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Capstone Project:

Reimagining Knowledge: Investigating Regional Inequity in Knowledge Production with a Focus on Local Stakeholders

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Abstract

Globally, there are significant regional variations in the creation and dissemination of knowledge. Given the expanding significance of data and knowledge in our society, a critical analysis of the knowledge production process is necessary to address regional disparities and guarantee a diverse and pluralistic knowledge society. In this capstone project, I will explore the potential role of local stakeholders in addressing regional inequity in knowledge production, with a specific focus on data equity. Data equity refers to the fair and just treatment of all individuals in the collection, access, and use of data. I will analyze the concept of knowledge infrastructure and the knowledge production cycle to reveal how these systems reinforce existing biases, marginalizing alternative knowledge forms and their holders. The findings of the literature review and the case study "Life IP GrassBirdHabitats" helped to identify barriers to equitable knowledge production. Barriers include bureaucratic challenges, epistemological hierarchies, lack of capacities, financial constraints, language barriers, and cultural differences. I conclude with recommendations for engaging local stakeholders from project design to dissemination, advocating for a shift from data-centric to human-centered approaches inspired by local and Indigenous ontologies. I highlight the importance of stakeholder involvement in data governance and the need to address individual consent and privacy concerns, especially within Indigenous communities. A central recommendation is the collective design of objects and databases to ensure benefits for all knowledge actors involved. This inclusive approach aims to diversify knowledge inputs thereby enhancing global ecological understanding and promoting regional equity in knowledge production.

Keywords: Data equity, Indigenous knowledge, knowledge infrastructures, academia, lay expertise

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Introduction

Data Equity is “the fair and equitable distribution of data’s benefits and the burdens of data collection, ensuring that all individuals have equal access to data-driven resources, technologies, and knowledge production” (Mayer, 2024). Considering the importance of knowledge and data in our current society, a critical investigation of knowledge production is needed. Acknowledging the voices of scholars in the field (Cole et al., 2023; Johnson et al., 2021; Soares et al., 2023) being supported by marginalized communities that claim ownership of their data (Wilson et al., 2018), it becomes clear that data equity is not yet achieved. Instead, there are huge regional discrepancies in the distribution, availability, and access to data. This global imbalance is described by the term regional data inequity. It is important to note that I will use the terminology "data equity" and "equity" throughout this work. This is intentional and not to be mistaken with "equality", the concept of providing the same opportunities and resources to all individuals, and treating them the same, regardless of their circumstances or needs. Equality differs from equity in that it focuses on the treatment instead of the outcome, and is uniform rather than tailored to meet specific needs. The notion of equity holds significance since it considers the intricate and multifaceted elements that influence the creation of knowledge. Data Equity is intrinsically linked to knowledge production, the process of generating new information, insights, and understandings. This involves research, experimentation, and analysis in and outside of academia (Beaulieu & Leonelli, 2021).

Regional disparities in data can have detrimental effects on knowledge production. For example, in academic settings, it hinders replication efforts as insufficient data diminishes the credibility and resilience of the information produced (Leonelli, 2018). Thus I argue that the large regional differences in the generation and dissemination of knowledge result from the lack of data in certain regions. As a consequence, certain locations are underrepresented in the

knowledge production system which limits their contribution to the global discourse (see Fig. 1 & Fig. 2).

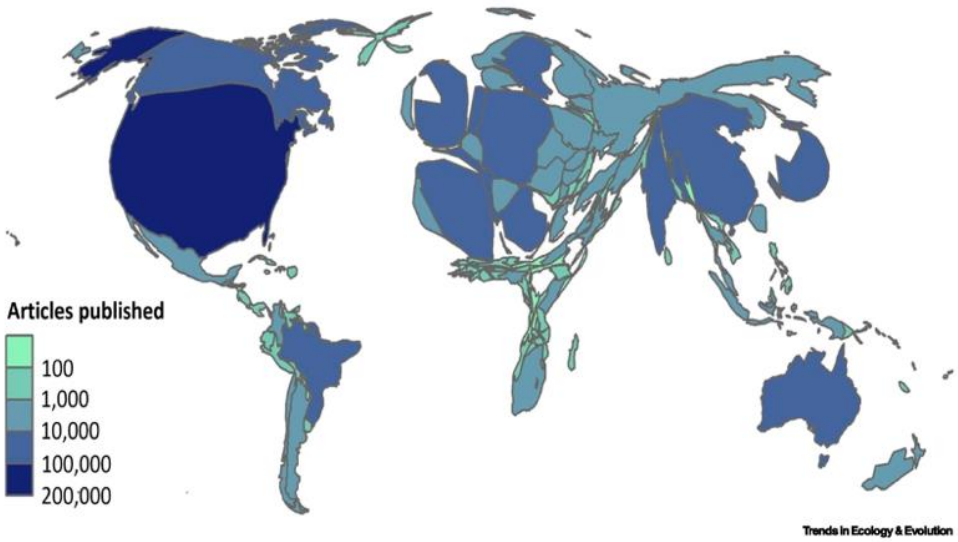

Figure 1 Proportion of ecological publications per country in the early 2000s, reproduced from Núñez et al., (2021).

For example, the clear dominance of publications in very few countries highlights the underlying problem of regional inequity in knowledge production (Fig. 1; Núñez et al., 2021). The extractive nature of research practices is illustrated by the uneven distribution in the share of north-south collaborative articles per hemisphere (Fig. 2; Nature Index, 2023). Both examples tell the same story; although collaborative research is taking place, the benefits and outcomes primarily remain in the global north, as almost half of the contributions to north-south collaborative articles published in Nature Index natural science journals from 2015 to 2022 came from five nations: the United States, Germany, the United Kingdom, China, and France (*Nature Index*, 2023).

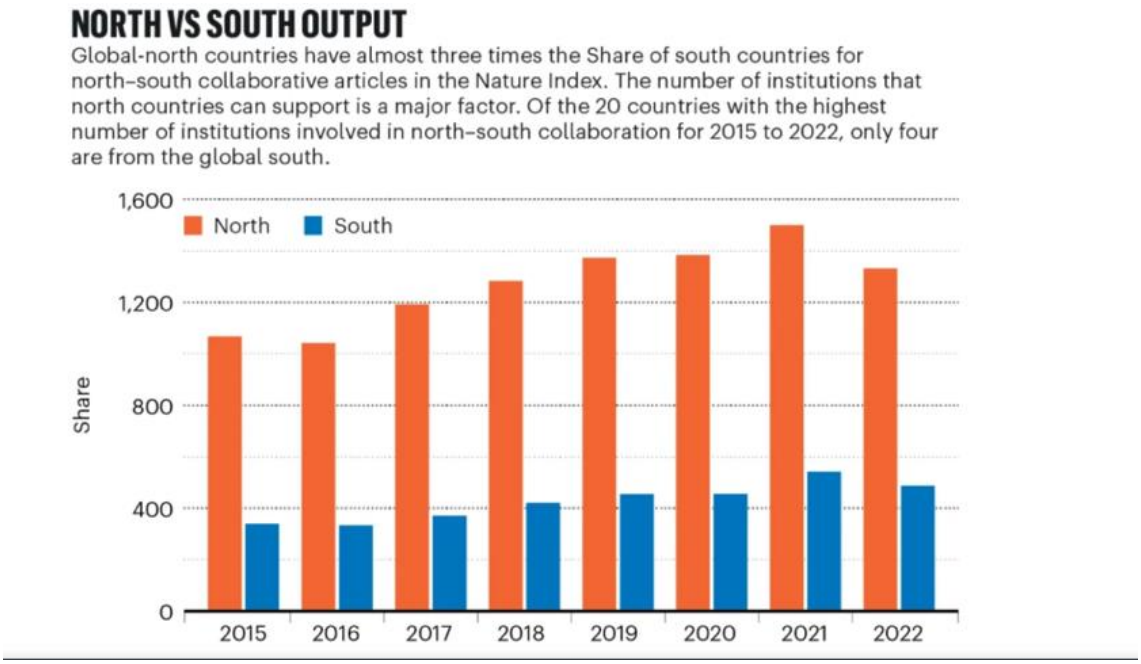

Figure 2 Publication of articles built on north-south collaborations per hemisphere, reproduced from Nature Index (2023).

I argue that the issue of inequity is embedded in the larger system, the so-called knowledge infrastructure, which I will define more in-depth later in the paper. Within this system there have been a set of barriers hampering the resolution of this issue until now, but which have been progressively identified in the literature. Among the most reported barriers to equitable knowledge production are communication issues, cultural biases, and rigid institutions (Benham, 2017; Soares et al., 2023; Trisos et al., 2021). The primary objective of this analysis, while acknowledging the existing body of literature on the subject, is to focus more closely on historically marginalized groups, including citizens, researchers from underrepresented nations, and Indigenous communities, to explore how more inclusive and democratic partnerships can address regional data inequity.

Research Question and Aim

In this study, I will focus on the relationship between data equity and local stakeholders, embedded in the complex system of knowledge infrastructures. I argue that there are three ways in which the involvement of local stakeholders in knowledge production and data equity intersect. Firstly, there is a normative dimension of data ownership and governance, which obliges researchers to return the benefits of the data to the communities from which they have been obtained. Second, utilizing contextual knowledge can enhance the relevance and quality of data (Norström et al., 2020). Finally, it does not only help local communities to build capacities, but it also helps to improve the global understanding of ecology (Núñez et al., 2021). Together with my supervisors, I developed the following research question:

"What is the role of local stakeholders in addressing regional inequity in knowledge production and how can they be involved?"

The research question will be answered in two parts. First, a literature review will be conducted to elaborate on the importance of the local stakeholders in knowledge production, highlighting the benefits and challenges of including the local actors in research projects. The review's conclusions will serve as the theoretical framework for my analysis. Secondly, I will use a "real-world" case study to understand how the involvement of local stakeholders can be enhanced and fostered by adequate project design. Finally, I will use the results of both the literature review and the case study to put forth recommendations on how to promote local stakeholder involvement and integration within the knowledge production cycle. Limitations include the fact that each stakeholder is unique, which restricts the conclusions' generalizability. Future studies should examine additional obstacles like publication structures, stereotypes, and

the viability of standardizing Indigenous and local data as well as how digital tools affect local knowledge methods.

Methods

Conceptualization

As the issue of regional data inequity is entwined with the global division of the world into the global south (or low-income areas) and the global north (or high-income areas), it would be convenient to use those terms. However, I believe that this polarisation is an oversimplification of the issue and omits other complexities within this system such as the (lack of) East-West relationships. To respond to these shortcomings, I will use my own classification system corresponding to the center-periphery model often used in development or sociology studies (Batur, 2014). This spatial metaphor seeks to explain the structural link between an advanced, dominant "center" (i.e. global north) and a less developed, often dependent "periphery" (i.e. global south) (“A Dictionary of Sociology,” 2014).

The generic term used to describe the historically exploited regions of the world includes Latin America, Africa, the Middle East, and large parts of Asia. In contrast, in the category of the center, I group Europe, the United States, the United Kingdom, Canada, Australia, New Zealand, and the Asian countries Hong Kong, Japan, Taiwan, Singapore and South Korea. As the model also captures the hierarchical relationship between industrialized and less developed regions, I believe that the use of these terms is fitting for this analysis. While there is still a connotation of dichotomy, the core-periphery model allows for a more fluid and mobile understanding of both poles. Finally, this way of phrasing the problem helps me to see it as a structural issue with knowledge generation rather than a lack of knowledge or data.

Study design

To answer the research question, I will use a mixed-method approach. First, I will conduct a literature review and analysis to build the theoretical framework for this argumentation. Then, I will complement and extend the findings of the literature review by analyzing a case study. By interviewing real-world researchers, I aim to gain unique and distinct perspectives on involving local stakeholders and the associated challenges. Finally, I will use the theoretical framework to identify recommendations that improve data equity in ecology.

Literature review and theoretical framework

Suitable literature has been identified using online repositories such as Google Scholar and SmartCat. Additional information has been provided by my supervisors and other researchers involved in the case study. Selection criteria for the articles were the following; limited years ranging from 2015 – 2024, and only peer-reviewed articles. Relevance has been assessed with the help of keywords such as “local stakeholders”, “conservation”, “community”, “local”, “Indigenous”, “regional”, “inequity”, “knowledge”, “collaboration”, “participatory”, “ornithology”. These keywords and their synonyms have been used, every time combined with the logical operators OR and AND, to extract articles. In total, I have incorporated 47 articles for my capstone project.

The literature review and analysis informed the construction of the theoretical framework for this analysis. While there is substantial literature examining the current knowledge system, there is no framework that sufficiently foregrounds the role of local stakeholders in regional equity in knowledge production. To better conceptualize the connections between data, knowledge, and local stakeholders, I examined the knowledge production cycle (KPC) and studied the role of non-academic actors in it. Furthermore, I identified the most relevant barriers

to the integration of local stakeholders and their knowledge that continue to sustain the inequity in knowledge production. The identified obstacles will be discussed within the scope of the knowledge infrastructure and KPC. Subsequently, the KPC will be used to put forth recommendations at every stage of the knowledge production process.

Case study

The Life IP GrassBirdsHabitats project serves as a case study for this analysis. The aim is to illustrate, contextualize, and extend the knowledge from the literature as well as to identify recommendations on how to promote the inclusion of local stakeholders into research projects by conducting semi-structured interviews with the project designers, coordinators, and leaders. I chose the conservation project as a suitable case study for the following reasons. Firstly, it is a cross-regional research endeavor requiring collaboration along the flyway. This cross-regional collaboration is a highly difficult and complex undertaking embedded in historical contexts and loaded with colonial connotations and power relations. Secondly, the project is representative of a north-south collaboration set up by European researchers. Thus, the process of project design and implementation is traceable and accessible to me which makes it relevant for my analysis. Moreover, the case study has been suggested to me by my supervisors who are themselves researchers and thus acquainted with the processes plus their contacts would allow me better access.

I have recruited the participants via various channels. Based on the recommendations of my supervisors I either approached the subjects face to face or sent an E-mail to request an interview (interview guide accessible in Appendix A). Snowball sampling is a popular method to recruit participants in qualitative research (Parker et al., 2020). The recruitment process is facilitated by contact recommendations of the participants. I have developed semi-structured

interview questions based on the information obtained in the literature (see Appendix A). Interviews lasted between 40-60 minutes and were conducted in English. This research is approved by the Ethics committee of the Rijksuniversiteit Groningen.

Background to the case study. A central actor in the Life IP GrassBirdsHabitats project is the black-tailed godwit (lat. *Limosa Limosa*), one of the national birds of the Netherlands. Being an endangered wet grassland breeding bird it is among the bird populations with the strongest decline in Europe (LIFE IP GrassBirdHabitats, 2020). Their habitats are threatened by intensified land use and their chicks are victims of increased predation. Previous efforts to protect this species have not been successful due to a limited understanding of the interconnectedness of wet grasslands, weak enforcement and collaboration with local stakeholders, and the lack of data on populations and their habitats on non-breeding sites in West Africa (LIFE IP GrassBirdHabitats, 2020; Verhoeven et al., 2020). Thus, the Life IP program GrassBirdsHabitas has been set up to create an integrated strategic action plan for the Atlantic Region of Europe and West Africa (see Fig 3.).

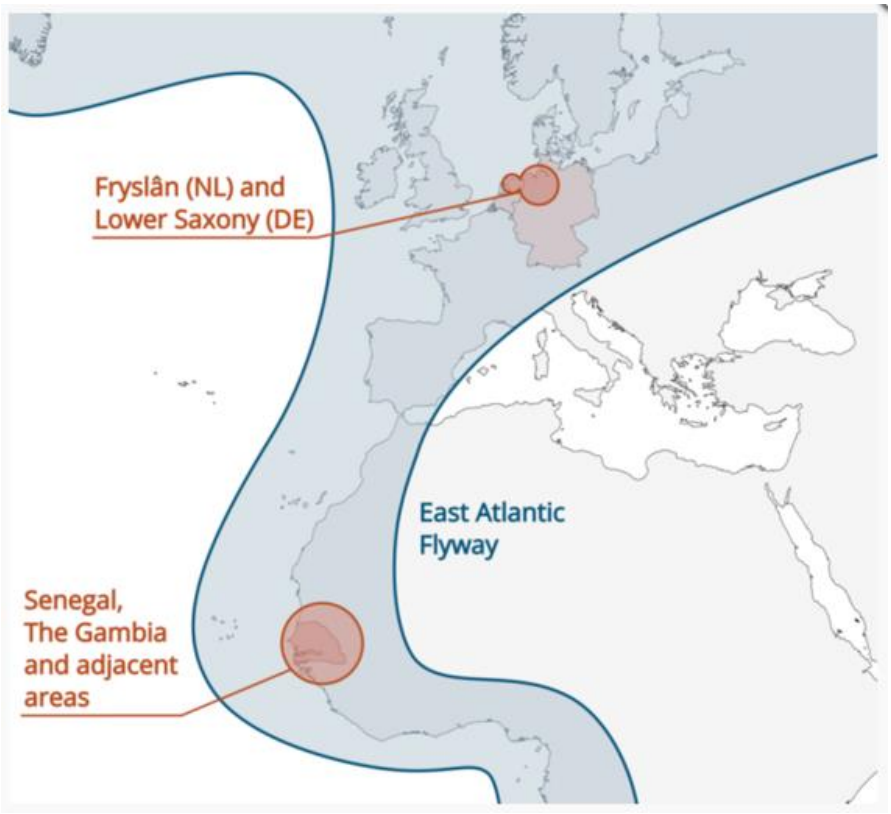

Figure 3 illustration of the GrassBirdHabitats project areas along the East Atlantic flyway, comprising Lower Saxony and Fryslân in Europe as well as Senegal and adjacent areas in West Africa. Graph copied from LIFE IP GrassBirdHabitats (2020), T. Gibme.

Considering the wide-ranging impacts of the conservation efforts, it becomes evident that this is not only a conservation and research project but a societal one. The project's success including the long-term commitment and sustainability within the socioeconomic environment depends heavily on the acceptance of societal and local actors.

The Role of Local Stakeholders in Knowledge Production: Integrating Lay Expertise

To answer the research question, the potential role of stakeholders in knowledge production needs to be understood. Local Stakeholders range from institutional entities such as governments and non-governmental organizations to knowledge partners such as Universities.

The most interesting role is the people who depend on the ecosystem (or subject) in question for survival. This includes but is not limited to farmers, fishers, and local, and Indigenous communities. (Sterling et al., 2017). Factors such as location, capacity, and feasibility influence the decision of who is an eligible stakeholder and who is not. For the context of this analysis, I will define local stakeholders as the organizations and people that are affected by or are in the power to affect a decision, process, or certain outcome. Thus, the identification of stakeholders is a complex endeavor that is not only shaped by the capabilities of the project designers but also depends on the motivation and interest of the population affected. In addition to the question of how stakeholders are identified, it is crucial to understand how and why they are included in the process.

The knowledge held by those non-academic actors is often referred to as lay expertise, local knowledge, or traditional knowledge (Turnhout et al., 2019). Participatory approaches to knowledge co - production, such as citizen science, attract more and more attention (Jessen et al. 2021; Turnhout et al., 2019). Despite being considered a valuable contribution to data collection processes, the inclusion remains superficial and limited to the initial stages of knowledge production (see Fig 4). Thus, I argue that to ensure equitable research, local stakeholders should be engaged in the whole process; from theory formation to data collection, and public dissemination. Consequently, the questions arise of how to engage lay expertise across the cycle?

Benefits

Understanding the importance of local stakeholders for the success of the project makes a clear case for their inclusion. Not only does the success of many projects on community involvement, but the hegemonic knowledge production leads to a global imbalance in data

which impacts adaptation and mitigation strategies (Amano et al., 2022) Moreover, concerning the close interrelation between science, society, and politics, the inclusion of societal actors increases legitimacy and acceptance of projects and helps restore the trust in science and institutions (Turnhout et al., 2019). Moreover, it enhances access, transparency, and accountability in addition to promoting the diversification of knowledge(s) (Jessen et al., 2021). The research project's capacity-building and potential trickle-down effects benefit the local communities (Sterling et al., 2017; Turnhout et al., 2019). According to Johnson et al. (2021), Indigenous communities are willing to participate because they see it as a means of empowerment and leverage.

Challenges

While there is no doubt that the inclusion of local stakeholders brings enormous benefits, the research shows that participation seems to remain a challenge (Jessen et al., 202; Turnhout et al., 2019). Collaborative efforts are impacted by cultural prejudice and presumptions held by both the local community and researchers. For researchers, it is often difficult to earn the population's trust. Additionally, project coordinators from the center often seem to struggle with issues regarding cultural challenges, identifying factors to enhance motivation and involvement, language barriers, and epistemological differences (Trisos et al., 2021).

One major challenge is the epistemological hierarchy contributing to the stigmatization of the respective knowledge holders. It is important to note that there is a distinction between local and Indigenous knowledge to respect the unique characteristics of these stakeholders. The IPCC defines Indigenous knowledge (IK) as "the understandings, skills, and philosophies developed by societies with long histories of interaction with their natural surroundings." (IPCC, 2016). In contrast, local knowledge (LK) is defined as understanding and skills of the natural

environment developed based on daily engagement with the local ecosystem (Jessen et al. 2021). While there are small but important distinctions, all of these knowledge(s) have in common that they are classified as non-scientific forms of knowledge. To get a better overview of the differences between lay expertise and technoscience, see Table 1.

Table 1

Differences between technoscience and lay expertise

Lay expertise	Technoscience
localized	universal
Culturally embedded	objective
holistic	reductionist
Tactic and informal	Explicit and formalized
Practice based, rooted in experience	Methodology based

Note: Information taken from Jessen et al., 2021, and Turnhout et al., 2019.

Besides increasing efforts at knowledge co-production the structural, epistemological, and institutional values of the research culture continue to present a barrier to equity in knowledge production (Norström et al., 2020; Trisos et al., 2021). The hierarchy in knowledge(s) seems to be associated with a clear task division, meaning local stakeholders are often reduced to data collection and logistical help (see Fig. 4) while researchers from the center analyze and publish the results. The idea is to move from a linear, extractive knowledge production to a circular one. Additionally, considering the normative dimension of returning

benefits to the community, equitable involvement is imperative (Mayer, 2024; Norström et al., 2020). But what has to change to enable equitable collaboration? To answer this question, a thorough analysis of the overarching system is needed.

Knowledge Infrastructure

Science and research are embedded in an overarching system. This system can be referred to as knowledge infrastructure (KI). According to Leonelli (2018), a KI is a socio-technical system that makes it possible for data to serve as evidence for knowledge claims. In this sense, ordered data serves as evidence to support a particular claim about the world. It might be helpful to look at its features to better envision the concept. According to Star and Ruhleder (1996), infrastructures are embedded, embody certain standards, are learned as part of membership, and link with convention of practice. They are also never static but require constant attention to maintain stability. As a complex, dynamic, and fundamental system, these structures can only be adjusted or fixed in modular increments. Similarly to infrastructures, KIs are like a socio-technical system including humans, non-humans, materials, organizations, routines, shared norms, and practices. These networks can also be understood as complex and interdependent relationships. It is important to understand the power of the KI in shaping perceptions of what constitutes valuable research outcomes, how it impacts research practices, and the understanding of biodiversity (Eren, 2024).

Actors and the Knowledge - Action Gap

If KIs can be perceived as a complex network of actors, the question arises who are these actors? Among the main stakeholders are scientists, societal stakeholders, and politicians connected in a complex and multi-layered web (Turnhout et al., 2019). For example, environmental policies rely on scientific knowledge as it requires a deep understanding of

ecosystem processes to adapt accordingly. However, often the scientific solutions clash with the interests of other (local) stakeholders.

The KI determines the practices of these actors. Researchers frequently behave in a manner influenced by earlier experts and advisory procedures, including formal and informal codes of conduct, as well as a particular conception of what constitutes authoritative knowledge and/or accepted outcomes (Turnhout et al., 2019). There is substantial research on the science-society relationship showing great discrepancies between the output desired by societal actors and how it differs from what researchers deem important. This so-called "knowledge-action gap" (Eren, 2024) might result from the lack of involvement of local stakeholders in research processes. On the other hand, policymakers must conform to the expectations, commitments, and agreements of the organizations they work for. Unfortunately, sometimes these regulations and agreements clash with the interests of biologists and environmentalists which is an obstacle to successful conservation and collaboration among the stakeholders (Turnhout et al., 2019). Thus, the practices and behaviors of individuals are determined by the existing KI. These actors and their practices contribute to maintaining and strengthening the existing KI. Quantifiable sciences or Technoscience cultivated within specialized institutions by accredited experts hold a privileged status in the eyes of the public, policymakers, and academia. In that sense, the actors expect scientific knowledge outputs that align with previous theories, practices, and beliefs connected to the scientific method. To conclude, established KIs bring forth one type of knowledge or output, often only serving a few actors. This correlates with the useability of knowledge (Turnhout et al., 2019).

Usability of knowledge

The science–society–policy interface is shaped by many stakeholders following their interests. From these interests' different expectations, questions and beliefs arise that shape the research agenda. Moreover, most actors might even disagree about the desired (political or scientific) outcomes which leads to the question of the useability of knowledge (Turnhout et al., 2019). One example from ecological research is the monitoring and protection of meadow birds. While experts aim to understand the problem from a scientific point of view, societal stakeholders such as farmers are more interested in the concrete action that can be taken (Selen, 2024). There is a clear discrepancy between the researchers' desire to define and detail the problem before working on solutions while the local stakeholder is focused on taking action. Similar gaps can be perceived when working with political parties, funding bodies, (conservation) institutions, and managers. Not only does it highlight the problem that science often seems to be disconnected from society (or the subject measured) but also that knowledge may not be considered to have the same relevance or useability by all KI actors. Turnhout et al (2019) conclude: "Usable knowledge is no simple matter, and the question of what knowledge is usable crucially depends on the context in which it is developed and applied." Therefore, knowledge becomes usable once it has value for its users. But who are the users? And who defines the use - context? The knowledge producer (i.e. researcher) has a certain power in defining which knowledge is produced and which interests are served (Beaulieu & Leonelli, 2021). With this implicit power, the researcher also has a responsibility to serve various knowledge users (Selen, 2024).

Knowledge Production Cycle

KIs play a central role in knowledge production by supporting and shaping the knowledge production cycle (KPC) (Beaulieu & Leonelli, 2021). The knowledge production cycle helps us to analyze knowledge as a concrete process and to comprehend its limitations and the purposes for which it is created.

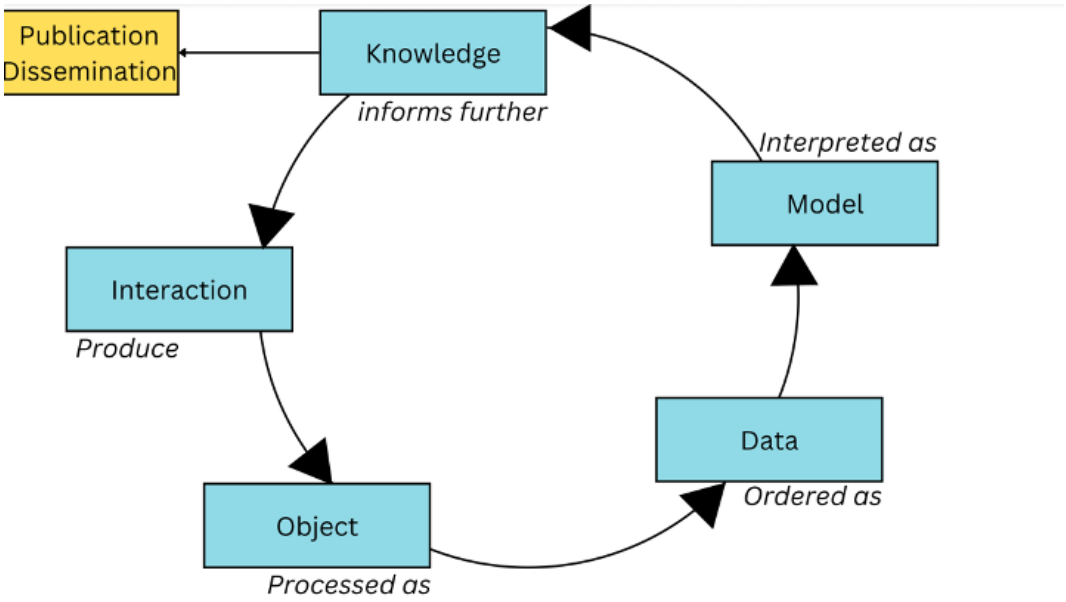

Figure 4 The Knowledge Production Cycle, reproduced from Beaulieu, A., & Leonelli, S. (2021), changes made by the author in yellow.

Building on previous work by Beaulieu, A., & Leonelli, S. (2021), knowledge production includes academic research next to other forms of research grounded on data. Producing knowledge is best depicted as an iterative process that consists of five crucial steps represented in Fig 3. First, objects are produced by interacting with the world. Secondly, these interactions produce objects that are further processed as data. This data is turned into evidence by filtering and cleaning the content to fit the research question. At this stage, it becomes evident that knowledge production is never fully impartial but is impacted by the researcher's

assumptions and interests. This evidence is then ordered and further processed in models that represent the world. Finally, these models help us make more sense of our surroundings, thus their output is interpreted as knowledge. This knowledge then might inform further research which would initiate a new cycle of knowledge production. It is important to consider that publication and dissemination are an equally important part of research.

Role of data

Beaulieu, A., & Leonelli, S. (2021) refer to two contrasting approaches to view data; the relational and the representational approach. While the latter refers to the belief that data is the objective and impartial basis of information and knowledge, the former recognizes data in the context of its production. Thus, data is understood as relational objects, the meaning of which can only become clear in connection with a particular context. Thus follows that the knowledge output is never objective, but should be analyzed through the lens of the KPC taking into account the conceptual space in which these data can be used (Beaulieu & Leonelli, 2021, *see section on useability of knowledge*). How we understand data is crucial because it impacts the societal perception and valuation of knowledge. The assumption that quantitative data is the only "true" basis of knowledge, marginalizes other forms of knowledge such as experiences or other more contextualized forms of knowledge held by "laypeople" (Turnhout et al., 2019). This phenomenon has been studied before and is often referred to as academic imperialism (De Sousa Santos, 2018; Mignolo & Walsh, 2018). It aims to explain the misconception that there is no universal or global standard, but a "Westernized world systemic structure of knowledge production" that has been established as global (Demeter, 2020). The superiority of data is fundamental to inequity in knowledge production.

Results

Theoretical framework

An analysis of the literature revealed that despite increased awareness, the inclusion of local stakeholders in knowledge production remains insufficient (see Fig. 4, red square). As citizen science and knowledge co-production gain more attention, numerous studies have examined the level of engagement among the stakeholders. Haklay (2013) introduces a four-level typology ranging from level 1 “crowdsourcing” to level 4 “extreme citizen science”. While the former views citizens merely as sensors and data collectors, the latter includes non-academics in problem definition, data collection, and analysis. While there are rare cases of “extreme citizen science”, the local stakeholders often hold more limited roles (Soares et al., 2023; Turnhout et al., 2019). As concluded by Asase et al. (2022), ornithologists from the periphery are frequently seen as field workers and local assistants who gather data and handle logistical issues; but their opinions are less relevant when it comes to determining the research agenda or analyzing findings. I conclude that researchers or local stakeholders are excluded based on their origin, research methods, backgrounds, and titles/reputations. These non-participatory approaches risk mirroring the extractive colonial practices and only benefit the center while neglecting the needs and contributions of stakeholders from the periphery, thus reinforcing regional inequity.

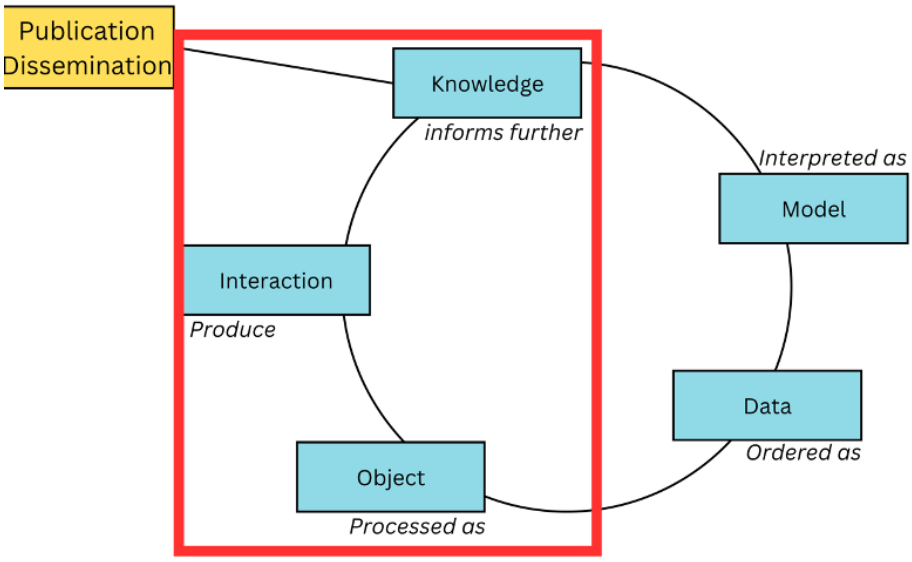

Figure 5 Illustration of limited inclusion of lay expertise in the Knowledge Production Cycle as indicated by the red square. Graph reproduced from Leonelli (2018), changes made by the author in yellow and red.

Table 2 summarizes some of the barriers that cause the global imbalance in knowledge production, with particular emphasis on major themes, including the accessibility of publication structures, next to communicational, financial, technological, and historical barriers. Considering the dominance of research methods and actors from the center, it becomes clear that the KI suffers from homogeneity that fails to account for the diversity of actors and knowledge(s) on a global scale.

Table 2

Barriers to equitable collaboration in regional collaboration

Barrier	Examples
Authorship	Citation bias, reputation
	Stigmatization
Representation and institutions in research (power positions)	Representation in journal editorial boards gatekeeper Publication output
	Ownership of publishing houses
	Ownership of international elite journals
	Representation in selection committees, especially selection committees that oversee international science funding actions Representation in academic associations
	Access to leading international academic associations
Epistemological hierarchies	One dominant knowledge (Data)
	Superiority of the scientific method (Determines internationally accepted methodologies and academic standards)
Communication	enforced language hegemony
Resource Access	Education
	Instruments
	funds
	Institutional support (R&D finance)
	Permits (incl. visa)
History	Political instability as one of the consequences of colonialism Access to land, resources and specimen
	Inequalities among individuals, regions and countries
Funding	Salaries
	Scholarships
	Publication charges

Note: drawing inspiration from previous work done by M. Demeter (2020), Soares et al. (2023), and Trisos et al. (2021).

The values and methods of the center dominate the international research culture. Recent work suggests a growing awareness of the obstacles to equitable collaboration ranging from historical factors to publishing bias (Martín, 2021). However, some shortcomings are worth highlighting. Firstly, even though researchers from the center may be aware of these inequities, they still do not act accordingly (Asase et al. 2022; Soares et al. 2023). Secondly, researchers from the periphery are significantly underrepresented among the international research leadership which results in exclusion from important policy decisions around research such as data-sharing, open access, and (Indigenous) community involvement. These structural problems are embedded in the KI and present obstacles to the local stakeholders. Consequences are the knowledge-action gap, the limited useability of knowledge, and the hierarchical dichotomy between researchers from the center and the periphery. These identified barriers serve as starting points to improve equitable knowledge production. Additionally, as data inequity relates to unequal access and contribution to knowledge production, the KPC serves as a model to examine the relationship between data, knowledge, and its holders.

Fig 6 illustrates the theoretical framework emerging from the literature analysis, which can be understood as three interdependent layers that interact with and shape each other. Drawing on inspiration from the multi-layered power imbalances schema from the African Charter (2023), this framework can be understood as a set of concentric circles. This framework captures how the field is limited by pre-existing beliefs that reinforce each other from the center to the periphery. The interdependent and concentric structures also imply that changes in the core can have spillover effects on the subsequent layers.

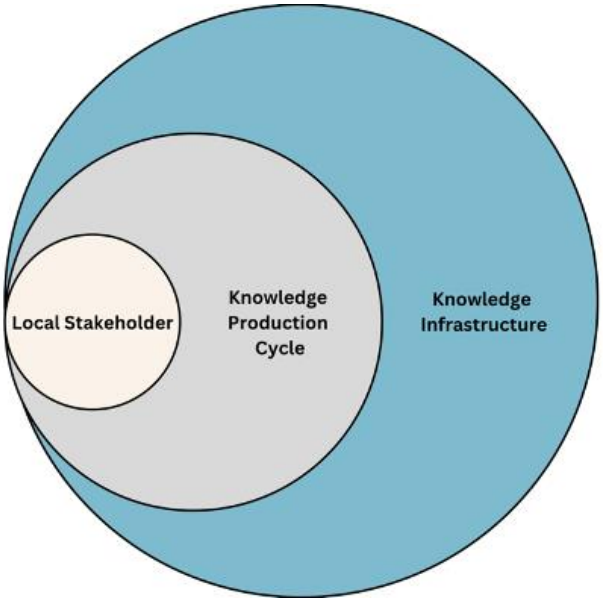

Figure 6 Visualization of the interdependence in the knowledge production system. Changes in one layer could have spillover effects to other layers thereby influencing each other

Case Study

The interviews exposed five prominent barriers that encapsulate the multifaceted challenges to the inclusion of local stakeholders: (1) Bureaucracy and capacities, (2) money and resources, (3) time, (4) communication, and (5) cultural differences (see fig 6).

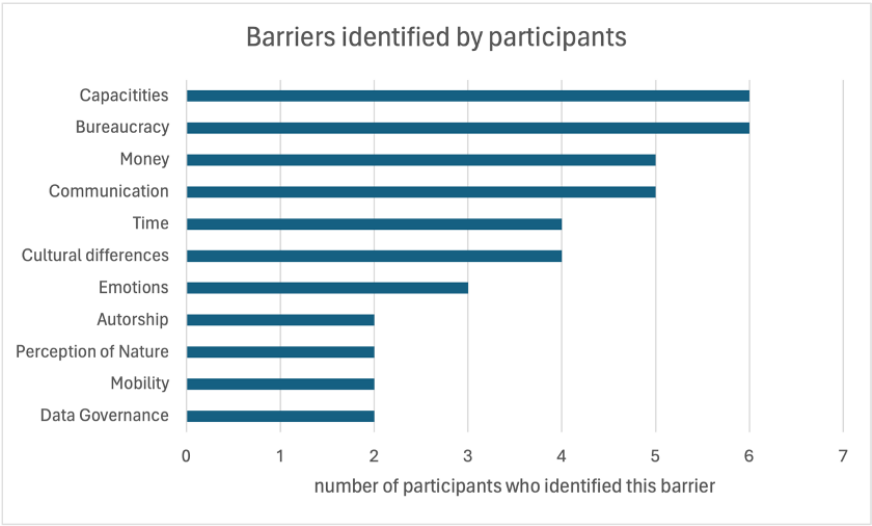

Figure 7 graph summarizing the barriers to the inclusion of local stakeholders in the knowledge production process of the Life IP GrassBirdHabitats, as identified by interviewees (n = 7).

Barrier 1: Bureaucracy and capacities

According to interviewees, bureaucratic effort refers to the preparation of proposals and assessments, identification of areas of high importance for meadow birds, making strategic action plans, and attending meetings. Six out of seven participants mentioned the high administrative burden as an obstacle to collaboration. However, often a heavy workload or lack of time did not seem to be the barriers; in the perception of interviewees, the underlying issue seemed to be a lack of capacity. Six participants have noted the lack of human capacity in all countries along the flyway. The periphery additionally suffers from a lack of research and resource capacity, referring to weak institutional support in the R&D sector and limited technological and financial resources. The administrative effort not only discourages new and potential stakeholders but also leads to obligations and pressures that impact the social relations among team members. On a regional level in the EU, the case of Spain and Portugal illustrates the problems caused by the high workload. While being among the most important and largest staging sites for Black-tailed godwits on their flyway, Spain stopped the collaboration due to the bureaucratic effort and a lack of motivation to comply with the requirements, as stated by one participant. In its place, Portugal has been included in the proposal which could fuel conflict between the two. This highlights the trade-off among stakeholders and points towards the twofold responsibility in a collaboration. As put by one of the participants: “There needs to be motivation to become a stakeholder, they need to be active”. In the collaboration with the West African partners, especially Gambia, the tight schedule led to misunderstandings or even cancellation of the project. Stakeholders with little human capacity often face difficulties in complying with strict regulations. Obligations by the project leaders towards the stakeholders can be understood as dictating, a concept that feeds into the historical sensitivity of center-periphery relationships. “So it is a matter of resources that they [local stakeholders] have, the

capacity that they have… That is sometimes insufficient for the procedures that the EU, for instance, demands.”.

Barrier 2: Financial resources

Funding is essential because it determines the project's capacities. Five participants mentioned money as the main limiting factor to successful conservation. Unclear was the connection between money and the local stakeholders, but interviewees mainly perceived money as a tradeable good that facilitates cooperation or as a benefit for the stakeholders. On the other hand, the limited budget was the main source of conflict between the project leaders and the governmental agencies. In that sense, it is both an enabler and restrictor which may force the actors concerned to make trade-offs. A lack of financial resources in the periphery impacts local research capacities and the capability to respond to bureaucratic needs and travel to meetings.

Capacity building. Countries and institutions (i.e. ornithology institutes or Universities) that are registered as beneficiaries receive money for their respective contribution to the project. This is to create capacities, hire experts, or finance education for the researchers and volunteers involved. Three interviewees drew the connection between financial resources and capacity building.

Barrier 3: Time

An equally lacking resource is time, as identified by 4 out of 7 interviewees. Collaborations are social relations that require a high level of trust, thus, it takes time to build equitable partnerships. In addition, the numerous meetings, the writing of proposals, and the reading of existing strategies are time-consuming tasks. As the strategic planner puts it “Very few people have time to [read these documents] because they're so busy with their daily tasks”.

A good schedule is key to the success of many projects, but the perceived pressure is frequently caused by the necessity of meeting external deadlines set by the EU, the governing body of the Life IP.

Barrier 4: Communication

Problems with communication, language barriers, subject-specific terminology, and literacy have been cited by 5 out of 7 participants highlighting its importance. It's interesting to note that the two individuals who did not cite communicational barriers are engaged locally and have ties to a specific location or area within a nation. I assume their interactions with foreign stakeholders are limited, thus there is less need to communicate in a foreign language for them. There is extensive literature discussing the issue of communication as a barrier to regional equity in knowledge production, (see Amano et al., 2022; Demeter, 2020; Haggart & Tusikov, 2023).

Barrier 5: Cultural differences

As this project extends beyond the borders of the EU, cultural differences have been mostly cited concerning working with West African partners. Four of 7 participants mentioned different working approaches and pace, cultural rules, and language barriers. The varying level of exposure to international research communities by interviewees might be the reason for the lower number of mentions. Within the EU, cultural differences have been less mentioned. Nonetheless, interviewees pointed towards different legal frameworks and approaches to research within one country or between countries that are a challenge to collaborative research.

Outstanding findings

Three participants highlighted the power of emotions. They are highly important considering that negative emotions can cause conflict while positive emotions (such as trust, security, and sympathy) benefit cooperation. One participant highlighted that "the researcher needs to be accepted by the community". This statement encapsulates more than respect, it refers to the genuine effort that needs to be made by researchers to earn trust. Two other interviewees stated that trust is the most important component for successful cooperation. Thus, emotions can act as facilitators. However, negative emotions among stakeholders present serious barriers to collaboration. Conflict has arisen from 1) different approaches in the field (researcher vs volunteer), 2) frustration over little results, and 3) lack of accountability. Communication is crucial to avoid conflict as one interviewee concluded: "So it's very important to explain why you do it. Why are you in the fields? What are you measuring? And what would you like to get from it?".

Applying the theoretical framework: lessons from the case study

The five obstacles listed above were identified throughout the interviews as being crucial to hamper the inclusion of local stakeholders from the periphery. Figure 8 illustrates how my research on equitable knowledge production revealed an agreement between the academic sources reviewed and the experiences shared by the participants during the interviews. Findings in line with the existing body of research include references to the language hegemony, the availability of funds, the problems with permits (incl. visas), and the political situation in the respective country. In addition, the knowledge-action gap is still perceived and has been mentioned by 3 out of 7 participants. Those 3 participants also stated that academic and non-academic actors have different approaches and motivations, probably stemming from different

epistemologies and understandings of nature. Yet, not much has been discussed regarding data management and the sharing of outcomes. Equally little has been said about the afterlife of the project and the long-term care. This suggests that interviewees might have disregarded these subjects due to a lack of expertise or experience, which calls for closer examination in the following section.

Discussion

The purpose of the case study was to identify obstacles to the inclusion of local stakeholders in knowledge production. Results indicated that, besides increasing efforts to build a more equitable knowledge system, the engagement of local stakeholders (from the periphery) is still limited. The most relevant barriers are a lack of human and research capacities, cultural and epistemological differences, financial resources, and communication. Considering the inequity in knowledge production and its implications for the global understanding of biodiversity, it is evident that we need to foster a more diverse knowledge production system. Following a more ethical argumentation it is imperative to ensure the fair contribution of all knowledge actors involved to guarantee that the data benefits all stakeholders.

Theoretical Framework: the Barriers

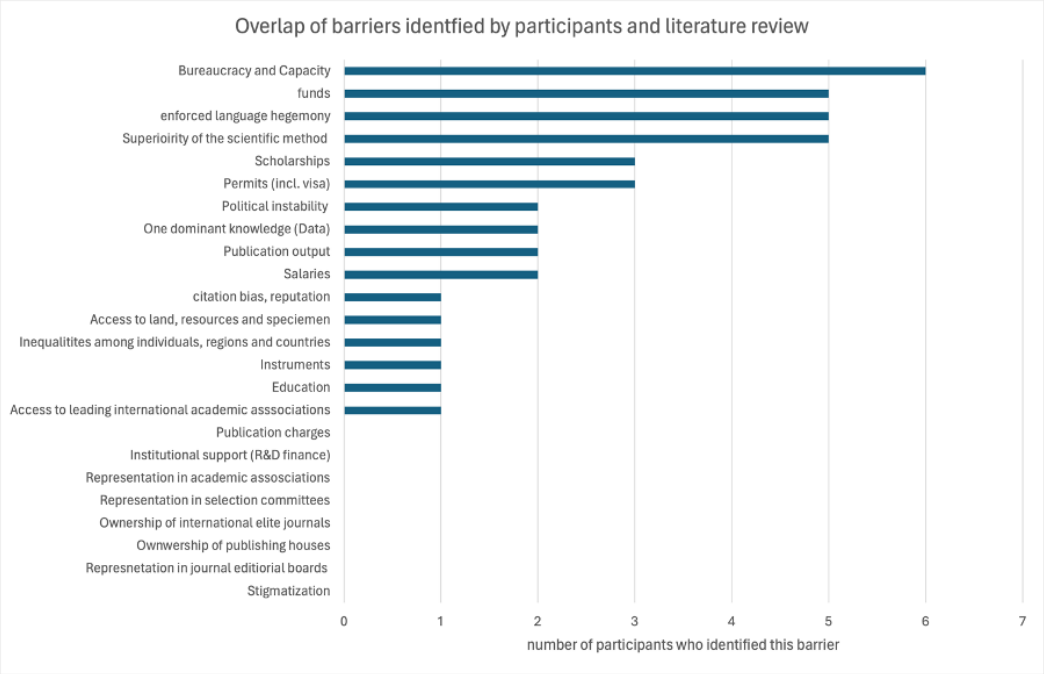

Figure 8 Illustration of the overlap of barriers identified by the interviewees and literature analysis.

Money and Resources. Funding is crucial for the project and its aftercare (5 out of 7, see Fig. 8). Interviewees perceived money as a resource that benefits the stakeholders. However, funds are equally important to create capacity, hire experts, and finance continuing education. In addition, when working with rural or Indigenous communities, money is needed to finance equipment and technical tools. There are regional differences in research capacities as a result of "epistemic colonialism" (Martín, 2021). Previous studies have shown that underfunding in the research and development sector leads to a shortage of research capacities as funds and resources are directed toward more pressing goals like welfare, housing, and stability instead of supporting the R&D sector. As Soares et al. (2023) conclude, political changes put institutional research capacity in jeopardy.

The most interesting aspect is the aftercare. Currently, German researchers are trying a payment scheme to encourage farmers to implement sustainable agricultural schemes. Thus, sustainable long-term action seems to be dependent on finances. Similarly, PhDs or postdocs involved in the project depend on the funding, once it runs out they will leave, as one participant stated. To tackle financial dependence, local ownership can be promoted to sustain care after the end of the project. Local environmental stewardship as defined by Bennett et al. (2018) is the "actions taken by individuals, groups or networks of actors, with various motivations and levels of capacity, to protect, care for or responsibly use the environment in pursuit of environmental and/or social outcomes in diverse social-ecological contexts.". The success of stewardship initiatives, thus, depends on three key components: actors, motivations, and capacity. In line with the argument from Bennett et al (2018), the project builds capacities in every conservation site to promote local ownership. As stated by one of the managers.: "So, this project is not a project that will end and that's it. We have the objective to build up structures, and personal capacities that work after the end of the project as well."

However, the idea of common stewardship is contested among the participants. While one argues that the motivation of the volunteers to care for the environment existed before the project and will continue afterward, another participant stated that without money there will be no continuation of the conservation efforts. There are also concerns that with promoting local ownership the responsibility of caring for the project will be outsourced to the local community (Bennett et al., 2018).

Power hierarchies. Hierarchies and power distribution are recurring themes in the literature and the case study. Historically, researchers from the center would go to underserved areas, collect data, and then return to their home institutions. This "helicopter science" (Núñez et al., 2021) has been associated with neocolonialism and reinforces the issue of global data

inequity. As the case study project spans the whole globe, it is interesting to investigate whether these hierarchies present an obstacle to collaboration. The project leaders expressed high awareness of the topic and the need to avoid hierarchies to fruitfully work together. Many interviewees spoke of a European inclusive conservation plan pointing towards different tasks of each stakeholder group. One participant stated: “We are equal partners in it, but we have different tasks to fulfill”. Thus, a well-defined and widely stated role division could prevent this perception. Nonetheless, previous research found that besides high awareness, researchers often exhibit contradicting behavior by excluding partners from publications (Asase et al., 2021). I contend that these contradictions result from the underlying KI that fosters certain behaviors as stated in the section *Actors and the Knowledge - Action Gap*. M. Demeter (2020) argues that publishing institutions prefer articles that conform to central theories and familiar styles, making it nearly impossible for peripheral researchers to access these platforms. Similarly, Haggart and Tusikov (2023) state that the commodification of data fosters the production of one type of knowledge that serves the economic and political elite.

Besides the power hierarchies, there are epistemological hierarchies between researchers and volunteers. This reinforces existing stereotypes about alternative forms of knowledge. As long as lay knowledge is perceived as inferior, the communities will never reach equal standing in knowledge production and decision-making (Martín, 2021). I conclude that epistemological gaps resulting from a lack of diversity and representation in the creation of environmental knowledge jeopardize our comprehension of ecology as a complex global field.

Different approaches and cultural clashes. Finally, the majority of participants (5 out of 7) referred to different approaches as obstacles to collaboration (Fig 7). In this category I grouped codes relating to 1) cultural differences, 2) distinct research methods, 3) different expectations about the outcome, and 4) different perceptions of nature. All of these overlap with

the barrier “superiority of the scientific method” (see Table 2) previously identified by M. Demeter (2020) and Soares et al. (2023). The superiority of the scientific method refers to the dominance of the scientific method over other cultural, epistemological, and rhetorical methods in different geographical regions and among researchers. In short, it captures the prevalence of Technoscience over Lay-expertise. I argue that codes A to D only present an obstacle to collaboration because they conflict with the standardized method of producing knowledge in the center (see S. *Actors and the Knowledge - Action Gap and the role of data).*

These distinctive approaches next to cultural differences have become highly visible when working with the West-African stakeholders. As stated by an interviewee: “And then you see this a bit of a cultural clash between Western people and African people that you say the pace at which things are taking place is different”. This statement omits the differences among the West African Stakeholders. While the Senegalese researchers seem reliable, accountable, and cooperative, the Gambian partners continue to cause worries for the project leaders. One participant mentioned that the collaboration has suffered from a lack of accountability, motivation, and communication from the Gambian partners. He expressed his frustration over the missing of an important deadline and the lack of attendance to the meetings (offline as well as online). This lack of accountability was associated with the political instability in this country by two participants. Contact with institutional stakeholders, such as the director of the Gambia's Ministry of Environment, is affected because the brief election cycles make it difficult to establish a reliable partnership. To tackle these problems, a focal point or liaison officer will be established in Africa. Hiring a Gambian person to oversee the Life IP in the region should respond to the problems with communication, accountability, and cultural challenges. Furthermore, being able to familiarize oneself with that person is essential for the partnership as trust and emotions have been cited concerning successful collaboration.

Theoretical Framework: the Relationship between Data and Stakeholders

In light of the research question, it might be useful to take a closer look at the KPC and the role of data and the stakeholders in the knowledge production process. Questions such as what are the players with the right and power to decide what kinds of data should be gathered, how those data can be used legally, and what kinds of data governance are appropriate, will guide the subsequent analysis (Haggart & Tusikov, 2023).

The literature analysis revealed that, among other causes, problems with data governance are rooted in the commodification of data and the Western individual perception of privacy (Haggart & Tusikov, 2023). First, the commodification of data in a knowledge economy turns private information into goods being protected by intellectual property rights. Therefore, knowledge is controlled by proprietary, giving the owner the ability to exclude others from accessing it (Fig 1 & 2, accumulation of knowledge in the center). Secondly, this conceptualization of privacy does not resonate with every culture, especially not the Indigenous ones (Haggart & Tusikov, 2023). This calls for the urgent need to reconsider data governance to ensure a more humanistic approach that benefits all. Additionally, Johnson et al. (2021) concluded in a qualitative assessment of the role of digital platforms in managing community-based monitoring data (CBM) how social and technical constraints (i.e. internet access) present an obstacle to participation in data management for the community members. This impacts their ability to shape and define the data's use context.

There is a heated debate among scholars on whether open access is beneficial or not to tackle regional data inequity. Opponents argue that open-access research will only continue to benefit the center (Haggart & Tusikov, 2023; Johnson et al., 2021). Thus, smaller grassroots initiatives have formed to articulate alternative approaches to data governance that respond to

the various needs of communities and different understandings of consent and privacy (Haggart & Tusikov, 2023). Scholars and activists are developing concepts that emphasize collective approaches that center human rights in the treatment of data. Common among those approaches is to move the emphasis from individual rewards to collective benefits or control, whether at the level of a domestic state, Indigenous nation, or local community. These governance systems are not always democratic, and benefits or control may not be distributed fairly or evenly among the participants. Rather, it should take an equitable approach, considering the various demands, contributions, and degrees of involvement (Haggart & Tusikov, 2023). Examples are the concept of Indigenous data sovereignty, data cooperatives, and data trusts. While data cooperatives are owned and run by their members, who voluntarily join forces to share their data for the benefit of all, data trusts are legal arrangements in which a trustee manages data for the benefit of an organization or group of people. In contrast, Indigenous data sovereignty emphasizes that data relating to them should be governed following their laws, customs, and values (Haggart & Tusikov, 2023). To this end, the CARE (Collective benefit, Authority to control, Responsibility, and Ethics) and FAIR (Findable, Accessible, Interoperable, Reusable) principles have been established (Carroll et al., 2020). These guidelines offer a framework for better data stewardship and management. They aim to facilitate the efficient discovery, access, integration, and use of data by researchers and other stakeholders (Aubin et al., 2020; Mayer, 2024). However, a strong critique of these two principles is the concept of consent. Informed consent is key to fair and confidential data collection. However, the idea of informed consent "is seen as valid only when people can understand what they are consenting and are given clear options to accept or decline the data collection, use or disclosure" (Haggart & Tusikov, 2023). Thus, consent requires understanding, and is tied to the individualistic understanding of privacy that does not resonate with the collective identity of Indigenous peoples (Mayer, 2024). Additionally, sometimes

stakeholders can not read or do not understand the terms of the condition. One idea to respond to this is to introduce group consent (Sherwood and Anthony 2020).

Next to the issue of consent, the topic of ownership and accessibility to data needs to be discussed. Access might be restricted to safeguard community needs by obtaining authorization from data users acknowledging collective ownership of the data (Johnson et al., 2021). Indigenous people in Canada defend their sovereignty by keeping some traditional information inside their communities and refusing others access to it (Haggart & Tusikov, 2023). Moreover, since data is gathered and shared from several knowledge systems, such as Indigenous knowledge, local knowledge, and conventional science, integrating alternative knowledge(s) creates novel challenges for data governance. Finally, there is considerable debate about the desirability and feasibility of standardizing Indigenous and local knowledge for use in environmental management and the associated risks for the traditions of the communities (Johnson et al., 2021). The elaboration above highlights the need to (re-)consider the data structure, management, and use to protect every stakeholder's interest. However, only one of seven interviewees mentioned data management concerning collaborative research. Another participant mentioned the untapped potential that would be revealed once all the fragmented datasets of the Life IP are aggregated. This points toward little awareness and experience in this realm. The literature review revealed that for many ecologists, a lack of familiarity with data management might be a big barrier to responsible data stewardship (Aubin et al., 2020). The project manager stated that the question of merging, interoperability, and access is beyond his capacities, which is why two specialists were hired to manage the databases in the GrassBirdHabitat project

To conclude, funds, hierarchical relationships, and cultural differences are major obstacles as confirmed by literature analysis findings and the case study. Epistemological

hierarchies are determined and shaped by the KI but also lie within the preconceived notions that researchers might carry (i.e. stereotypes). Being a holder of Indigenous or lay knowledge results in different approaches in the field but also leads to differentiated needs. These discrepancies could fuel conflict when considering the useability of knowledge, the desired outcome, and questions of data management.

Recommendations

Based on the elaboration above it becomes clear that the knowledge infrastructure is a hegemonic system mainly serving the center while disproportionately affecting the periphery. These structural problems feed into the data inequity in knowledge production. To build a more equitable system, I will put forth recommendations to design a knowledge production cycle that engages the stakeholders from the proposal to the publication. Thus, it might be useful to return to Figure 4. I will give recommendations drawing on conclusions from the literature analysis, the interviews, and personal experiences. In Appendix B, guiding questions for equitable project design can be found.

Recruitment process

I contend that in an equitable research process, the local stakeholder needs to be contacted respectfully, involved voluntarily, and protected by informed consent. The recruitment process should be conducted in culturally appropriate ways respecting the needs of the participants regarding space, time, and setting. In some cases, such as when collaborating with stakeholders in unfamiliar environments (West Africa), it might require a contact point to enhance reliability. Moreover, there should be collective consideration of who is in charge of the project, establishing a clear task division to improve accountability. Those considerations are important to take before the project begins to avoid shortcomings during its implementation.

Project Implementation

Step One: Interaction. Interactions with the world are the first instance to produce objects that are then processed as data. Findings revealed that the engagement of local stakeholders was more instrumental than intentional, as depicted in Fig 5. I argue that stakeholders ought to be included in formulating the research question, the project design (including the selection of methods), and the decisions on which data is collected and how. For the advantage of all knowledge actors involved, data management and aftercare should be included from the beginning and not as an afterthought. A shift in practice towards more community participation research will be fueled by the growing recognition of Indigenous and local knowledge and the creation of frameworks and protocols for its application (Carroll et al., 2021; Johnson et al., 2021). Additionally, drawing from the inspiration of Indigenous worldviews, involving stakeholders in the initial stage can help shift the attention from a techno-science perspective to a more humanist framing (from "how can data address the problem" to "what problem is relevant and urgent to address"). In this way, emphasis would be put on the collective benefits of data collection (Sherwood & Anthony, 2020).

Step two: Object. As a result of the interaction with the world, objects are constructed. Those are quantifiable and measurable concepts that represent something such as Biodiversity. Turnhout and Boonman-Berson (2011) refer to Bowker (2005) who argues that these objects are a way to frame the world, thereby limiting our understanding of the subject measured. For example, biodiversity indicators are created by researchers based on preconceived notions. Specific criteria determine "what gets classified in them." (Bowker, 2005; Turnhout and Boonman-Berson, 2011). Based on these categories, decision-making perpetuates preexisting biases and knowledge systems. This scientific viewpoint ignores other cultural conceptions of biodiversity, such as those of Indigenous or local peoples, who see nature as an essential

component of who they are, formed by customs and behaviors (Belfer et al., 2019; Jessen et al., 2021). Thus, it is important to include the local stakeholders in the project design to collectively decide on the categorization of the objects and which indicators are relevant for the various knowledge actors. As concluded above, the needs and interests of the actors differ, which shapes the object's definition.

Step 3: Data. In the KPC, once the object is defined, it will be processed as data. This involves primarily data collection, filtering, and sorting. To respond to the high scientific requirements on data points (generalizability and standardization), local stakeholders (e.g. volunteers) sometimes need to be trained or educated. This capacity training is beneficial for local communities if executed cautiously to avoid reinforcing the existing shortcomings in the knowledge production system and historical power structures.

Because of differences in epistemology, different monitoring practices become most apparent when engaging with Indigenous populations. To make collaboration more equitable, the Indigenous peoples should participate in defining the objects and databases, two intrinsically linked steps (Bowker, 2005). This might help to tackle the problem of incorporating different knowledge(s) into the database. Taking inspiration from CBM initiatives already in place, like the Yukon River Inter-Tribal Watershed Council, demonstrates how standardization challenges can be addressed by establishing common objectives and realizing that standardization may produce higher-quality data that can support local decision-making requirements (Johnson et al., 2021). By collectively designing the database the researcher steps up to his normative responsibility by giving the stakeholders sovereignty and authority over their data.

The following components are relevant when designing the digital platforms where the data gets stored. First, the data management program chosen should fit the needs of the whole

research group (community members, scientists, and decision-makers). Depending on the main actors involved, the data theme and format must be tailored and respond to different epistemological needs (Johnson et al., 2021). The choice of platform software and customization depends on the technical knowledge of the members, the availability of resources, and the accessibility to digital infrastructure. The functions and accessibility have to be determined by the communities to ensure local ownership (see FAIR and CARE principles) (Carroll et al., 2021). This involves determining the accessibility and the level of interoperability depending on whether the data should serve academia or stay within the local community (Johnson et al., 2021). Access can be controlled by various protectionist measures such as password protection, restricted access based on community or project membership, and area-based access. The management can be done collectively, by designating a trustee, or by a third party (Haggart & Tusikov, 2023).

Step 4: Model. Models are used to make sense of the data by producing information that will turn into knowledge. The way these models work depends on the underlying script, the input variables, the data, and the aims. While this ties into discussions about Artificial Intelligence and the fairness of algorithms, it will not be further discussed in this analysis.

Step 5: Knowledge. Since the KPC produces new knowledge that informs further interactions with the outside world, this stage is both the beginning and the end. Because iterative procedures tend to strengthen the current knowledge claims, it becomes essential to critically examine the starting point, considering which knowledge(s) go into the circle and which actors will use the knowledge output (Demeter, 2020; Mignolo & Walsh, 2018).

One way to break with the central hegemony is to end with the methods, routines, and approaches that sustain this system. From the elaboration above, it becomes clear that scientists

and researchers have an unavoidable impact on knowledge production and the results. By acknowledging their impact on the global dynamics in knowledge production, researchers are in a powerful position to challenge the existing structures by participating more purposefully in shaping their research conditions and results. Overall, a pluralistic research community is more likely to consider different kinds of epistemologies, which would contribute to more equitable knowledge production.

Step 6: Publication. Since they regulate and shape what is published, the knowledge governance and publication institutions are powerful entities in the knowledge field. Researchers from the periphery often struggle to access the commercialized publishing system. In addition, these institutions place a lot of emphasis on financial matters. According to Haggart and Tusikov (2023), the decommodification of data and knowledge might tackle the issues with authorship and citation bias by removing the financial dependence on these factors. There is a strong call for these institutions to account for regional inequities by supporting the periphery with research tools, resources, and infrastructure (Cole et al., 2023). This will allow for the direct exchange of knowledge and resources between actors and communities of practice, thereby building capacity and new knowledge. In addition, stronger support for initiatives that are already engaged in collaborative practices helps to modify the field towards more diversity (Cole et al., 2023). In that sense a new research culture can be fostered, one that values quality, openness, collaboration, and responsibility in research, and that takes into account the entire spectrum of academic actors and tasks (Trisos et al., 2021). Ultimately, to recognize the epistemic diversity in knowledge production, we need to diversify institutional actors, processes, and practices.

Limitations and suggestions for future research

When studying the potential role of local stakeholders in contributing to regional equity in knowledge production, it is important to note that every project and stakeholder is individual which limits the generalizability of the results. Furthermore, this analysis focused on one barrier within the overarching system of the KI. Future research could investigate other barriers such as the publishing structures and institutions, how to eliminate biases and stereotypes to tackle epistemological hierarchies, and the desirability and feasibility of standardizing Indigenous data. As digital data is essential to the monitoring and observing process, the use of technology and digital data will become more prevalent in ecology. I have examined some of the concerns brought up by the growing use of digital data and technology, such as the requirement for more data literacy, but further study is required to examine the potential conflicts. For example, it's unclear if using digital apps to collect observational data will threaten local or Indigenous methods of environmental observation and knowledge, or if these apps will instead support and encourage the continuation of place-based methods. In respect of working with local and Indigenous communities, the question of consent is highly relevant. Future research should investigate further options on how to negotiate consent while respecting the needs of the participants. Concerning the qualitative analysis, it needs to be noted that the interviewees are only from two countries, the Netherlands and Germany. Therefore, this analysis lacks the West African perspective.

Conclusion

In response to the research question on how the inclusion of local stakeholders can contribute to more regional equity in knowledge production, this analysis revealed the following findings. First, to better understand the process of generating knowledge the concept of

knowledge infrastructure and the knowledge production cycle have been introduced. The KPC allows us to understand knowledge production as a reiterative process, but a thorough analysis shows that this cycle tends to reinforce existing beliefs, practices, and theories. Moreover, based on the assumption that data is the only “true” basis of knowledge other forms of knowledge - and its holders - are marginalized. Second, it is imperative to look into the role of the stakeholder in the knowledge production process as our comprehension of data and knowledge requires an investigation of the human actors involved to understand its use context.

To provide a theoretical framework for this research, I conducted a literature review. Within that framework, I discussed the findings from the case study, "Life IP GrassBirdHabitats," a real-world flyway-scale conservation initiative. I identified several barriers to equitable knowledge production such as epistemological hierarchies, bureaucratic efforts, lack of capacities, financial availability, language barriers, and cultural differences.

The case study's results supported the conclusions of the literature, yet emotions have emerged as a relevant topic. Central issues seem to be the long-term care of the project and data governance as often the individual consent and the notion of privacy present an obstacle to working with (Indigenous) communities. I end with recommendations on how to engage the local stakeholders throughout the whole process, from project design to implementation and finally dissemination.

Finally, including local stakeholders and their epistemologies creates a window of opportunity to tackle the existing knowledge hegemony and incorporate lay expertise which will contribute to a better understanding of global ecology. Thus, diversifying the input of knowledge production can lead to a more equitable output corresponding to the needs of all societal actors.

This requires us to move from a data-centric approach to a human-centered approach in the first step drawing on inspiration of local and Indigenous ontologies.

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Appendix A

Semi-structured interview questions

1. **Introduction**
    a. Can you tell me a little bit about yourself? (where are you from? How did you end up in this position? Where did you study?)
    b. Can you tell me a little bit about the Life IP project? And your role within the project?
    c. Are you working with local stakeholders? And, if yes, how are they involved? (At which stage? Which basis? How can they contribute?)
    d. How are local stakeholders identified in Senegal? Whom do you consider a local stakeholder?
    e. How do you perceive community involvement? Is everything going as planned? Or did you face some struggles in working and collaborating with the Senegalese stakeholders?
    f. If yes, how did these struggles manifest? How did you deal with them?
    g. Do you perceive power hierarchies among the stakeholders? How do they manifest? If there are hierarchies, how would you suggest dealing with them?
2. **Project implementation and aftercare**
    a. How do you ensure the engagement of the local stakeholders throughout the whole project?
    b. Do you know what is going to happen with the conservation sites after the project ends in 2030? How do you plan to protect the achievements of conservation?

3. Capacity Training in Senegal

a. How do you perceive the possible collaboration with other stakeholders?

b. Can you tell me a bit more about the Master in ornithology that is taught there? (what is being taught, who teaches, who set up the program)

c. Is it possible to share the curriculum with me? Or is it accessible somewhere?

4. More regional

a. Do you know other researchers or stakeholders involved in the project? (in West Africa or beyond)?

b. Did they visit Senegal? Who visited and when? What did you do?

c. Do you have experience in working with other local stakeholders in the region (West Africa)? How did this go?

5. Closing questions

a. Is there anything else that you would like to add?

b. Do you have any other contacts for me that could contribute to this investigation or offer a new perspective?

Appendix B

Questions for Equitable Project Design

Recruitment process

- Which stakeholder is relevant for the project, depending on capacity, aim, and needs?
- How do I contact this stakeholder in a culturally appropriate and respectful way?
- How do we negotiate consent?
- Who is in charge of the aftercare?

Interaction

- How can researchers make sure benefits return to the communities? What problems are relevant to address?
- Is there data or services that the communities need?
- How can access to the data collected be ensured? But more importantly, how can control/ownership of the data be guaranteed to the community?

A: Problems with various knowledge(s) and their translation into quantifiable data

B: Access: open access, project-based, area based?

C: Authority: Trustee, collectively, individual?

Object

- What is the object measured?
- How do we define this object from various epistemological perspectives?
- How does this object translate into indicators and a categorization scheme?

Data

- Who are the intended users?
- How do we regulate access? (considering limited internet access)
- What is the data theme or format? (taking into consideration various knowledge)
- Which platform software is relevant? How do we design customization?
- Which functions should the platform serve? (in accordance with FAIR and CARE, principles)
- Time scale: Do we need regular data collection? How long should the monitoring last?

Knowledge

- Which actors are involved and how does it impact epistemological diversity?
- Which methods are used to answer the research question?
- Which context should the knowledge serve? → useability of knowledge

Publication

- Who are the authors?
- What are institutions that support diversity, openness, and equity in knowledge production?