https://doi.org/10.51408/issi2025_133

Conceptualizing Metascience Observatories

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Abstract

Science can serve as a powerful source to inform decision-making at the national and international levels. It can also be a source of reflective information: that is, to provide decision-makers with information about the science and technology (S&T) ecosystem. Scientific information about science—i.e., metascience—can provide decision makers and their advisers with evidence needed to direct research activities, allocate resources, and build collaborative relationships (soft power diplomacy). Several institutions around the world are dedicated to the observation of science—i.e., metascience observatories. However, these vary significantly in scope and function, and little is known about the degree to which they directly inform diplomatic decision-making. Therefore, the goal of this research is first to provide an empirical basis for conceptualizing metascience observatories. Through this work, we can clearly delineate metascience observatories from other types of institutions. The generated registry of metascience observatories will then serve as a platform for understanding the role of metascience in diplomacy.

Introduction

Science, as a social institution (Thorpe, 2013), can have a profound influence in politics and social imaginations (Ezrahi, 2012), directly affecting the political landscape. Science diplomacy, therefore, can also be driven by scientists as agents who apply their expertise to global challenges in ways that go beyond government-directed diplomacy. Scientists assume an expert role in society and can activate this role within the context of diplomatic relations (Weisskopf, 1969). As noted by Jasanoff (2009): "the very virtues that make democracy work are also those that make science work: a commitment to reason and transparency, an openness to critical scrutiny, a skepticism toward claims that too neatly support reigning values, a willingness to listen to countervailing opinions, a readiness to admit uncertainty and ignorance, and a respect for evidence gathered according to the sanctioned best practices of the moment". Despite this strong connection, there is limited evidence on the formal ways in which she is translated into the diplomatic process.

Science diplomacy has been classified into three main areas (AAAS, 2010): *diplomacy for science* (use of diplomatic action to facilitate science), *science for diplomacy* (use of science to advance diplomatic objectives), and *science in diplomacy* (support of diplomatic processes with scientific evidence). All of these, and particularly the latter two, require a strong evidence base drawn from monitoring the scientific system[1]. Monitoring science—that is, formalized observations of the knowledge ecosystem—is referred to in contemporary parlance as *metascience* (a term that was previously used in a different context; other current labels include 'science of science' and 'research on research') and several organizations dedicated to this activity operate around the globe. Metascience observatories should not be confused with *scientific* research infrastructures which gather scientific data on a specific topic (e.g., CERN). Rather, metascience observatories study how science operates within national and international ecosystems, how funds are allocated to research organizations, what knowledge is produced, and in what form it is communicated. In this way, metascience observatories can inform science diplomacy strategies targeted at facilitating access to national and international research capabilities and data, promoting and attracting talent, as well influencing public opinion, and political and economic leaders at national and international levels (Flink & Schreiterer, 2010).

The goal of this research, therefore, is to conceptualize metascience observatories, with the objective of creating a codified registry of metascience observatories across the globe. For this project we ask: *what are the necessary components of a metascience observatory*? Understanding how metascience observatories operate can provide valuable insights into the dynamics of national and international research systems, allowing for more informed diplomatic strategies. In particular, the evidence produced by metascience observatories can enhance the capacity of science diplomacy to address global challenges, and support evidence-informed policymaking.

[1] In using the term "science", we emphasize that it should be understood to encompass all forms and sectors of knowledge creation (including social sciences, arts, and humanities), evoking the notion of German *Wissenschaft* or Latin *scientia*. In metascience, however, this is restricted to the formal manifestation of this knowledge (e.g., through published and indexed journal articles).

Candidate identification

We took an iteratively inductive and deductive approach to conceptualizing metascience observatories. The highly interdisciplinary and geographically diverse team began with discussions on what constituted metascience observatories within their known spaces and across history. This created an initial set of key criteria. Using these criteria, the team began the generation of a list of "seed candidates". From this, we utilized snowball sampling, by expanding to a larger group of experts who provided additional candidates for investigation. The initial list was highly skewed towards geographies to which our experts were proximal. Therefore, we generated an inclusive list of all countries (including non-recognized states and territories for broadest coverage). We then conducted searches for each of these countries using the name of the country + terms such as "metascience", "research evaluation", "research council", "sci tech policy", and "science diplomacy." This generated a list of 209 candidates for investigation.

Codebook generation and justification

Using these 209 candidates as cases for discussion, we refined the inclusion criteria into a codified codebook, with sequential elimination. That is, an affirmative answer must be received for all questions to be considered a metascience observatory. The absence of a single criterion warrant exclusion. Four main categories, with nine subcategories were generated:

1) **PURPOSE**. Metascience observatories are dedicated to the study of the science and technology (S&T) system.
   a) Are observations of the S&T system one of the primary functions of the organization?

2) **FORM**. Metascience observatories are formal organizations.
   a) Does it have more than one individual in the organization?
   b) Does it have a division of labor within the organization?
   c) Does it have rules of membership (which dictates the association of products with the organization)?

3) **FUNCTION**. Metascience observatories collect, analyze, and maintain data about the science and technology (S&T) system.
   a) Are the data about science and technology (as opposed to e.g., scientific data)?
   b) Is there evidence of data analysis and interpretation of these data by the organization?
   c) Are data maintained by the organization?

4) **DISSEMINATION**. Products of a metascience observatory are disseminated consistently to a broad audience.
   a) Are the products (i.e., data analysis and interpretation) of the metascience observatory consistently disseminated as an integral part of its mission?

b) Are products of the observatory accessible to the public?

PURPOSE (1) was identified as the first criterion, as the organization should have, as one of its primary objectives, the study of the science and technology (S&T) system. This was functionally a binary distinction with only one inclusion question **(1a)**. Several organizations, as we will see, are dedicated to science and technology, but do not observe this system. Furthermore, some have observation as a small part of their portfolio, but this is not their primary activity. Operationalizing this criterion typically took the form of reviewing the mission statement for these organizations: if the mission did not articulate observation, it was likely not a primary activity.

The **FORM (2)** that an organization took was also a critical component. To serve as an observatory, we argued that the organization must have a degree of formalization and could not be a single investigator or collaborative platform without governance. The true contrast is a contract specifying a deliverable, in this case, metascience analysis and reporting, even when the contract has hierarchical elements in it, such as standard operating procedures, authority systems, among other possibilities (Williamson 1975; Stinchcombe 1990). We consider two major components for a bureaucracy: (a) specialization and (b) rules of membership. As Durkheim (1893) noted, as specialization increases, rules and norms become essential for maintaining coherence. Likewise, Weber (1922) emphasized that bureaucratic administration relies on knowledgeable structured expertise to guide decision-making. This reinforces the necessity of formal governance and institutional membership, without clear rules, the observatory would lack the structure needed for sustained operations and legitimacy. We operationalize specialization by asking whether there is more than one individual **(2a)** and whether those individuals have **(2b)** clearly defined roles and responsibilities. This distinguishes collectives, such as teams under contract, where individuals use the data, but do not formally affiliate to the institution in the products that they create with the use of these data **(2c)**. In contemporary sociology of organizations, these three components would be summarized in the labor contract, fiduciary relations, standard operating procedures, legal status and internal performance systems that constitute the organization as a hierarchy or bureaucracy (Stinchcombe op. cit.).

Although the function might be implied by 1a, we found that while several organizations stated as their mission to observe the S&T system, they did not produce results that provided evidence of this operation. Therefore, **FUNCTION (3)** is concerned with identifying that the organization collects, analyzes, and maintains data about S&T. The first criterion is **(3a)** whether the data are *about* science and technology (i.e., metascience), as opposed to scientific data. This is what fundamentally distinguishes a *scientific* observatory (e.g., an astronomical observatory) from a *metascientific* observatory. An observatory cannot merely collect these data, but it must also add value to the data through analysis and interpretation. Therefore, we look for *evidence* for such analysis **(3b).** This rule out those who may analyze the data, but do not make this analysis or interpretation available. Finally, we seek to look at those institutions who do not merely utilize third-party sources, but collect and **(3c)** *maintain* data themselves.

Finally, we consider a core component of a metascience observatory to be in the **DISSEMINATION (4)** of their data and analysis to the general public. These criteria draw from previous research (focused on the Latin American context) (Macedo & Maricato, 2022) which state the observatories of science and technology "have and make available indicators and/or statistics…indicate the sources of information for these indicators…[and] have services on an *online portal*." We ask first whether the data are disseminated on a regular basis **(4a)**; that is, not merely ad hoc publications as might be produced by a research lab. This requires that dissemination is a codified part of the mission of the organization. The role of the observatory must have consistency over time and in its domain that cannot be reduced to research projects with changing specifications (Macaulay 1963; Scherer 1964). Secondly, we ask whether data are made accessible to the public **(4b).** This removes organizations who only provide data privately to clients.

Conceptualization

Using the criteria as our guide, we can deduce the following definition for a metascience observatory: **"*A metascience observatory is a formal organization dedicated to the collection, analysis, and maintenance of data about the science and technology (S&T) system which disseminates results consistently to a broad audience*."**

Application of codebook

Given this conceptualization and operationalization, we returned to the list of 209 candidate metascience observatories and applied the codebook, with sequential elimination, that is, we examined the inclusion criteria in order and eliminated a candidate as soon as it failed to meet one of the criteria. That point of exclusion was documented and provided below. Five coders initially looked at candidates and discussed points of disagreement. From this initial conversation, four of the five coders examined a larger number of candidates, again resolving disagreements as they were identified. Finally, two coders examined all 209 independently and then resolved conflicts post-hoc, with engagement from the larger group of initial coders. The analysis was conducted unobtrusively, focusing on material found on the Internet. For a few cases, the websites did not load properly at the time of analysis—these were documented as "Technical" difficulties. The number of candidate metascience observatories excluded at each point is summarized in Table 1.

Table 1. Number of candidate metascience observatories excluded at each criterion.

Reason for exclusion	*Number*	*Percentage*
1a: dedication to observation	92	44%
2a: more than one individual	–	–
2b: division of labor	7	3%
2c: rules of membership	1	<1%
3a: metascience	24	11%
3b: analysis and interpretation	25	12%
3c: data maintenance	3	1%
4a: consistent dissemination	7	3%
4b: public dissemination	2	<1%
Technical difficulties	9	4%

The modal exclusion was (1a): 44% of the candidates (n=92) were excluded because they did not have the *observation* of the S&T system as one of their primary goals. This included several academies of science, research councils and private funders, ministries and governmental organizations, professional organizations, and scientific research centers. All of these organizations had missions to support or promote science, but not necessary to observe it.

Seven candidates (3%) failed to meet (2b). These were either small research labs or research consortia, where there was no clear division of labor or specialization within the organization. One candidate was excluded at (2c)—it had a division of labor, however, no publications affiliated with the organization, demonstrating that it did not have an affiliation property.

Twenty-four candidates (11%) were excluded due to the fact that they did not collect or analyze data *about* science and technology (3a). That is, while they had a primary objective of observing science, they did not collect, analyze, or maintain *metascientific* data. Similar to (1a) this category included several academies of science, research councils, and national centers for science and technology; however, those excluded at this stage had stated monitoring of science in their mission but failed to conduct metascience research.

Twenty-five candidates (12%) were excluded for the lack of analysis and interpretation added to the data (3b). The most common type of organization in this category were open science monitors and dashboards. In addition, there were national indices of researchers, corporate databases, and some ministries and other national organizations which collect data, but do not analyze or provide interpretation to the data.

Three candidates were excluded for the lack of evidence of data maintenance (3c). These were largely highly developed research centers, which analyzed third-party data, but did not collect or maintain data themselves.

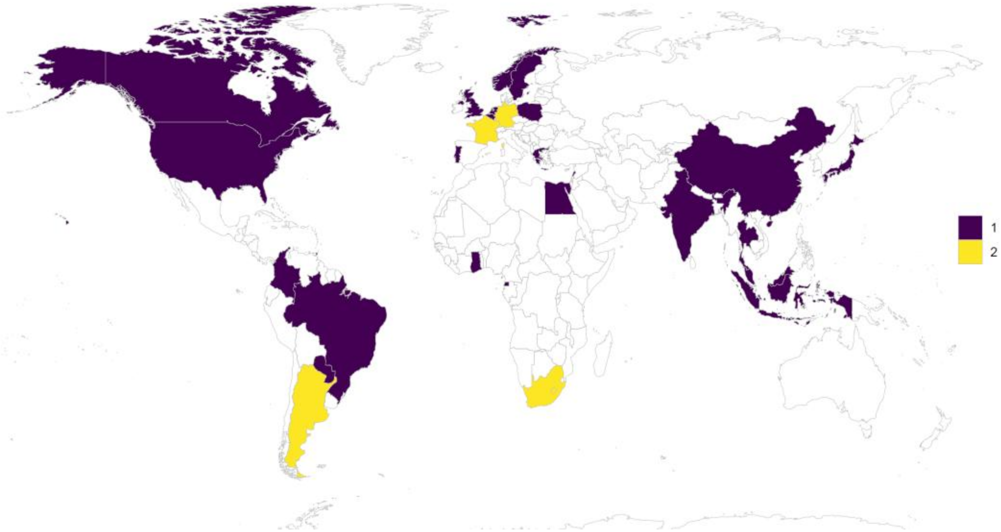

Figure 1. Location of identified metascience observatories ("2" indicates that two observatories were in this country).

Seven candidates were excluded due to a lack of consistent dissemination of products (4a). These included academies of science, ministries of science, national councils, and research labs—all of which met the initial criteria but failed to have consistent publications. One corporation was excluded at (4b) for not providing public access to their reports.

Nine candidates were discarded for technical difficulties (i.e., the websites were inaccessible). These represented a range of countries (Vietnam, Slovenia, Mozambique, Algeria, Nicaragua, Spain, and Austria) and types of institutions (national academies, governmental institutions, and research projects).

Thirty-nine candidates (19%) met all the inclusion criteria. Of these, 31 were explicitly tied to a country; with 28 unique countries represented. The remaining eight were multinational organizations (two with a focus on Europe, one with a focus on Latin America, and the others global (e.g., World Bank and UNESCO)).

Future work

In the next stage of our work, we will code metascience observatories according to several variables, considering the type of organization (e.g., NGO, university, government), the level of autonomy it has in the conduct of business, the type of data collected and produced, the core functions and scope of work, and the intended audiences of the observatory. We are particularly interested in the degree to which these observatories serve in a capacity to inform science diplomacy. Therefore, our next stage of analysis will move from the unobtrusive to obtrusive, meeting with directors and staff of the observatories to understand their functions and context more thoroughly. The goal will be to both describe metascience observatories, but also to be able to provide guidance to current and future observatories on the ways in which they can have heightened relevance both nationally and globally.

Acknowledgments

We are grateful to all members of the IMSO4DIPLO project team, who have contributed in various ways to this work, through the submission of the proposal and discussions in general team meetings. We also acknowledge the IMSO4DIPLO funding from each of our countries: United States (National Science Foundation #2437013); Poland (National Science Centre UMO-2023/05/Y/HS2/00201); South Africa (TAPG231103160452); Brazil (São Paulo Research Foundation. – FAPESP #23/15178-1).

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