Bridging Knowledge Systems to Guide Natural Resource Decision-Making

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ABSTRACT
International agreements call for inclusion of Indigenous and local knowledge in resource management, yet practical approaches remain underdeveloped. We argue that knowledge co-assessment offers a feasible pathway. Drawing on examples from practice in the Arctic, we provide guidance for equitable engagement, communication, and scaling, ensuring legitimacy, inclusivity, and actionable governance.

Keywords: bridging knowledge systems, co-assessment, co-production, Indigenous Knowledge, large ecosystems, local communities, local knowledge

MAIN TEXT

The need to move from policy to practice

Many policy documents now call for **Indigenous Knowledges** (IK; see Glossary) and **local knowledge** (LK), alongside scientific knowledge, to guide natural resource management (IPBES 2019, see: *www.ipbes.net/ipbes-global-assessment-report-biodiversity-ecosystem-services;* CBD 2022, see: www.cbd.int/doc/decisions/cop-15/cop-15-dec-04-en.pdf; UN 2025, see: https://www.un.org/pga/wp-content/uploads/sites/109/2025/05/UNOC3-declaration-final.pdf). Yet practical guidance on how managers should bring these knowledge systems together without eroding their uniqueness or legitimacy remains scarce [1]. Consequently, management decisions and implementation often proceed with minimal genuine input from the Indigenous Peoples or local communities most impacted – perpetuating marginalization, eroding trust, and undermining the legitimacy and effectiveness of management interventions.

Indigenous Peoples and scholars argue that IK has its own processes of validating credibility and legitimacy and therefore does not need validation by scientific knowledge [2,3]. Conversely, proponents of the arm's length principle [4] in government resource management are concerned that decision-making based on IK and LK may not be impartial. However, ignoring one system – or subsuming it under another – leads to decision-making that misses potentially important available information. We need pragmatic processes that respect each system's logic, validation criteria, and voice. Here, we draw upon Arctic practices, where IK and LK have long shaped governance, to provide lessons of broad relevance for bridging knowledge systems. We focus on knowledge co-assessment, describing how it can be carried out through institutions for equitable engagement, appropriate terminology, communication and documentation strategies, scaling, and capacity.

Structuring knowledge co-assessment

Ideally, decision-making should be informed by the questions posed and knowledge produced by Indigenous Peoples, other local resource users, and scientists in a collaborative manner [2]. One example of this type of research, led by an Indigenous community in Alaska, showed climate change reduced bearded seal *Erignathus barbatus* hunting opportunities and the need for resource management to consider food security, well-being, and culture [5]. However, government resource management often have minimal operational funding, and **knowledge co-production** may not be practically feasible [6,7]. In this context, obligations nonetheless remain to engage with IK under international human rights standards [3] and this may also improve effectiveness. Decisions may instead be informed by **knowledge co-assessment** where both

existing IK, LK, and scientific knowledge are validated and assessed by representatives of Indigenous Peoples, other local natural resource users, and scientists (Figure 1). Knowledge co-assessment, then, brings existing IK, LK, and scientific knowledge into a joint evaluation process, with representatives from each system weighing reliability and relevance against agreed criteria rather than subsuming one form of knowledge under another. Co-assessment boards, whether long-term or *ad hoc*, should consider how knowledge is included and validated in decisions.

Institutions for equitable engagement

Successful knowledge co-assessment requires the establishment of equitable, inclusive, and transparent structures that respect each system's integrity [1,3,8]. Ethical engagement necessitates open discussion and a clear understanding of goals, methods, and how the knowledge will be used – e.g. in policy decisions, advocacy, resource management, public communication, or confidentiality. In Canada, the Nunavut Wildlife Management Board exemplifies co-assessment, sharing authority between communities and government to address colonial imbalances [9]. Both IK and scientific knowledge are used to inform decision-making through culturally-adapted rules [10]. Elsewhere in the Arctic, co-assessment bodies of Indigenous representatives, local users, and scientists play a vital role in validating and assessing information, fostering trust and legitimacy, for example in the Alaska Beluga Whale Committee [11].

Navigating terminology, modes of communication, and documentation strategies

The words we use shape which – and whose – knowledge counts. Intentional and inclusive language, as well as mutual learning of key terms and concepts – particularly between scientists and IK/LK-holders –, is crucial [12]. Many IK/LK-holders prefer oral or experiential exchanges over technical reports. Tools like visual aids, maps, radio, social media, and community workshops can bridge linguistic barriers and foster wider engagement [13] .

Co-assessment bodies have to connect pieces of information from the different knowledge systems, and there are several methods that can be used (Table 1). One example is the Information-source-relevance approach in which the co-assessment body scores the information provided by IK/LK-holders and scientists based on: 1) the reliability of information; 2) the reliability of the source; and 3) relevance to the decision (Table 1). IK/LK-holders and scientists should co-develop locally-relevant scoring criteria (example in Supporting Online Table S2). After scoring, the weight of the various pieces of information can be compared. This method respects the foundations of the different knowledge systems – although the approach still asserts Western structures rather than Indigenous approaches. Since government agencies are concerned that they cannot base decision-making on IK and LK where there is no traceable evidence, the key may be to make it clear what was observed, where it was observed and why we should believe the observer. Once a decision has been made, the evidence and reasoning behind it should be made readily available and accessible, for example, through circulating plain language decision letters to community leaders, or maintaining a public registry of decision documents with a listserv that automatically distributes updates to all subscribers once a new decision is posted.

Scaling, capacity, resourcing, and relational practice

Scaling co-assessment from local to international frameworks is complex. It is essential to retain local context and integrity as initiatives expand to include larger areas and ecosystems such as Pikialasorsuaq/North Water Polynya [14], which involves communities and governance institutions in Canada and Greenland, along with the Central Arctic Ocean which entails inclusion of large areas of international waters beyond national jurisdiction and subject to an agreement to prevent unregulated fishing (see: https://vlab.noaa.gov/web/caofa). In both the Pikialasorsuaq and the Central Arctic Ocean case, the Inuit Circumpolar Council (ICC) affirms the Inuit's right to be consulted and involved in discussions relating to ecosystem governance. Institutional mechanisms for Indigenous leadership or co-management approaches within resource governance frameworks, at a minimum in the form of regular dialogue and consultation with Indigenous Peoples and local communities, must be embedded within scaled-up governance frameworks to ensure that co-assessment processes remain grounded in local realities and continue to reflect IK and other local community values, needs, and priorities. This approach will be a priority for efforts to protect large areas of the Arctic Ocean, as well as initiatives such as a plan for Nunavut and Greenland to form a joint fisheries committee.

Bridging knowledge systems faces persistent barriers with regard to capacity. Many Indigenous and local organizations lack funding, staffing, and infrastructure to participate equitably, while government agencies often operate under tight budgets and short timelines that hinder long-term relationship-building [7]. Nonetheless, the burden and responsibility of transforming natural resource decision-making "in a good way" falls to those in decision-making power [2]. Closing these gaps requires dedicated funding for language and cultural translation services, communication, training, and facilitation. Capacity-building should support mutual learning between scientists and communities, with boundary spanners helping bridge methods, values, and governance to improve coordination and decision-making [12].

Engagement with IK-holders must allow space for reflection. Many IK-holders prefer to take time to formulate questions and responses and may not engage immediately in fast-paced dialogue replete with scientific terminology. Non-Indigenous participants, often eager to contribute, may unintentionally dominate discussions, leaving little room for IK voices. This situation is often rooted in differing cultures of discussion: IK-holders tend to contribute when they feel they have something meaningful to add, in contrast to some non-Indigenous participants who may be accustomed to open-ended, exploratory dialogue where any topic can be discussed at length.

Long-term investment in institutional capacity is vital. Governments and research institutions must create mandates that support staff to engage in co-assessment beyond short-term projects. Success metrics should reflect process outcomes (trust, inclusivity, accountability) as well as knowledge outputs. They must also recognize the value of IK and LK by compensating IK/LK-holders on equal terms with scientists and government staff. It is important for non-Indigenous participants to recognize, respect, and make space for different worldviews, acknowledging that genuine collaboration advances diverse ways of knowing and being.

Conclusions

If natural resource management is to be informed significantly and meaningfully by IK, LK, and scientific knowledge, practical guidance on bridging knowledge systems in resource-, and time-

poor, policy environments is essential. Otherwise, efforts to connect different forms of knowledge are likely to remain no more than isolated academic exercises. Embedding principles of respect, equity, and context-specific cultural values is critical to ensuring that bridging knowledge systems is not only aspirational but actionable, leading to legitimate, inclusive governance based on all forms of the best available knowledge and evidence.

Author contributions

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Declaration of interests

The authors declare that they have no competing interests.

Supplemental information

Supplemental information associated with this article can be found online.

Glossary

Indigenous Knowledges (IK): Understanding, skills, and worldviews developed by societies with centuries to millennia of interactions with their natural surroundings, and with the potential to inform decision-making on fundamental aspects of day-to-day life. Embodying interrelated relationships between people, their ecosystems, and the other living beings of a geographic area, this knowledge is integral to a cultural context that includes language, systems of classification, resource-use practices, social interactions, rituals, and spirituality [3]. IK is highly diverse and evolves continuously through interaction of experiences, innovations, and various types of knowledge (written, oral, visual, tacit, gendered, practical, and scientific) [15]. Here, we apply a plural form to acknowledge that Indigenous Peoples and their Knowledges are not a monolith with uniform epistemologies. The Greenland Association of Fishermen and Hunters (KNAPK), which is the key organization representing Greenland's fishers and hunters, recognizes Inuit Knowledge as rooted in thousands of years of life in the Arctic, shaped by region, community, and livelihood. This knowledge is both universal and diverse, encompassing traditions, practices, and professional expertise such as fishing and hunting, while also evolving regionally and sometimes disappearing with small communities. In addition, KNAPK recognizes that the

knowledge of resource users in Greenland is based on the profession of fishermen and hunters, and that there is significant overlap between Indigenous Knowledge and user knowledge.

Knowledge co-assessment: Resource management decisions rely on the best available information. Knowledge co-assessment is a less costly and time-restrictive approach than knowledge co-production, focused on pairing local stakeholders, rightsholders, and resource managers or scientists to jointly consider and weigh all available existing (IK, LK, and scientific knowledge) data and evidence and provide collective guidance [6]. In some Arctic regions, wildlife co-management boards serve as examples of co-assessment [9-11].

Knowledge co-production: A process to collaboratively develop research goals, methods, analysis and products or outcomes involving scientists, resource managers, stakeholders, and rightsholders. Flourishing knowledge co-production efforts to bridge IK with scientific knowledge and policy emphasize equitable and ethical practices [8,12] yet perils remain to doing research "in a good way" when one knowledge system is subsumed by or integrated into another [2]. Co-assessment follows the same principles but focus on validating and assessing all available *existing* IK, LK, and scientific knowledge data.

Local knowledge (LK): Understanding and skills developed by groups of individuals in a specific local geographic setting, often informing decision-making in day-to-day life. In contrast with IK, local knowledge does not presuppose a broader, shared worldview, although it is often associated with a shared local understanding of context [15].

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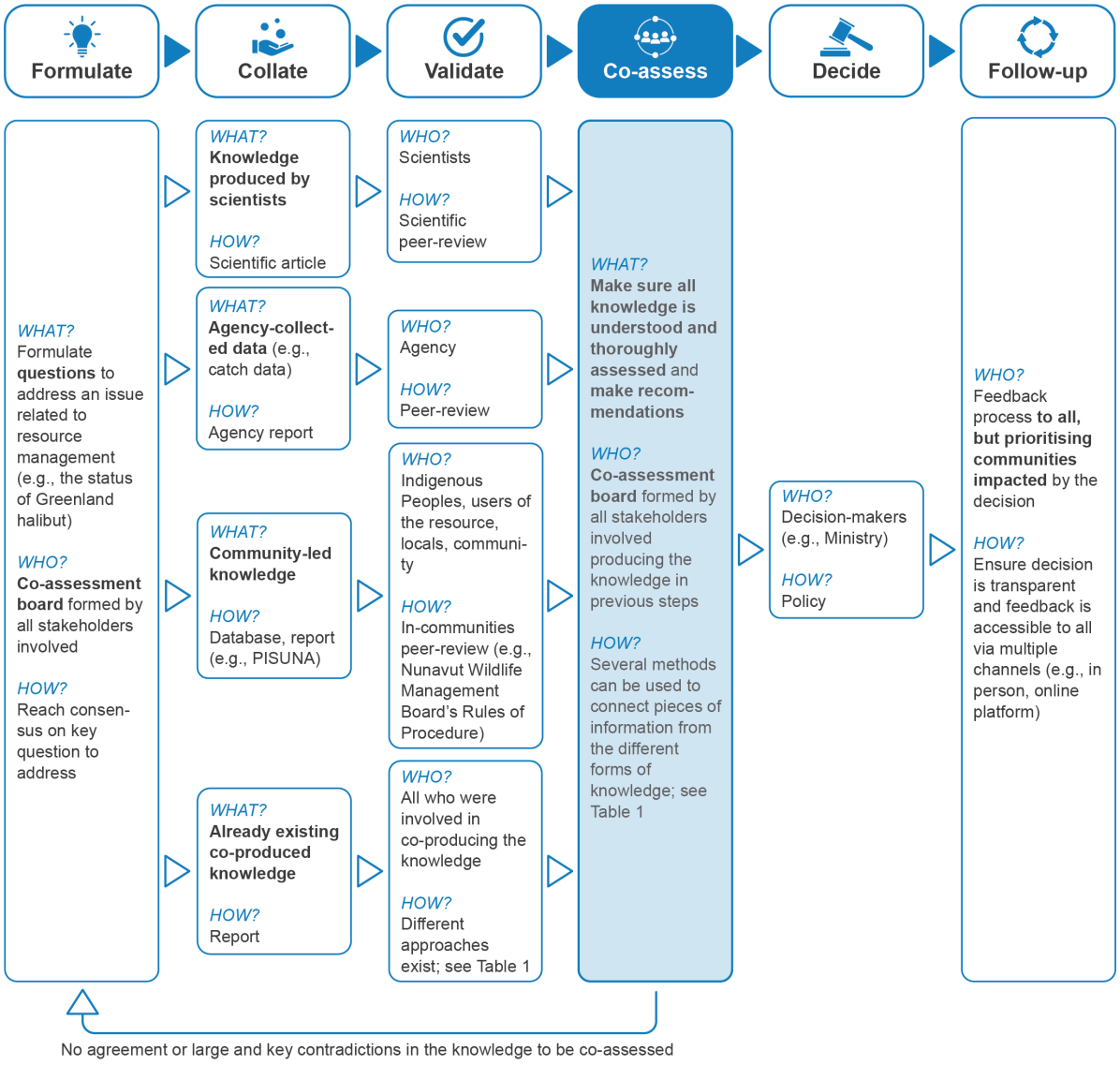
Figure and table

Figure 1. Six stages of evidence-based decision-making using co-assessment for bridging knowledge systems with examples from Greenland and Nunavut, Canada (abbreviation: PISUNA, the Piniakkanik Sumiiffinni Nalunaarsuineq Programme; Opening Doors to Native Knowledge; https://pisuna.org/).


Formulate
Collate
Validate
Co-assess
Decide
Follow-up
WHAT?
Formulate questions to address an issue related to resource management (e.g., the status of Greenland halibut)
WHO?
Co-assessment board formed by all stakeholders involved
HOW?
Reach consensus on key question to address
WHAT?
Knowledge produced by scientists
HOW?
Scientific article
WHO?
Scientists
HOW?
Scientific peer-review
WHAT?
Agency-collected data (e.g., catch data)
HOW?
Agency report
WHO?
Agency
HOW?
Peer-review
WHAT?
Community-led knowledge
HOW?
Database, report (e.g., PISUNA)
WHO?
Indigenous Peoples, users of the resource, locals, community
HOW?
In-communities peer-review (e.g., Nunavut Wildlife Management Board's Rules of Procedure)
WHAT?
Already existing co-produced knowledge
HOW?
Report
WHO?
All who were involved in co-producing the knowledge
HOW?
Different approaches exist; see Table 1
WHAT?
Make sure all knowledge is understood and thoroughly assessed and make recommendations
WHO?
Co-assessment board formed by all stakeholders involved producing the knowledge in previous steps
HOW?
Several methods can be used to connect pieces of information from the different forms of knowledge; see Table 1
WHO?
Decision-makers (e.g., Ministry)
HOW?
Policy
WHO?
Feedback process to all, but prioritising communities impacted by the decision
HOW?
Ensure decision is transparent and feedback is accessible to all via multiple channels (e.g., in person, online platform)
No agreement or large and key contradictions in the knowledge to be co-assessed

315

316 **Table 1.**
317 Examples of approaches that are used to combine quantitative scientific outputs with qualitative
318 context-rich lived experiences from Indigenous Knowledges, local knowledge, and scientific
319 knowledge (References in Table S1 in the Supplemental Information Online)
320

Approach	Example	Reference
Assist Indigenous Knowledges-holders and local knowledge-holders with documentation and statistics	Supporting Indigenous Knowledges-holders and local knowledge-holders in using science-based tools for documenting, synthesizing and sharing their knowledge	16
Authority	The authorities make decisions (based on, for example, common sense, personal experience, speaking to other resource managers in the region, or their assessment of the evidence from scientific knowledge, Indigenous Knowledges and local knowledge)	
Consultation	Engaging knowledge-holders and government resource managers to gather their views, knowledge, and concerns to improve decision-making	17
Critical ontologies	Examination of the assumptions, worldviews, and power relations that shape Indigenous Knowledges, local knowledge and scientific knowledge with a view to promoting more inclusive decision-making	18
Delphi	Knowledge-holders' opinions are gathered and evaluated anonymously and iteratively, through multiple survey rounds, to reach consensus	19
Discuss why different	When findings from Indigenous Knowledges, local knowledge and scientific knowledge diverge, the reasons for these differences are examined through discussion between the knowledge-holders	20
Further assessment and evaluation	Systematically measuring and analyzing particular environmental attributes (e.g. trends in the abundance of a natural resource) to inform decision-making	21
Indigenous decision-making	Representatives of Indigenous Peoples make decision (based on, for example, common sense, personal experience, speaking to other resource managers in the region, or their assessment of the evidence	22

	from Indigenous Knowledges, local knowledge and scientific knowledge)	
Indigenous Knowledges, local knowledge and scientific knowledge equity	The evidence from Indigenous Knowledges, local knowledge and scientific knowledge is given equal weight when decisions are made	23
Information-source-relevance	The weight of evidence is assessed (by a co-assessment board) according to information reliability, source reliability, and relevance, using locally-relevant scoring criteria jointly developed by Indigenous Knowledges-holders, local knowledge-holders and scientists (example of scoring criteria in Supporting Online Table S2)	24-25
Legal courts	The use of judicial processes to resolve disputes and to inform decision-making	26
Narrative review	Existing published research is summarized qualitatively, synthesizing key themes and findings, without the use of systematic or statistical methods	27
Precautionary principle	When a natural resource's status is uncertain, a decision is taken to reduce harvest levels (instead of waiting for a fuller understanding)	28
Q-analysis	The perspectives of knowledge-holders are documented, areas of consensus and conflict are identified, and a decision is agreed upon	29
Quantitative data and meta-analysis	Numerical results from multiple studies are combined systematically and used for decision-making	30
Repeat survey	Reassessment of a population or an area to obtain additional information, replicating the survey approach that was used in the past	
Social learning	Cultural and knowledge exchanges between policy decision-makers, resource managers, scientists, stakeholders, and rightsholders to increase usefulness of outcomes and adaptive capacity of institutions	31
Systematic review	All evidence is synthesized in a rigorous, transparent process to inform decision-making	32
Tribunal	The knowledge-holders present arguments and evidence before an "impartial" panel that deliberates and recommends decisions	33

Vote-counting	Each knowledge holder has one vote, and the decision with the most votes is selected	34

Supporting Online Table S1. References used in Table 1.

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Supporting Online Table S2. Example of criteria for source reliability, information reliability, and relevance based on Indigenous Knowledges, local knowledge and scientific knowledge. The criteria are envisaged used by a co-assessment board when assessing the weight of a piece of information about a given population of a species/resource in an area. Each criteria can be answered with a Yes or a No. Indigenous Knowledges and local knowledge are here treated together, but in some contexts, each of these forms of knowledge should be evaluated by distinct criteria. The criteria must be locally-relevant, and they should be co-developed by Indigenous Knowledges-holders, local knowledge-holders and scientists. The rightsholders' voice should be central in the development of the criteria. Source: Denis N. Etiendem (Nunavut Wildlife Management Board), Mikael Petersen (Greenland Association of Fishermen and Hunters, KNAPK), and PâviâraK Jakobsen (the Piniakkanik Sumiiffinni Nalunaarsuineq Programme, PISUNA, Qeqertalik Municipality).

	Source reliability	**Information reliability**	**Relevance**
Indigenous Knowledges and local knowledge	Does the person have experience with the **resource** and the **area**? Is the person **recognized** within the community as an expert on the topic?	Is the result based on **consensus** among several persons from the community? Is the result based on multiple **observations**? Is **supporting information**, such as photos available?	Is the **resource** (species, population) the same as the topic of concern? Is the **area and time** the same as for the topic of concern? Are the **conditions** (weather, regulations) the same as for the topic of concern?
Scientific knowledge	Does the person have a **reliable,** unbiased track record? Has the person previously published in high-impact **journals**?	Is the study of sufficient **duration**? Are key **assumptions** met? Are the **conclusions** appropriate given the information available?	Is the **context** of the study close to the topic of concern?