Indigeneity and spatial information science

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Abstract: Spatial information science has given rise to a set of concepts, tools, and techniques for understanding our geographic world. In turn, the technologies built on this body of knowledge embed certain "ways of knowing." This vision paper traces the roots and impacts of those embeddings, and explores how they can sometimes be inherently at odds with, or completely subvert, Indigenous Peoples' ways of knowing. However, advancements in spatial information science offer opportunities for innovation whilst working towards reconciliation. We highlight, as examples, four active research topics in the field, to support a call to action for greater inclusion of Indigenous perspectives in spatial information science.

Keywords: data sovereignty, Indigenous knowledge, spatial information, GIS, location-awareness, SDI, uncertainty, ontologies

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1 Introduction

Indigenous Peoples around the world identify themselves, in part, through their historical connection as the First People of a specific regional area [63]. Acknowledging that definitions of Indigeneity can be deeply contested and controversial [66], Indigenous identity is continuously shaped through Indigenous Peoples' relationships with land, sea, and sky. Accordingly, many of the basic rights of Indigenous Peoples set out in the 2007 UN Declaration on the Rights of Indigenous Peoples (UNDRIP) [69] have an inherently spatial aspect. Space, place, region, locality, and natural features are essential elements to constituting Indigeneity [7].

In contrast, today's systems for representing and managing spatial information—and the body of knowledge that underpins those systems—has developed in close connection to colonial approaches to land and Eurocentric approaches to science. This connection can

be seen as an instance of what Cowen [12] terms the "infrastructure of the empire." Beyond a critique of GIS and GI science, the traces of this history can be found deeply embedded in today's technology.

For instance, there is a widespread acknowledgment that the process and outputs of map-making are deeply political [4, 50]. Many of today's GI technologies can be seen as an evolution of early map-making tools. A wealth of literature underlines the innate politics of the technology, such as critical cartography (e.g., [25–27, 48]) and critical geography (e.g., [14, 15, 35, 36, 56]). As Rose-Redwood et al. argue, map-making and spatial technologies continue to perpetuate mapping as "an important ontological role in the making, unmaking, and remaking of 'worlds' " [57, p. 152]. This is not simply an epistemological critique; it has practical consequences for inclusion of Indigeneity in formal negotiations of treaty, in public sector information, as well as in everyday spatial practices.

In this vision paper, we make the case for conscious and concerted action by GI science researchers to foreground this dissonance. This case rests not only on the moral imperative to face up to the historical role of spatial technologies in producing inequity and exclusion; it rests on the scientific imperative to pursue knowledge responsibly and ethically, through authentic representation of Indigenous Peoples and their worldviews [9].

More broadly, this work recognizes that that Indigenous practice of spatial knowledge predates western science. Indigenous science and traditional knowledge has a long history of unrecognized contributions to "western" science in areas such as medical, agricultural, ecological, climatological, and materials sciences. Indeed, any apparent dichotomy between western, Eurocentric science and Indigenous science is recognized by most scholars as simplistic and superficial [2, 3, 6, 45, 49]. Regardless of differences, Indigenous or Eurocentric sciences have in common the primacy of observations as a basis for forecasting and prediction.

2   Approach

To date, only a small proportion of GI science research considers Indigeneity directly. Amongst the earliest GI science to attempt this was pioneered by Andrew Turk [67, 68], leading to influential comparative research on English and Indigenous Australian Yindjibarndi language terms for landforms [38, 39].

More recently, research in connection with *public participation GIS* (PPGIS) has actively attempted to support Indigenous communities through counter-representation and co-creation of knowledge using GIS. For example, in [43] GI science researchers worked with the Barapa people, Traditional Owners of of Gunbower Island, Australia, to develop education and teaching resources using GIS and mapping techniques. The topic of volunteered geographic information (VGI, also termed user-generated geographic content, UGGC) similarly offers the potential for more direct engagement of marginalized Indigenous People in the co-creation of spatial information (e.g., [10]). There are a host of other works that have sought to challenge the hegemony of Eurocentric representations of territory (e.g., [5, 11, 47, 61, 70]).

Such work is important because it points to the potential of spatial technologies, and the knowledge management systems that support them, to work *for* Indigenous communities and disrupt settler narratives within the spatial disciplines. However, this direct approach is not without its own risks and tensions. GI science, when used to spatialize Indigenous

knowledge, has long been caught in a quandary: it simultaneously empowers and disempowers [5, 28, 52, 62]. Methodologies and tools from GI science have been mostly developed in Eurocentric contexts before being transferred to non-western contexts [58]. Arguably, the abstraction that is core to representation in GI science is only possible because of widespread dispossession of Indigenous People of their lands [62]. From this perspective, maps are part of the assemblage of practices that promulgate western perspectives while suppressing Indigenous knowledge systems and worldviews [51]. For example, as state mapping has become inextricably linked to national statistics, so "cartographic calculations of territory"—where statistics are represented as, and assumed to be, value-neutral—has become a normative assumption [14].

Working together on the co-creation of knowledge requires an investment of time, effort, and trust-building with Indigenous People. Importantly, it requires that we as spatial information scientists are prepared to reflexively question, challenge, and ultimately reconfigure our disciplines' logics and epistemologies. Even with the best intentions, initiatives may be only partially successful [20]. More damaging still is the acknowledged danger of engagement that masks or reinforces power imbalances [28], or even actively contributes to exploitation of Indigenous Peoples' knowledge, culture, or resources [72].

In complement to such work on co-creation of knowledge, this paper focuses on established topics in GI science with particular relevance to Indigenous Science and Indigeneity. Our aim is highlight ideas and concepts where integrating an awareness of Indigeneity already offers clear chances of accelerating innovation and opening up new avenues of productive research for all, both Indigenous and non-Indigenous scientists.

3   Vision

Maps are no longer an elite instrument of the state or the profession; almost anyone today is now able to take up map-making to frame "competing and equally powerful claims" [15, p. 12]. This change has facilitated a shift in the use of spatial technologies, such as GIS, away from traditional applications and towards supporting a diversity of alternative ways of understanding the world [13, 34, 37, 61, 65].

For example, participatory GIS pioneered the transfer and use of GIS technology and expertise to those normally excluded from accessing it [21, 22, 60]. This has included possibilities for enabling different spatial perspectives to be accommodated simultaneously [71] as well as introducing information about the social, political, and institutional context through metadata [59]. Non-traditional information types, such as qualitative data, multimedia, and sketch-maps, are now more frequently integrated alongside more traditional spatial data [32]. The results have imbued spatial technologies with improved abilities to support the social and contextual relationships long understood to provide place with meaning [42].

In keeping with this shift towards more inclusive underpinnings to the technology, there has also been a move towards integrating Indigenous and Western perspectives. Albert and Murdena Marshall, Indigenous Mi'kmaw Elders of the Eskasoni First Nation located in Nova Scotia, Canada, quoted in [40], use the term "two-eyed seeing" to describe the idea of understanding from multiple perspectives in balance. The approach has been applied in research aiming to embrace Indigenous worldviews and co-design applications of science to improve indigenous outcomes [1, 41, 46, 73]. For the GI scientist, "two-eyed

seeing" involves questioning our partial perspectives and valuing a plurality of different ways-of-knowing in research.

Accordingly, this section selects four examples of active research areas in the field to highlight how GI science can support and incorporate Indigeneity at the same time as presenting new scientific challenges. Underlying these examples is the broader principle that an understanding and acknowledgment of different perspectives provides a stronger basis for the advancement of knowledge. In other words, not allowing one perspective to dominate promotes better science.

3.1   Uncertainty

Uncertainty in geographic information is amongst the most fundamental and long-standing research topics in GI science [23]. The concept of uncertainty in geographic information inherently admits the possibility of different perspectives and contested knowledge [19]. In this sense, and in common with "two-eyed seeing," uncertainty can also be about balancing different perspectives. Uncertainty thereby provides a way to engage with the inherent heterogeneity across Indigenous knowledge and the dynamic nature of Indigenous relationships with land, sea, and sky.

For example, crisp and unambiguous boundaries are at the root of many concepts, analyses, and data structures in GI science. Vector data, for instance, is a boundary representation of geographic phenomena. Acknowledging, however, that boundaries are frequently not crisp, unambiguous, or immutable, many ingenious mechanisms and concepts have been proposed in GI science that aim to relax these assumptions and admit indeterminacy (e.g., [8]).

Boundaries in Indigenous communities are often flexible, relative, and ambulatory, defined with reference to landforms, lived experiences, and subject to contest, challenge, and change. Hence, Indigenous knowledge of boundaries arguably resonates strongly with existing GI science approaches to indefinite and uncertain formulations of boundaries.

3.2   Spatial ontologies

Ontologies are defined as an explicit specification of a conceptualization [24]. As a result, ontologies are inherently connected with different perspectives. Acknowledging the wide variety of different specialisms and applications connected with geographic information, GI scientists have become particularly adept at bridging these different perspectives.

Although accepted to be useful in safeguarding Indigenous knowledge, the process of documenting, storing, and reifying Indigenous knowledge in databases is itself a political act. Agrawal [3] has highlighted the tendency to privilege only "useful" knowledge (likely determined by non-Indigenous practitioners), filtered and transformed and subject to validation against (western) scientific standards. This process can denude Indigenous knowledge of much of its meaning, or render it invisible.

Reframing and reconstituting spatial knowledge remains a prerequisite for increased engagement between Indigenous and settler-colonial ontologies. However, Reid and Sieber [55] caution that the universalizing principle of existing ontological approaches can impose a structure that is incapable of representing Indigenous ontologies and therefore pose a threat to respectful representation. In particular, they argue that ontologies make explicit

distinctions between objects, agents, and processes that "discount Indigenous notions of agency of geographic kinds" (p.9).

3.3 Sharing spatial data

Capabilities for sharing and exchanging spatial data constitute another longstanding area of focus for GI scientists. Spatial data or geographic information infrastructures (SDI, GII), for example, concern both the technological and the institutional barriers to spatial data sharing [16].

Indigenous knowledge presents particular challenges to sharing spatial data, including: increasing digitization of indigenous knowledge, leading to loss of control of that knowledge by its Traditional Owners; a lack of legal frameworks to protect sacred or secret Indigenous knowledge; and a lack of understanding or processes for protecting copyright of Indigenous knowledge documented as part of native titling or heritage processes [64].

In keeping with the UNDRIP framework, Indigenous Peoples' rights must extend to the collection, ownership, and application of data about them, their places, and their culture [33]. As such, *Indigenous data sovereignty* (IDS) seeks to ensure that the data governance rights of Indigenous nations are protected regardless of where the data is held [53]. Improving support for Indigenous data sovereignty is a key area for future research in connection with spatial data sharing, and potentially one of the most vital for responsible GI science.

Initiatives such as FAIR (findable, accessible, interoperable and reusable) point in this direction. FAIR is a global framework for supporting knowledge discovery, data integration, sharing, and reuse of data [1]. However, FAIR only emphasizes the technical aspects of data and ignores the power and politics that underpin production, use, and management of data, especially significant for Indigenous knowledge. In response, Indigenous Peoples have led in the development of the CARE principle for Indigenous data governance: collective benefit, authority to control, responsibility, and ethics [2]. This is intended to complement the FAIR principle and ensure that the move towards making data more open and accessible engages more responsibly and ethically with Indigenous Peoples.

3.4 Location-awareness

Advances in technology over recent decades have opened up many new possibilities for adapting computing processes to a user's specific context. A user's location is one of the most important elements of that context. For example, location-based services are a major area of study with its own journals and conferences [54]. The related areas of decentralized systems and geosensor networks similarly are connected with computing in a location, with that location integral to the computational process itself [18].

The idea of computing dependent on location is also congruent with the concept of "two-eyed seeing". In classical GIS analyses, we expect everyone submitting the same query to the system to receive the same answer. In contrast, location-awareness implies we expect different people in different locations to get different answers to the same queries.

It must again be underlined, however, that augmenting established GI science research areas with Indigenous perspectives is always accompanied by the danger of exploitation.

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[1]https://www.go-fair.org/fair-principles/
[2]https://www.gida-global.org/care

This danger is especially apparent in the case of location-awareness. Along with location-awareness comes the potential for increased surveillance and privacy infringements, for example in revealing the location of culturally sensitive sites.

4   Next steps

The four areas surveyed in the previous section have been selected as initial examples of promising areas for convergence of concepts from spatial information science and Indigeneity. In discourses on Indigeneity, four themes tend to recur: heterogeneity, dynamism, relationality, and self-determination [17, 30, 31, 44]. It is already possible to envision how the four research topics surveyed in the previous section can support and be in service to Indigenous Peoples. For example, work on ontology and uncertainty, can be linked directly to discourses on dynamism, heterogeneity, and a plurality of perspectives. Location-awareness can be seen as an instance of computing in relation to place. Work in spatial data sharing and Indigenous data sovereignty relate directly to self-determination for Indigenous Peoples.

We stress though, that these are provided as contemporary entry points into what is a longstanding campaign and there are myriad productive examples that can be drawn from other disciplines with a history of developing effective and ethical methodologies of engagement with Indigeneity (e.g., sociolinguists), as well as from in countries where governments provide leading examples of negotiating the consequences of treaty with First Peoples (e.g., New Zealand).

In all cases, changes to practice in GI science to be more inclusive of Indigeneity are essential to reconciliation [29]. This is practical and methodological, but is essentially predicated on a conscious shift in how we position ourselves: the fundamental principle of engaging when there is free, prior, and informed consent underscores the centrality of Indigenous Peoples as knowledge owners, and GI science researchers as co-producers or service providers. Realizing the vision outlined here as action is about rethinking technologies and how we use them, and rethinking approaches in conduct and engagement. These should be seen as important drivers of, not constraints to, future research and innovation in the field.

Acknowledgments

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