more flexible, with opportunities for ad hoc engagement. Some SPIs are of a mixed type.

- ***Communication and outreach*** – the extent of SPI engagement with the public beyond scientists and policymakers, measured as low, medium or high.

- ***Level of knowledge-source inclusion*** – sources of knowledge (e.g. scientific knowledge, Indigenous Peoples' knowledge, traditional and local knowledge, grey literature) used by the SPI. An SPI can use many types of knowledge and knowledge sources. An SPI can restrict itself solely to knowledge from peer-reviewed literature. The scale for this subcategory is low, medium or high.

- ***Diversity of mechanisms for achieving goals*** – approaches and procedures adopted by the SPI to fulfil its aims. It assesses whether the SPI relies mainly on science/knowledge synthesis approaches or whether it carries out other types of activity, such as capacity building or more advanced engagement mechanisms, including multistakeholder dialogues and policy tool development. This subcategory is measured as low, medium or high.

4.4. Learning

Learning refers to the actual or prospective ability of the SPI to incorporate new knowledge and experience, with a view to improving its overall effectiveness and legitimacy. Learning can be categorized in many ways, from experiential at the individual level to learning at the organizational level. The academic literature distinguishes formal and informal learning practices (see Obermeister, 2020 on science advisors), where the informal is more difficult to gauge because it is less obvious. There is also separation of single loop learning, which aims to improve the achievement of an existing objective, from double loop learning, which involves questioning the objective (Borie *et al.*, 2020). Additionally, instrumental learning is distinct from transformational learning (Pallett and Chilvers, 2013). The latter has evolved and is defined by Borie *et al.* (2020) as "learning that creates change […] and learning that is achieved reflexively". Instrumental learning is goal-oriented and enables work in and/ or engagement with the SPI as it stands, whereas transformational learning refers to the SPI learning about itself (e.g. its intended or unintended practices, impacts, etc.) and changing itself accordingly.

Learning is divided into four subcategories: *goal-oriented learning, formal evaluations, enabling conditions for improving knowledge, and criticism and scrutiny*.

- ***Goal-oriented learning*** – instrumental forms of learning, such as capacity building, training, mentorship, are measured as yes if detected through analysis of publicly available information and no if not.

- ***Formal evaluations*** – whether the SPI undergoes formal evaluations, reviews, impact assessments, audits and other practices that can promote transformational learning (i.e. that are necessary but not sufficient for this type of learning). Transformational learning is difficult to measure, but it is used as a proxy to assess the learning potential of an SPI. Hence, this measures the potential for transformational learning rather than its existence. It is measured as yes if detected through analysis of publicly available information and no if not.

- ***Enabling conditions for improving knowledge*** – the existence of conditions by which an SPI can actively foster situations or processes to improve the quality of knowledge used. This involves self-critical learning about how the SPI operates and how it could improve, demonstrating its reflexivity. Examples include ways to incorporate feedback from review processes and inclusion of different knowledge systems. It is measured as yes if detected through analysis of publicly available information and no if not.

- ***Criticism and scrutiny*** – whether the SPI has received criticism and scrutiny in the academic literature. This was included because criticism can stimulate reflection. The effect of criticism and scrutiny can be positive or negative, with more criticism potentially leading to learning. It is measured as yes if detected through analysis of publicly available data and no if not.

4.5. Measurement of framework categories and subcategories

When the framework of categories and subcategories was finalized, metrics were defined based on the type of information available and its categorization to provide insights into SPI operation. The metrics and definitions are provided in Table 2. A summary estimate is provided for *scope and governance, co-production* and *learning*, to indicate the estimated levels of complexity, co-production and learning.

Table 2. Global science–policy interface measurement protocol

CATEGORY	CATEGORY DESCRIPTION	SUBCATEGORY	SUBCATEGORY DESCRIPTION	ASSOCIATED METRIC
Purpose and origin	**Refers to the officially determined goal of the SPI and its historical origins**	Integration of science and policy in aims/goals	Refers to the extent to which the purpose of the SPI is to integrate science and policy, as discernible from publicly available information	LOW: the SPI is only mandated to synthesize/provide knowledge and evidence, without experts interacting with policymakers
				MEDIUM: the SPI is mandated to synthesize/provide knowledge and evidence, and experts interact with policymakers only minimally
				HIGH: the SPI is mandated to synthesize/provide knowledge and evidence, as well as engage in an iterative process of interplay between experts and policymakers
		Institutional origin	Refers to the roots of the SPI, whether the SPI originates from the United Nations system or not	UN: the SPI has been established within the UN system, either by UN Member States or by UN agencies/bodies
				Non-UN: the SPI has been established outside the UN system (e.g. by science/research group, NGOs or communities)

CATEGORY	CATEGORY DESCRIPTION	SUBCATEGORY	SUBCATEGORY DESCRIPTION	ASSOCIATED METRIC
Scope & governance	Refers to complexity of the institutional and governance aspects	Geographic scope of SPI products	Refers to the geographical scale for which the SPI produces outputs	**GLOBAL**: the SPI provides outputs for the global level
				REGIONAL: the SPI provides outputs for regional levels (e.g. by continent, UN region or other)
		Sector(s)	Refers to whether the SPI is addressing a single or multiple sectors as divided within the UN system. The sector(s) were identified based on the main UN organization they interact with (e.g. WHO, FAO, UNEP, UNDP, UNESCO, etc.).	**SINGLE**: the SPI tackles a single sector or policy domain (e.g. interacts mainly with UNDP or WHO)
				MULTIPLE: the SPI tackles more than one sector or policy domain (e.g. UNEP and WHO)
		Funding source	Refers to whether the SPI is financed by public, private or mixed funding	**PUBLIC**: the SPI is financed by public resources that come from either UN Member States or UN agencies/bodies
				PRIVATE: the SPI is financed by private resources that come from non-public actors, such as companies or philanthropic foundations
				MIX: the SPI is financed by a mix of public and private resources
		Decision-making structure	Refers to whether the decision-making process of the SPI follows a demand-driven or a supply-driven approach or a mix	**DEMAND-DRIVEN**: the SPI provides advice only based on specific requests coming from the policy side
				SUPPLY-DRIVEN: the SPI autonomously provides advice to policy (i.e. in absence of specific requests from the policy side)
				MIXED: the SPI responds to policy requests or acts autonomously
		Output complexity	Refers to the combination of two items: output variation and policy audience variation. Output variation is limited (few types of outputs) or numerous. Audience variation is either narrow or expansive, depending on the range of potential decision-makers targeted. Based on publicly available information	**LIMITED-NARROW**: Few types of outputs dedicated to a narrowly defined set of decision-makers
				LIMITED-EXPANSIVE: Few types of outputs dedicated to a broader range of decision-makers, including scientists
				NUMEROUS-NARROW: Multiple types of outputs dedicated to a narrowly defined set of decision-makers
				NUMEROUS-EXPANSIVE: Multiple types of outputs dedicated to a broader range of decision-makers, including scientists
Summary: Scope and governance		Level of complexity	This is an estimate/summary of the complexity of the SPI based on its scope and governance and based on publicly available information	**1 to 3**

CATEGORY	CATEGORY DESCRIPTION	SUBCATEGORY	SUBCATEGORY DESCRIPTION	ASSOCIATED METRIC
Co-production	Refers to the features and dynamics of the SPI in terms of co-production	Openness to stakeholders	Refers to the degree of openness of the SPI in terms of cooperation with stakeholders as discernible from publicly available information. Stakeholders are defined here in a narrow intergovernmental sense. They include all actors that fall outside the following groups: member states, international organization bureaucracies, scientists/ experts that are members of SPIs	**ELITE**: the SPI has no or very limited openness to stakeholders that are not normally considered part of the SPI process
				SELECTIVE: the SPI allows for the participation of stakeholders in the SPI process, but there are limitations related to the type of stakeholder that can participate and/or to the degree of their involvement (for instance, stakeholders may only belong to the academic community and/or may only have observer status)
				UNIVERSAL: the SPI is open to all stakeholders, allowing for their participation in the SPI process without substantial limitations
		Type of co-production process	Co-production processes between SPIs and stakeholders, if they are described in publicly available information to exist, are of various natures. The spectrum ranges from consultative to immersive	**CONSULTATIVE**: the SPI consults on a punctual basis with stakeholders on a given and defined topic
				IMMERSIVE: the SPI involves a broader range of actors deeply involved in a more fluid and flexible process. In this case, the content of the knowledge to be produced is less certain at the outset, but the knowledge produced is more adapted to the potential users, and regarded as more legitimate
				MIXED: a mix between the two. For instance, the SPI can entertain immersive co-production process at the outset, and then select a certain number of actors to participate in a more consultative fashion as the projects carried by the SPI mature
				NONE
		Communication and outreach	Does the SPI engage with the general public beyond scientists and policymakers? If so, to what extent? (based on publicly available information)	**LOW**: The SPI does not engage in efforts of popularization (e.g. minimal internet presence)
				MEDIUM: The SPI popularizes knowledge for the media or the public
				HIGH: The SPI popularizes knowledge for the media and the public
		Level of knowledge-source inclusion	Refers to sources of knowledge (e.g. scientific knowledge, Indigenous Peoples', traditional and local knowledge, grey literature) used by the SPI in its work according to publicly available information. An SPI can make use of many types of knowledge sources available to it. While some SPIs restrict themselves to only particular knowledge found in peer-reviewed literature, others make efforts to identify, engage with and include relevant knowledge from other sources	**LOW**: Peer-reviewed research only, e.g. scientific journals
				MEDIUM: Grey literature such as institutional reports, non-peer reviewed knowledge
				HIGH: multistakeholder dialogues or consultations, informal and non-written contributions, such as oral contributions, traditional knowledge, art, etc.
		Diversity of mechanisms for achieving goals	Refers to the approaches and procedures adopted by the SPI in fulfilling its mission, according to publicly available information. Does it rely mainly on science/knowledge synthesis approaches, or include capacity building, or more advanced engagement mechanisms like multistakeholder dialogues or policy tools?	**LOW** - only scientific/knowledge synthesis/assessment mechanisms
				MEDIUM - scientific plus capacity building/training
				HIGH – scientific, capacity building, multistakeholder dialogues and policy tools mechanisms
Summary: Co-production		Level of co-production	This is an estimate/summary of the degree to which the SPI engages in co-production based on the findings in the above categories	**1 to 3**

CATEGORY	CATEGORY DESCRIPTION	SUBCATEGORY	SUBCATEGORY DESCRIPTION	ASSOCIATED METRIC
Learning	**Learning can take many forms and can be categorized in many ways, e.g. from experiential at the individual level to learning at the organization level**	Goal-oriented learning	For the purposes of this review, elements like capacity building, trainings, mentorship, etc. are considered as being goal-oriented/'instrumental' learning. (Assessment based on publicly available information)	**YES**
				NO
		Formal evaluations	Due to transformational learning being difficult to measure, one can only identify whether practices that could in theory 'enable' transformational learning are present, rather than stating the SPI is actually learning and changing. Formal evaluations, reviews, impact assessments, audits, and other practices can make such learning possible (i.e. are a necessary but not sufficient condition for this type of learning). (Assessment based on publicly available information)	**YES**
				NO
		Enabling conditions for improving knowledge	SPIs can actively foster situations or processes that allow for improving the quality of knowledge that can be used by the SPI. This involves learning about how the SPI itself operates. It demonstrates reflexivity of the SPI. Examples could include collecting feedback about review processes and inclusion of different knowledge systems, etc. (Assessment based on publicly available information)	**YES**
				NO
		Scrutiny and criticism in the academic literature	This category refers to the criticism received by an SPI	**YES**
				NO
Summary: Learning		Level of learning	This is an estimate/summary of the learning level of the SPI	**1 to 3**

5 COMPARING SCIENCE–POLICY INTERFACES: CASE STUDIES

This section presents the findings from the desktop review. Findings are first presented in order of the framework categories – purpose and origin, scope and governance, co-production, and learning – and then as full summary findings. Comparative evidence from the review is provided and accompanied by descriptive text. It is important to highlight that data collected for this review are based on existing literature and web-based materials, many of which are produced by the SPIs and are publicly available. While efforts were made to verify the data, longer-term analysis that includes collection of primary data is recommended.

5.1. Purpose and origin

The purpose and origin of SPIs includes three subcategories: *date of creation, integration of science and policy in stated aims and goals, and institutional origin*. The SPIs are presented in chronological order of their establishment (Table 3).

South Centre, IPBES and MedECC show high levels of integration of science and policy in their aims and goals. South Centre does policy-oriented research on development politics and provides policy advice and technical support. It also generates its own ideas and responds to membership and developing country requests. IPBES goes beyond assessing and strengthening knowledge to include policy support and capacity building. It also works on communication and engagement, and on the effectiveness of its platform. MedECC explicitly seeks to bridge the gap between research and decision-making and contribute to policy improvement. It makes up-to-date and consolidated knowledge accessible to policymakers and key stakeholders, including citizens. It also engages in building capacity of scientists.

5.2. Scope and governance

This includes five subcategories: *geographical scope, sector(s), funding source, decision-making structure, and diversity of outputs*. A final category provides a summary across all subcategories and estimates overall complexity of the SPI (Table 4).

Among the 12 SPIs analysed, ICES and MedECC are regional and provide outputs related to the North Atlantic and Mediterranean regions respectively. Most others provide global outputs. South Centre provides research and advice for Global South actors, with specific outputs for the state coalitions represented in large international organizations such as the African Group at the United Nations. IPBES produces global and regional level assessments. The IPCC produces global and regional assessment reports and fact sheets.

Table 3. Purpose and origin of selected science–policy interface organizations

PURPOSE AND ORIGIN			
SPI name	**Date of creation**	**Integration of science and policy in aims/goals**	**Origin of SPI**
ICES	1902	medium	non-UN
IPCC	1988	low	UN
GEF/STAP	1994	medium	UN
South Centre	1995	high	non-UN
AHPSR	1997	medium	UN
REGPROC	2004	low	non-UN
HLPE-FSN	2009	medium	UN
IPBES	2012	high	UN
ITPS	2013	low	UN
SAB	2013	low	UN
UNCCD SPI	2014	medium	UN
MedECC	2015	high	non-UN

ICES – International Council for the Exploration of the Seas, IPCC – Intergovernmental Panel on Climate Change, GEF/STAP – The Scientific and Technical Advisory Panel for the Global Environment Facility, AHPSR – Alliance for Health Policy and System Research, REGPROC – Regular Process for Global Reporting and Assessment of the State of the Marine Environment, including Socioeconomic Aspects, HLPE-FSN – The High Level Panel of Experts on Food Security and Nutrition, IPBES – Intergovernmental Platform on Biodiversity and Ecosystem Services, ITPS – Intergovernmental Technical Panel on Soils, SAB – The Scientific Advisory Board of the United Nations Secretary-General, UNCCD SPI – Science–Policy Interface of the United Nations Convention to Combat Desertification, MedECC – Mediterranean Experts on Climate and environmental Change.

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Table 4. Scope and governance of selected science–policy interface organizations

SCOPE AND GOVERNANCE						SUMMARY: SCOPE AND GOVERNANCE
SPI name	**Geographical scope**	**Sector(s)**	**Funding source**	**Decision-making structure**	**Output complexity**	**Estimated complexity**
ICES	regional	multiple	*	mixed	numerous–expansive	**2**
IPCC	global + regional	multiple	public	supply	limited–expansive	**1**
GEF/STAP	global	multiple	public	mixed	numerous–narrow	**2**
South Centre	global	multiple	mixed	mixed	numerous–narrow	**3**
AHPSR	global	single	mixed	mixed	numerous–expansive	**2**
REGPROC	global	*	*	demand	limited–expansive	**2**
HLPE-FSN	global	single	public	demand	numerous–narrow	**2**
IPBES	global + regional	multiple	mixed	demand	numerous–expansive	**3**
ITPS	global	single	mixed	demand	numerous–narrow	**1**
SAB	global	multiple	*	demand	limited–narrow	**1**
UNCCD SPI	global	single	public	demand	numerous–narrow	**2**
MedECC	regional	single	mixed	mixed	numerous–expansive	**2**

* insufficient information

ICES – International Council for the Exploration of the Seas, IPCC – Intergovernmental Panel on Climate Change, GEF/STAP – The Scientific and Technical Advisory Panel for the Global Environment Facility, AHPSR – Alliance for Health Policy and System Research, REGPROC – Regular Process for Global Reporting and Assessment of the State of the Marine Environment, including Socioeconomic Aspects, HLPE-FSN – The High Level Panel of Experts on Food Security and Nutrition, IPBES – Intergovernmental Platform on Biodiversity and Ecosystem Services, ITPS – Intergovernmental Technical Panel on Soils, SAB – The Scientific Advisory Board of the United Nations Secretary-General, UNCCD SPI – Science–Policy Interface of the United Nations Convention to Combat Desertification, MedECC – Mediterranean Experts on Climate and environmental Change.

The majority of SPIs interact with multiple sectors or policy domains as indicated by the main UN organizations they engage with. While funding sources were not always identifiable (identified for 9 of 12 SPIs) a similar number of SPI operations are supported by public funding (4) as by a mix of public and private funding (5).

In terms of SPI decision-making, IPCC stands out as being mainly supply-driven because it autonomously provides advice to policy without explicit requests. Six SPIs are demand-driven, responding to specific policy requests, and five SPIs operate using a mixed approach, responding to policy and acting autonomously.

Many SPIs (9 of 12) produce various outputs, aimed mainly at policymakers and a broader set of decision-makers (including scientists). About half target outputs mainly to policymakers and half target a range of actors.

Most SPIs are of average complexity (58 percent), 17 percent are highly complex, and about 25 percent are of low complexity. IPBES and South Centre are the most complex SPIs in terms of their scope and organization because they cover a broad range of topics, have multiple relationships with UN organizations, have mixed funding sources and produce diverse outputs.

5.3. Co-production

This includes five subcategories: *openness to stakeholders, type of co-production, communication and outreach, level of knowledge source inclusion*, and *diversity of mechanisms for achieving goals*. Summary estimates for the general level of co-production across the five subcategories are given in Table 5.

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Table 5. Co-production for selected science–policy interface organizations

CO-PRODUCTION						SUMMARY: CO-PRODUCTION
SPI name	Openness to stakeholders	Type of co-production process	Communication and outreach	Level of knowledge-source inclusion	Diversity of mechanisms for achieving goals	Estimated co-production
ICES	selective	none	medium	low	medium	**1**
IPCC	elite	*	medium	low	medium	**1**
GEF/STAP	elite	none	low	low	low	**1**
South Centre	selective	consultative	medium	high	high	**2**
AHPSR	selective	mixed	low	medium	medium	**2**
REGPROC	elite	*	high	low	medium	**2**
HLPE-FSN	universal	mixed	low	medium	low	**2**
IPBES	universal	mixed	high	high	high	**3**
ITPS	elite	none	low	low	low	**1**
SAB	elite	none	low	low	low	**1**
UNCCD SPI	elite	none	low	medium	low	**1**
MedECC	universal	immersive	high	low	high	**3**

*insufficient information

ICES – International Council for the Exploration of the Seas, IPCC – Intergovernmental Panel on Climate Change, GEF/STAP – The Scientific and Technical Advisory Panel for the Global Environment Facility, AHPSR – Alliance for Health Policy and System Research, REGPROC – Regular Process for Global Reporting and Assessment of the State of the Marine Environment, including Socioeconomic Aspects, HLPE-FSN – The High Level Panel of Experts on Food Security and Nutrition, IPBES – Intergovernmental Platform on Biodiversity and Ecosystem Services, ITPS – Intergovernmental Technical Panel on Soils, SAB – The Scientific Advisory Board of the United Nations Secretary-General, UNCCD SPI – Science–Policy Interface of the United Nations Convention to Combat Desertification, MedECC – Mediterranean Experts on Climate and environmental Change.

MedECC and IPBES stand out as showing relatively open stakeholder involvement that may enable co-production. MedECC holds multi-stakeholder dialogues with the scientific community, decision-makers and stakeholders, where stakeholders can request outputs and training (e.g. technical/scientific). IPBES creates opportunities for reviewing its assessments and to obtain inputs to elements of its work programme. AHSPR also engages with a broad range of actors and considers strategic partnerships to be the cornerstone of its activities, which shows more co-production activity than for many other SPIs. For seven SPIs, no co-production processes between SPIs and stakeholders were identified, although two undertake scheduled consultative engagement on specific topics. Most SPIs have low levels of communication and outreach, do not disseminate their work widely and use limited knowledge sources, depending primarily on peer-reviewed science. IPBES, MedECC and South Centre include scientific approaches, capacity building and multi-stakeholder mechanisms or policy tools, while four others use scientific approaches and capacity building, and five rely only on scientific approaches.

Most selected SPIs provide only limited opportunities for potential co-production (50 percent), while 17 percent have a high level of co-production potential, and 33 percent have a medium level of co-production potential. It is possible that there is a relationship between SPI complexity and levels of co-production – the level of resources needed to maintain a level of complexity may relate to the ability to engage and/or engage in co-production processes.

Some SPIs are more represented in several subcategories of co-production because they take a broader approach to their work and engagement with stakeholders. SPIs with higher summary estimates demonstrate greater openness to stakeholders, engage more with the outside world and employ a greater diversity of mechanisms to achieve their goals.

5.4. Learning of selected SPIs

This includes four subcategories: *goal-oriented learning, formal evaluations, enabling conditions for improving knowledge, and scrutiny and criticism*. A summary estimate establishes the general level of learning across the four subcategories (Table 6).

Table 6. Learning of selected science–policy interface organizations

LEARNING					SUMMARY: LEARNING
SPI name	Goal-oriented learning	Formal evaluations	Enabling conditions for improving knowledge	Scrutiny and criticism in the academic literature	Estimated level of learning
ICES	yes	yes	no	yes	**2**
IPCC	yes	no	no	yes	**1**
GEF/STAP	no	yes	yes	no	**2**
South Centre	no	no	no	no	**1**
AHPSR	yes	no	no	no	**1**
REGPROC	yes	yes	yes	yes	**3**
HLPE-FSN	no	no	no	yes	**1**
IPBES	yes	yes	yes	yes	**3**
ITPS	no	no	no	yes	**1**
SAB	no	no	no	no	**1**
UNCCD SPI	no	yes	no	yes**	**1**
MedECC	yes	no	no	no	**1**

*insufficient information; **positive criticism

ICES – International Council for the Exploration of the Seas, IPCC – Intergovernmental Panel on Climate Change, GEF/STAP – The Scientific and Technical Advisory Panel for the Global Environment Facility, AHPSR – Alliance for Health Policy and System Research, REGPROC – Regular Process for Global Reporting and Assessment of the State of the Marine Environment, including Socioeconomic Aspects, HLPE-FSN – The High Level Panel of Experts on Food Security and Nutrition, IPBES – Intergovernmental Platform on Biodiversity and Ecosystem Services, ITPS – Intergovernmental Technical Panel on Soils, SAB – The Scientific Advisory Board of the United Nations Secretary-General, UNCCD SPI – Science–Policy Interface of the United Nations Convention to Combat Desertification, MedECC – Mediterranean Experts on Climate and environmental Change.

Across the three chosen measures of learning, instrumental learning is most clearly demonstrated, with half of the twelve selected SPIs showing some degree of goal-oriented learning (training, capacity building, mentoring, fellowship programmes). Formal evaluations or reform processes were evident in five SPIs, but few displayed a reflective process to learn about their own ways of operating. Learning is identified by GEF-STAP as being important and it recognizes that systematization of learning is needed so knowledge is not lost when staff leave. IPBES has a specific approach to working with local and Indigenous Peoples' knowledge that, in principle, could provide conditions for reflection on its own operations. It also has a social sciences and humanities component (member organization) as part of its *ONet* stakeholder network that *inter alia* also reflects on its functioning. REGPROC invited feedback from member states, observers and other participants, which was requested by UNGA and captured under formal evaluation. IPCC shows lower levels of publicly accessible information about learning. While its instrumental learning activities are evident as training and capacity building, and inclusion of gender, diversity and inclusion, reflexive learning, which could result in improvements in its work, is not evident.

There were instances of scrutiny or critique in the academic literature for seven of the twelve SPIs. Five SPIs have not undergone it, but it is possible that lack of critique is due to the recent establishment of some SPIs (e.g. MedECC, established in 2015, SAB in 2013). No public criticism was evident for some of the older SPIs (GEF-STAP established in 1994, South Centre in 1995, AHPSR in 1997). This may be due to lack of interest or the absence of SPI-established mechanisms to encourage academic engagement for learning.

The majority of the selected SPIs exhibit low estimated levels of learning (67 percent), while the remaining 33 percent are evenly split between high and intermediate learning levels. These data confirm conclusions from the general literature that SPI learning processes are generally low and should be investigated further.

5.5. Summary of results

Based on the results on level of complexity, level of co-production and level of learning, IPBES stands out. The South Centre has a high level of complexity with a high-level integration of science with policy, a broad range of topics addressed, mixed approaches and funding, and a diversity of outputs for policy. MedECC has a high level of co-production. Although it includes mainly scientific knowledge, it emphasizes knowledge sharing and awareness raising, interacts with a broad range of stakeholders in the form of multi-stakeholder dialogues, and provides training and capacity building. Regular Process has a comparatively high level of learning and not only has capacity building measures for instrumental learning, but has also undergone a formal process to identify lessons learned as requested by UNGA. Feedback on lessons learned from the second cycle of the World Oceans Assessment was invited from Member States, observers and other participants.

Three SPIs had low estimates for all three summary metrics: SAB, ITPS and IPCC. SAB was an ad hoc panel and is no longer active. ITPS was recently established and may still be developing in terms of learning, co-production and transparency. It also appears to operate relatively independently from the policy processes. IPCC, which is considered a success, mainly operates as an aggregator and supplier of scientific knowledge on the biophysical impacts of climate change. There is moderate integration of co-production and low evidence for a functioning learning mechanism. It shows a medium level of openness to stakeholders and co-productive processes, and a relatively limited level of knowledge inclusion.

To understand whether the summary statistics produce insights about patterns of observed structure and governance, the findings were reviewed. Firstly, patterns related to the date of establishment were examined. The expectation was that SPIs established recently might be more likely to adopt and integrate co-production and learning mechanisms. The results were also arranged by organization type, separating UN origin (IPCC; GEF/STAP; HLPE; AHPSR; IPBES; ITPS; SAB; UNCCD) from non-UN origin (ICES, South Centre, Regular Process, MedECC). It was anticipated that non-UN origin SPIs might integrate less co-production and less learning.

Neither effort produced clear results. Age of organization is not related to summary measures. While results on the UN/non-UN comparison are not conclusive, many UN-associated SPIs (except IPBES) had lower levels of co-production and learning. Of the eight UN-associated SPIs, only one had a moderate level for observed co-production or learning, but most of the non-UN-associated SPIs showed moderate levels for co-production or learning.

Additionally, the summary results were organized by sector identified earlier in this report (Table 1). HLPE and ITPS are in the agriculture sector, GEF/STAP, IPBES, IPCC, Regulatory Process and UNCCD address environment, AHPSR and SAB cover health and education, respectively, and ICES, MedECC and South Centre cover other issues. Agriculture was the one sector where there was little public evidence for learning.

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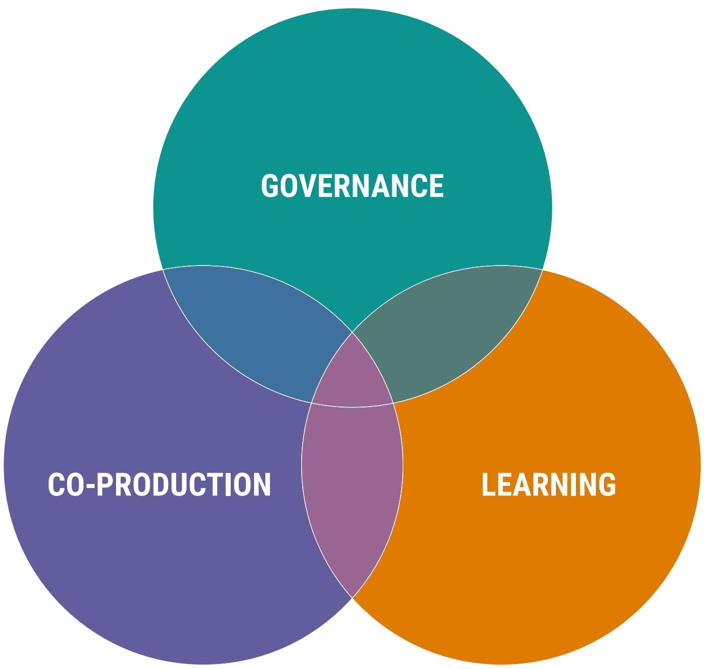
6 DISCUSSION AND CONCLUSION

The aim of this desktop review was to promote understanding of how different international science–policy interfaces operate to address the complexities of their tasks. The review was based on a literature-informed investigation to create a conceptual framework that could be easily communicated to various audiences and be useful for eliciting features and patterns of SPIs as evidenced in publicly available information. Although the review was limited by its dependence on available secondary data, it provides insights into how individual SPIs work and what structures and mechanisms operate. Future work could include collection of primary data, including interviews of staff associated with specific SPIs to provide a more nuanced understanding of each SPI.

Key questions for this review include: 1) Which international SPIs appear to be more effective at overcoming the linear model of scientific advice? and, 2) Are there patterns of operation that can be discerned across international SPIs? Overall, the findings of this review, combined with those of the national-level study (Stewart and Patiño-Lugo, 2024), will provide a foundation for informing future development of guidance on the design and development of science–policy interfaces.

Figure 1. Balancing core science–policy interface organization components



The conceptual framework builds on a comprehensive literature that identifies three key components of SPIs that, operating together, have the potential to anticipate and respond to needs and demands for both policy and science (Figure 1). Governance comprises the formal and informal structures, norms, rules and procedures for operation and integration among the numerous actors and potential actors at the interface of science and policy. It sets the boundaries of how and to whom it responds and also determines the avenues of intended influence. Additionally, governance provides a mechanism for addressing the complex political context of the SPI. Co-production specifies the mechanisms by which diverse stakeholders and knowledge types are integrated and recognized in SPI activities. It sets the norms and processes for inclusion and determines the level of openness and iterative nature of the SPI engagement activities that contribute to its influence. Learning represents the intention and capacity of the SPI to gain insights from what works and what does not work as it carries out its tasks. When learning mechanisms create opportunities and spaces for criticism (self-criticism and external criticism), meaningful reflection, and adaptation, SPIs are potentially better able to communicate effectively and influence science and decision-making.

In the chosen conceptual framework, three components – governance, co-production, learning – comprise the critical SPI pillars that operate in concert and influence each other. Governance systems enable co-production and learning. Similarly, learning is both a potential outcome of co-production and governance, and a means of addressing what might be misaligned or counterproductive. Hence, by examining all three components, this report explains the extent to which an SPI recognizes and integrates the complexities of a non-linear influence process between science and policy. Additionally, the report details patterns across SPIs as represented in the public domain and suggests possible next steps.

The findings show that across SPIs, patterning of the three components varies. The information presented is based on information available in the public domain and there may therefore be a discrepancy between it and actual SPI practices. The practices could: 1) be more extensive or advanced than discernable in this review, or 2) be more accentuated in publicly available information than they are in reality. This underscores the need to collect primary data for further study. Additionally, because summary estimates are descriptive, higher estimates are not necessarily desirable. SPIs serve different purposes as they respond to different demands and contexts and are established to accomplish different goals. This means, for example, that some SPIs may not require high complexity, co-production, or learning, while others will. Furthermore, establishing a highly ambitious SPI based on a flawed process is arguably worse than not being ambitious. This has the potential to lead to disappointment, erode trust and result in disengagement.

It is noteworthy that there are significant analytical challenges in determining impact of international SPIs because:

- Although international SPIs can play a role in agenda-setting, implementation mainly happens at national level, which international SPIs cannot influence directly.

- Due to the specificity of each issue area, a case study research design, rather than a comparative approach across issue areas, is better suited to focus on particular impacts. No consensus exists on a set of standardized indicators for evaluating impact across global SPIs to enable comparison across cases and draw lessons on the features of a successful SPI.

- Assessing the overall influence of an international SPI would require an in-depth, long-term study, which would be possible only for well-established SPIs.

A recent evaluation of a global SPI indicates scope for improvement on impact as there may be a discrepancy between setting ambitious goals and achieving them (Stevance *et al.*, 2020). Building stronger shared methodological goals and approaches, through a set of criteria and standardized indicators, while recognizing the need for contextuality and pluralism, is a challenge still to be met (Strand, 2022; Posner and Cvitanovic, 2019). This methodological challenge has important practical implications for individuals, teams and organizations performing this interfacing role because they "often wrestle with similar challenges but come at them in different fragmented ways, sometimes 'reinventing the wheel' in the process" (Posner and Cvitanovic, 2019, p.142).

This review should therefore be considered an initial assessment that highlights the importance of observing actual practices. In conclusion, and given the limitations inherent in a desktop review, there are three important findings that may require further investigation, given their importance in the STS literature related to SPI effectiveness.

1. **The extent to which the SPI focal domain or issue area influences design and function**. The variability among SPIs and the absence of clear patterns could possibly be explained by differences in the nature of the domain that are not captured by the current framework, as well as uneven capacities, resources, or interests of the SPIs. It is clear that the domains of environment or health entail different processes and knowledge than do agrifood systems, and there are divergences within a single domain. For example, within the environmental domain, the issue of climate change is traditionally more tractable than that of biodiversity. For the former, the metric for carbon emissions often operates as a core reference point, while the latter includes various levels of observation of living systems, from genes to ecosystems. Similarly, a more narrowly defined domain, such as soil, identifies a clearly defined community of stakeholders that could facilitate SPI work and design policy options and undertake policy implementation. The experience with IPBES and the HLPE-FSN shows that broader topics, such as agrifood systems and biodiversity, must often focus extensively on enhancing policy convergence across states and across stakeholders that have a variety of values and interests.

2. **The overall difficulty for SPIs to engage in co-production and the need for improvement**. The review demonstrates that SPIs may have difficulty working with stakeholders to co-produce relevant knowledge. While there is general acceptance that low levels of co-production can result in low relevance and impact, co-production could take several forms (Bandola, Arthur and Ivor Leng, 2022), including: enhancing interaction among scientists and policymakers, improving uptake of evidence in policy (use), fostering new forms of knowledge production in science (production), and opening up knowledge systems to diversify what knowledge counts and is considered relevant and credible in SPIs (knowledge pluralism). It is difficult to distinguish among the variations in definitions that the SPIs use regarding co-production with stakeholders. This is a topic that warrants more in-depth analysis. For example, future work could examine the possible impacts of co-production practices on the balancing of inputs in a setting with various power imbalances in the face of pluralistic views of reality and an increasing epistemic uncertainty. The question of what constitutes evidence for whom deserves more explicit attention. More work is needed to better qualify the diversity of co-production forms as well as the intensity of co-production within existing SPIs before useful lessons can be formulated into guidance for SPIs.

3. **The relatively scant information available on how SPIs operate**. Despite their critical role and complexity, there is relatively little publicly available information that provides insights into how SPIs operate, possibly creating an inaccurate and incomplete picture of their activities and characteristics. This is either due to a deliberate lack of transparency or is reflective of the generally low capacity of SPIs to present their processes in ways that inform different audiences. Limited transparency is also likely to have negative effects on trust, which is an important condition for learning (Obermeister, 2020). These aspects are most acute for learning. Learning can be defined in different ways and is notoriously difficult to measure because it can happen informally and be difficult to track or record. There is evidence that formal and informal learning spaces are needed (Borie et al., 2020). Nevertheless, when information about learning is made available, it mainly refers to goal-oriented/instrumental forms of learning such as capacity building, training and mentorship. In this review, only three SPIs communicated on mechanisms explicitly in place and/or their involvement in more transformational learning regarding enabling conditions for improving knowledge co-production and enhanced impact. This is surprising because the existence of such mechanisms does not guarantee that effective transformations take place according to the linear model. Other forms of data collection, such as interviews, might have provided greater insight into learning in SPIs that undertake transformative learning activities. More generally, the observation of a gap in attention paid to learning among SPIs exists despite the known wealth of knowledge and experience among SPI experts and practitioners, indicating an opportunity for future linkages.

Overall, the lack of identifiable patterns among UN SPIs provides some evidence of the lack of a shared framework and vision across SPIs about governance, co-production and learning, and the relationships among the three components. Nevertheless, establishing, agreeing to, and adhering to a transparent framework is critical for the ability for SPIs to fulfil their potential and have more impact on decision-making. In this regard, the work planned by FAO to develop guidance on strengthening agrifood SPIs is essential. More specifically, future work by FAO will build on the findings from three efforts: 1) this review, 2) the study on national-level models (Stewart and Patiño-Lugo, 2024) to support the use of evidence in agrifood policy, and 3) the FAO online consultation that addressed the question "What are the barriers and opportunities for scientists and other knowledge holders to contribute to informing policy for more efficient, inclusive, resilient and sustainable agrifood systems?". The intention is to develop harmonized, coherent and practical guidance for building science and evidence-based policy processes in the agrifood systems sector. Developing such guidance will likely require bringing SPI experts into more direct contact with individuals who practise SPI work, with the overall objective of building on the most up-to-date understanding of SPI design and operations. It will also rely on the establishment of a new professional community of practice that takes up the challenges of navigating the (meso-level) SPI governance space and enhancing collective learning on general principles for effective SPIs across many political and sectoral contexts as well as on how to measure effectiveness and impact through a plurality of perspectives.

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Annex 1 WORKSHOP COMPONENTS

A. Invitation

Online workshop on international science–policy interfaces

February 8th, 2023, 3PM-6PM CET, online

BACKGROUND

The need for science–policy interfaces has become so well appreciated that numerous SPIs are already in existence and their number is still growing. The recent UN Food and Agriculture Organization Science and Innovation Strategy includes a pillar on strengthening science and evidence based decision-making, and the Chief Scientist Office has commissioned two background studies on SPIs (national and international). This team is conducting the expert review and providing the background study on international SPIs.

The goal of the focused virtual workshop is to discuss with the group:

1. How different SPIs understand and use knowledge;
2. Strengths and weaknesses of current major SPIs;
3. Learning mechanisms of these SPIs.

Please find a descriptive table outlining different SPIs covering different sectors. This is based on information collected about international SPIs in a more detailed database. The synthesis categories incldiung definitions are the topics of our discussions, as well as possible emerging patterns. Attached is also the draft programme and several questions to be addressed through our interactions.

ENVISAGED APPROACH

A list of international SPIs was jointly identified for team members to collate data on. Based on prior knowledge, the team identified simple overarching themes/issues to research and compare among international SPIs. In order to facilitate and streamline the data collection, subthemes with guiding questions were identified (see list at end of the document). Please also consider the questions in the programme enclosed. The work is still under development, and we would like to discuss with you the draft themes, subthemes and guiding questions.

B. Workshop Programme

Overall Outline

Presentation of the background to the review:

Session 1:
- Overview of the classification/categorization of SPIs
- Q & A and discussion of the classification/ categorization of SPIs

Session 2:
- Discussion of the analysis and identified issues

Session 3:
- Focus on the specific issue of institutional learning mechanisms

Closing words & next steps

Guiding questions

Session 1

Case selection
- Have we covered major fields that have SPIs?
- Have we identified the major SPIs per field?
- Are there any gaps or any additional SPIs you can suggest?
- If we chose a selection of SPIs, which would be your top SPIs to include? Why?

Categories
- Gaps: is anything missing in the categories?
- Can you see large overlaps between categories?
- Do the categories of analysis and their descriptions make sense to you?
- Is the wording clear to you / an outside audience in your view?

Session 2
- Could you share your general thoughts/review on the table?
- Are there particular points you particularly agree with?
- Are there particular points you particularly disagree with?
- Can you share additional knowledge (literature, tacit knowledge, fieldwork) to support or nuance the analysis?

Session 3
- What are the mechanisms of learning in SPIs you know? (in practice)
- What are other mechanisms of learning known to you? (in theory)
- What was considered, in your study case(s), an asset for institutional learning?
- Are the SPIs you know reflective and deliberative towards their own practices?
- Could you share your general thoughts/review on this?
- Are there particular points you particularly agree with?
- Are there particular points you particularly disagree with?
- Can you share additional knowledge (literature, tacit knowledge, fieldwork) to support or nuance the analysis?

C. Workshop Attendees

LAST NAME	FIRST NAME	INSTITUTION
Gallagher	Louise	Université de Genève
Turnhout	Esther	University of Twente
Morin	Jean-Frédéric	University of Laval
Orsini	Amandine	Université Saint Louis Bruxelles
Krieger	Kristian	JRC
Orr	Barron	UNCCD
Stevance	Anne-Sophie	International Science Council
Jagannathan	Kripa	Lawrence Berkeley National Lab, Berkeley, CA, USA

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