



All Strings Attached: Negotiating Relationships of Geographic Information Science

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Abstract

Human geography has driven substantive improvements in methodologies and applications of Geographic Information Systems (GISs), yet Indigenous groups continue to experience erasure in geographic representations. GIS ontologies comprise categorised labels that represent lived contexts, and these ontologies are determined through the shared worldviews of those labelling spatial phenomena for entry into GIS databases. Although Western ontologies and spatial representations reflect Western understandings of human experience, they are often inappropriate in Indigenous contexts. In efforts to be represented in courts and land management, Indigenous groups nevertheless need to engage Western spatial representations to ‘claim space’. This paper examines what GISs are and do and shows that GIS technology comes with strings attached to the myriad social contexts that continue to shape the field of GIScience. We show that Intellectual Property Rights Agreements can sever and control these ‘strings’; the agreement between the Yorta Yorta Nation Aboriginal Corporation and university researchers reframes GIS from a technology of erasure to a technology of opportunity that enables Indigenous groups to define their own engagement. The visual and narrative outputs will contribute important understandings of the environmental crisis facing the Murray–Darling Basin and connect older and younger generations through knowledge sharing. We conclude the application of GIScience is never simply technological but always has potential to empower particular communities. Applying GIS technology to new circumstances is an engagement of new relationships in the social praxis of technology transfer, where worldviews meet and negotiations are made over what exists and how we know.

KEY WORDS *GIS; Indigenous; ontology; Yorta Yorta; intellectual property*

We must acknowledge that [Ontologies] are not just cultural constructions and accept instead that they may be actually (as well as metaphorically) valid.

– Paul Nadasdy

Introduction

Since Geographic Information Systems (GISs) were developed through aerospace engineering, computing, and weapons industries in the 1960s and 1970s (Palmer and Rundstrom, 2012), their

history has been examined from many perspectives in human geography (Pickles, 1995; 2004; Harley, 2002; Wood, 2010). Documenting change in the technology and its use, scholars have described how GIS have successfully ‘created space’ for Indigenous (Sparke, 1995; 1998; Pearce, 2008; 2009; Pearce and Louis, 2008), feminist (Schuurman and Pratt, 2002; Kwan, 2007), queer (Brown and Knopp, 2008), and other ‘hidden’ geographies (see, e.g. Pickles, 2004; Sheppard, 2005; Wood, 2010). Despite these substantial advancements, Palmer and Rundstrom (2012) and Alessa *et al.* (2011) highlight that while there is potential for GIS to provide appropriate and powerful representations of Indigenous space and place, there are serious concerns for how GIS projects link with broader issues of Indigenous representation. Bryan (2011, 40) cautions that ‘questions of what to map and how to go about doing it are (...) never merely technical concerns’, but ‘are diagnostic of broader relations of power’, where Indigenous perspectives are frequently marginalised. Resultantly, Alessa *et al.* (2011) foresee changes in methodologies and in the software itself to better engage Indigenous contexts. These concerns are not unique to Indigenous mapping. Crampton (2009, 2) is concerned that the increasing separation of GIS and mapping from geography as a whole reflects ‘the evolution of GIScience as a technology-based subject rather than a geographic methodology’. This paper identifies processes that prevent this convergence, and in doing so offers an exploration of the metaphysical and cognitive bases of mapping through the shared term ‘ontology’.

In metaphysical terms, Ontology (capital ‘O’) refers to the study of the nature of being, and the literature frequently guides students to a perspective that Indigenous worldviews are best conceptualised as distinct from Enlightenment traditions (Smith, 1999; Suchet, 2002; Langton, 2005; Ingold, 2006; Howitt and Suchet-Pearson, 2006b; Pearce, 2009). Broadly speaking, Enlightenment traditions understand the fundamental nature of being as conforming to Linnaean taxonomy, where relationships simply connect what already exists. GIS adopted the word ontology (lower case ‘o’) to refer to the terms used to categorise a dataset when creating spatial representations through software application (Agarwal, 2005). Agarwal (2005) describes Ontology as a ‘supremely abstract term’, yet Ontology can also be understood as irreducibly practical, relational, and physical. Many

relational worldviews understand the nature of being cannot be reduced to universal categories but remains emergent through dynamic, practical, and shifting relationships (Christie, 1994; Ingold, 2006; Howitt and Suchet-Pearson, 2006b; Suchet-Pearson *et al.*, 2013); there is no ‘ultimate’ reality. Yet it is important to note that while relational Ontology signifies that there is no fundamental reality shared by *all*, there are realities shared by *some*. Haraway (1988) warns that the twin of totalising is relativising and that the postmodernist trap renders everything (and therefore nothing) important. A relational Ontology does not value everything equally, nor does it signal that categorical descriptions are always inappropriate; it is claims of their spatial and temporal universality that is problematic.

There is currently an ‘unprecedented questioning of (...) Ontological assumptions’ in a wide range of disciplines (Slife, 2004, 158). Slife (2004) understands theory and abstraction are Ontologically secondary to actual and physical practice, and he argues such a shift in perception will produce better outcomes for individuals and their social context. His call for ‘taking practice seriously’ in psychology finds company in GIS (Del Casino and Hanna, 2006; Schuurman and Leszczynski, 2006), Indigenous research (Smith, 1999; Howitt and Suchet-Pearson, 2006a), sociology (Law, 2004), feminist literature (Haraway, 1988), anthropology (Bordieu, 1980; Ingold, 2006), policy science (Lasswell, 1971; Clark, 2002), and numerous other fields and disciplines that place emphasis on dynamics and change.

This paper explores perspectives on what GIS are and what they *do*. We first discuss how participatory and community-based mapping are framed, and then consider how mapping can empower communities. We then explore how worldviews are presented in GIS ontologies and make an argument for mapping as a relational *praxis*. Finally, we present the rationale for developing an Intellectual Property Rights Agreement (IPRA) to manage relationships between researchers and the Yorta Yorta Nation Aboriginal Corporation (YYNAC) in Australia, over the development of a GIS of Indigenous knowledge. We conclude that GIScience is a fundamentally relational praxis that always expresses particular worldviews through its immersion in social relationships.

Doing GIS

In *Seeing Like a State*, Scott (1998, 4) constructs the relevant past to account for

Enlightenment mapping as a servant to the state and finds that ‘much of early modern European statecraft seemed (. . .) devoted to rationalizing and standardizing what was a social hieroglyph into a legible and administratively more convenient format’. This interest ignored non-revenue uses of the forest by people on the ground, such as ‘foliage [for] fodder and thatch; fruits, as food for people and domestic animals; twigs and branches, as bedding, hop poles, and kindling; bark and roots, for making medicine and tanning; sap, for making resins; and so forth’ (Scott, 1998, 12). German state interest led to precise measurements of trees in representative plots in a grid, and eventually to elaborate tables organised by the size and age of trees under specified conditions. ‘By radically narrowing his vision to commercial wood, the state forester had, with his tables, paradoxically achieved a synoptic view of the entire forest. This restriction of focus reflected in tables was in fact the only way in which the whole forest could be taken in by a single optic’ (Scott, 1998, 15).

However, the aspirations of scientific forestry were thwarted by variations in topography and natural contingencies – ‘fires, storms, blights, climatic changes, insect populations and diseases’ (Scott, 1998, 19) – and by humans living nearby who depended on the forest. ‘Like all utopian schemes, it fell well short of attaining its goal; the critical fact was that it did partly succeed in stamping the actual forest with the imprint of its designs’ (Scott, 1998, 19).

Scott describes the early imprints of Enlightenment land management planning, where scientific and industrial purposes marginalise considerations for subsistence activities and the natural variability of ecosystems. As a current example of such planning, Walker *et al.* (2013) show the Canadian Institute of Planners’ (2014) definition of planning as ‘the scientific, aesthetic, and orderly disposition of land, resources, facilities and services with a view to securing the physical, economic and social efficiency, health and well-being of urban and rural communities’. The Planning Institute Australia (2009, 1) similarly defines planning as ‘the best way to manage urban growth, secure necessary infrastructure investment, determine appropriate settlement patterns for our cities and towns, to generate economic development that contributes positively to the wellbeing of individuals and communities, and the natural and built environments on which we rely’. Walker *et al.* (2013)

contrasts such planning paradigms with the emerging field of Indigenous planning, where ‘planning represents both an approach to community planning and an ideological movement (. . .) in a manner that incorporates “traditional” knowledge and cultural identity’ (Jojola, 2008, 1).

Mapping is key to having a voice in planning, and cartographic practice is therefore an important site where marginalised communities fight for recognition. Critiques of cartographic practice are variously directed at masculine (Kwan, 2002), Western/colonial (Sparke, 1998; Pearce, 2009), heterosexual (Brown and Knopp, 2008), conventional (Elwood and Ghose, 2001), or other practices, depending on the perspectives of the researchers, practitioners and other stakeholders in question. For instance, Kwan (2002) critiques GIS as an originally masculinist enterprise that has silenced feminist views and presents key literature that has reformed parts of GIS to better engage with non-masculinist spatial practice. Crawhall (2007) describes GIS as a Western cartographic practice that spread through colonial mercantile interests, where local, Indigenous place names were replaced into ‘a system that was convenient to the dominant culture’ (Crawhall, 2007, 3). Efforts to counteract such erasure often invoke ‘participatory’ and ‘community-based’ mapping, but critics argue these are often simply window dressing exercises that veil business as usual (e.g. Alessa *et al.*, 2011; Palmer and Rundstrom, 2012). Lorde (2003, 1) cautions, ‘the master’s tools’ ‘may allow us temporarily to beat him at his own game, but they will never enable us to bring about genuine change’, arguing that it is ‘an old and primary tool of all oppressors to keep the oppressed occupied with the master’s concerns’. In order to escape, and influence, colonial concerns, Smith (1999) and other Indigenous scholars nurture knowledge from within Indigenous traditions, explicitly, and as far as possible, without reference to colonial traditions. Alessa *et al.* (2011, 245) ask,

What would a system based on Indigenous spatial realities, practices, protocols, and presentations look like? From the zenith of the sky to the core of the earth. From the potential being through the long and everlasting night into the world of light. From the morning star and the breath of life through the passion of the warm southern winds, through to the dark home of the thunders into the long night of

wisdom. In the center dwells the everlasting spark of spirit that animates our being.

In order to ensure mapping better accounts for local perceptions of space in Hawai'i, Pearce and Louis (2008) show that the map needs to include diurnal and tidal variations and an oblique view from the sea. Stoffle *et al.* (2008) show problems inherent in protecting secret and sacred sites in mapping high-use hiking areas. Pearce (2009) illustrates inherent difference from Western mapping and argues processual mapping is a uniquely non-Western practice, giving examples such as a radiating coordinate system, scale and direction shift, multiple perspectives, mirroring, and incorporation of temporality, and the inclusion of spiritual and other relational elements into the map. With such critiques in mind, ESRI, the creators of ArcGIS (a major mapping software developer) initiated a separate field of training and resources for Indigenous research. They offer conference support, provide free software and training through the Bureau of Indian Affairs, and support tribal GIS groups and papers, and Indigenous and Aboriginal mapping networks (Esri, 2007). Yet limitations remain significant. Palmer and Rundstrom (2012) show that participatory GIS in the Bureau of Indian Affairs has failed to follow the anticipated trajectories of self-improvement, and they argue that land-use mapping has always been embedded in colonial practices that favour non-Indigenous interests in natural resource development.

Empowering communities

Insights from Land Use and Occupancy Mapping and counter-mapping illustrate how participatory mapping is implicated in negotiations over power. Land Use and Occupancy Mapping follows on a tradition of engagement between Indigenous communities and researchers in which maps and map-making tools have been used to document Indigenous knowledge and land use patterns in order to protect Indigenous rights in the context of land claims processes. Tobias (2009, 11) warns, 'a good GIS technician can take any map dataset, good or bad, and make it look impressive.' He shows that 'good' GIS relies on 'good' groundwork and presents how the Inuit Tapiriit Kanatami (Canada's national Inuit organisation) Land Use and Occupancy Mapping has shifted the power in Inuit claims to restore self-government and sovereignty. Tobias (2009, 11) says Land Use and Occupancy Mapping 'is about making sure the dataset is

impressive, before GIS people even get their hands on it'. In Canada in the 1970s, for example, map biographies (Tobias, 2009) were used to document the extent of individual Inuit hunters' use of lands for hunting and travel (Usher, 2003). These were compiled through the Inuit Land Use and Occupancy Project (Freeman, 1976) and its successor initiative, the Nunavut Atlas Project. The latter, also based on map biographies, formed the basis of the Nunavut Land Claims Act of 1992, the largest land claim in Canada. This claim led to the establishment of Nunavut Territory in 1999, a vast region comprising nearly a fifth of Canada's land mass. The point here is that maps are powerful legal tools (Wood, 2010) that can be used to engage with the political processes that support colonial or decolonising goals.

Depending on how the mapping exercise engages with the social process of technology application, the outcome can serve colonial or decolonising goals. Peluso (1995, 384) introduced counter-mapping 'to appropriate the state's *techniques* and *manner of representation* to bolster the legitimacy of "customary" claims to resources', and her publication led to a burgeoning of counter-mapping exercises. For the Maasai, counter-mapping was a two-edged sword that simultaneously enabled staking claim to areas bounded by agricultural, conservation, and other bordering land use zones but that in doing so temporally fixed nomadic and shifting land use (Hodgson and Schroeder, 2002). If the Maasai did not map themselves in this way, someone else would map them out. It is apparent that the emancipatory intentions of many critical approaches to spatial representation remain bounded within the realpolitik of political ecology and can never be an isolated and unpoliticised enterprise.

O'Sullivan (2008, 783) writes that it is unlikely 'that the numerous GIS users in commerce and government are paying very much attention to' human geography insights on GIS. He joins Kwan (2007), Rambaldi *et al.* (2006), Crampton (2009), and Palmer and Rundstrom (2012) in saying the insights from participatory GIS and cultural mapping have not contributed to change perception of GIS as a purely technological tool. A central limiting factor for such change is the conceit that there is a kind of GIS that is participatory, community-based, local, and specific, whereas there is another that is technological and universal. All mapping projects can be said to be participative and community based and

to empower communities. The question is which communities benefit – the scientific communities, local communities, the business communities, the military communities, the international communities, or other social groups that can be given the same label; as Lasswell (1971) says, ‘Who gets what, when and how?’ In this way, it is problematic that participatory mapping (and practice) is seen as a special kind of mapping process, rather than as a general description of all GIS (and indeed of any scientific endeavour). At any level, GIScience variously involves the participation of GIS practitioners who know the software; of researchers, lawyers, business and governments developing questions and setting about answering them with GIS tools; of decision-makers drawing knowledge from the maps generated; of media reporting on developments; and so on. By the same token, scientific work is evaluated and edited by journals and granting bodies where the peer groups span military researchers, critical geographers, Indigenous researchers, political scientists, economists, medical researchers, or development specialists. The endeavour of creating and improving GIS is essentially a participatory practice drawing from a cohort of intellectual domains. The lack of change driven by participatory GIS can be seen as the inertia of existing intellectual relationships. This inertia relates to differences in worldview, and the following discussion explores the significance this has for the development of GIS ontologies.

The world as GIS ontology

Making sense of the world around us is a characteristically human endeavour. Many Aboriginal Australian worldviews have been described as belonging to a relational Ontology, where reality is conceived as a constantly creative process and where people, places, animals, and other entities are always in the process of *becoming* (Christie, 1994; Rose, 1996; Howitt and Suchet-Pearson, 2006b; Suchet-Pearson *et al.*, 2013). People, animals, Dreamings, landscapes, seascapes, spirits, weather, and other entities are ‘living’ in the sense that they have agency to interact, overlap, and subsume each other. Christie (1994) describes such worldviews as ‘ex-centric’, where there is no recognised centre (e.g. people) around which relations gravitate. Knowledge about the nature of being is accessed through story-telling, dance, ceremonies, hunting, and other rituals, where the goal is to account for context as it emerges through

extant relationships (Christie, 1994). Applying representational labels on phenomena can prove problematic in these contexts, where abstractions such as names may not be recognised as Ontic but situated as more ephemeral expressions emerging through narrative process (Verran, 2004).

Nevertheless, GIScientists engage in developing a basic formal ontology that will facilitate correlation across datasets (e.g. Smith and Grenon, 2004). Smith (2012, 1) explains that basic formal ontology is ‘concerned only with what exists (which means in practice: only with those sorts of entities for which we have good – for example empirical-scientific reason to believe that they exist)’. These categories would be universal across all settings, and Agarwal (2005) gives three expressions of formal ontology, all of which follow dualist and atomist perspectives: (i) Universals and Particulars (used in Basic Formal Ontology GIS), (ii) Endurant–Perdurant (used in SNAP-SPAN GIS), and (iii) Independent-Dependent. SNAP-SPAN, Agarwal (2005) explains, parallels the *endurant–perdurant* perspective on metaphysical Ontology, where *endurants* (SNAP) such as chairs, people, spatial regions, niches, and environments are contrasted with *perdurants* (SPAN) such as actions, social and physical change, and events (Grenon and Smith, 2004). Agarwal (2005, 507) holds that ‘a “nation” is an *endurant* while its “history” is the *perdurant*’, and that a similar relationship exists between ‘ocean’ and ‘tide’, and ‘population’ and ‘migration’. Smith and Grenon (2004) argue that while *perdurants* (SPAN) and *endurants* (SNAP) are hard to pin down, formal ontologies can be made of terms that connect the two, and they give numerous suggestions (e.g. Genidentity, transgranular part–whole relations, segmentation, participation, perpetration, and initiation). These are nevertheless labels given to processes, units, and links that make sense from a Western perspective but whose precise meaning can be problematic in different linguistic or Ontological settings.

Smith and Grenon’s (2004) caution with identifying formal ontology SNAP and SPAN categories is justified in the context of mapping Indigenous space in Australia. Muller (2008) problematises *endurant* categories when she explains that Aboriginal worldviews in the Northern Territory of Australia do not separate land and sea (Allen, 1994; Jackson *et al.*, 2005; Muller, 2008). This observation eluded all 12 anthropologists who worked in Arnhem Land

communities in the Northern Territory between 1921 and 1977 (Peterson and Arthur, 2005), with practical implications for the *Aboriginal Land Rights (Northern Territory) Act of 1976*, which defined property boundaries along the high water mark. Following the Blue Mud Bay ruling in 2008, the Land Rights Act now includes the area down to the low tide mark – with important financial and cultural benefits for Aboriginal landholders along the coastline of Australia's Northern Territory. Similarly, Verran's (2004) example of Aboriginal Australian storytelling shows temporally fixing elements as endurants was inappropriate. Furthermore, spirits are active policy participants from many Indigenous (and many non-Indigenous) perspectives. In this way, the expression of an atomist/abstractionist nature of being, such as through an endurant (SNAP), perdurant (SPAN), or Smith's (2012) definition of basic formal ontology, can have the effect of erasing important Ontic expressions.

Mapping as processual praxis

Indigenous mapping is often framed as a unique and fundamentally different kind of exercise where animist worldviews are represented through processual mapping. Yet it is important to recognise that ontological categories are relational also in conventional or Western GIS and to recognise that abstraction is present in relational worldviews (all speech and writing require abstraction, for instance). There is a risk of presenting Western knowledge as hagiography, where its central tenets of abstractionism and atomism are situated as untouchable and oppositional to relational worldviews and where the relational nature of GIScience is resultantly rendered invisible. From the perspective of symbolic representation, Kant's *noumena*¹ parallel Indigenous perspectives in important ways. Where many Indigenous worldviews hold that spirits and spiritual acts can only be perceived or performed by special individuals who have been appropriately trained and initiated, the Enlightenment tradition holds that facts can only be discovered through objective and abstracted understanding of context-free observations. The question begs whether spirits or abstracted knowledge are different in a phenomenological perspective, as both require processes of initiation and training in order to access privileged knowledge that permits perception of phenomena that are unobservable to others. From this perspective, Enlightenment science emerges as a relational practice where practitioners are privy

to a particular processual knowledge through initiation. The importance here is the degree to which any ontological category is acceptably 'real' to outsiders when participants invoke them as important. It is problematic to claim the universality of symbolic representations.

These insights show mapping as an inherently processual and cultural undertaking. The creation of the Universal Transverse Mercator (UTM) coordinates to force a two-dimensional structure on a globe represents an equally socially constructed map as what a radial coordinate system, mirroring or temporal incorporation might constitute. 'Dance and chant, the incorporation of the landscape into the map' (Pearce, 2009, 375) correlate with research proposals, peer-reviewed publications, public presentations, and procedures of data collection, programming and presentation, forming the social process that results in conventional Western mapping. As Pearce and Louis (2008) observe, UTM map projections present a view from 'no-where', outside lived space and time, and thereby represent a particular worldview where the world is an expression of abstracted knowledge. Aboriginal Australian 'everywhen' (Stanner, 1969) might correspondingly be seen to constitute the world as inextricably implicated in all time and space.

Effective orientation to the complexities and diversity of individual perspective (in epistemic and Ontological terms) requires a sufficiently stable frame and language for discourse that provides adequate comprehensivity and range (Mattson and Clark, 2011). Bateson (1972) argues that the usefulness of a map is not necessarily a matter of its literal truthfulness but of its having a structure analogous, for the purpose at hand, to the territory. A perceived absence of noumena has considerable consequences for cross-cultural engagement in GIS; participants may not agree there is an objective reality we can depend on to define endurants, notwithstanding enduring engagement, such that the mapping is never 'done'. In defining ontological categories, the terms used may or may not translate well the etymology of local names for landforms and processes, and local languages may not lend well to, e.g. English grammar or the Roman alphabet. Reducing stories and trails to points, lines, and individual names on maps may be inappropriate.

Widlok (1997, 324) argues that knowledge of location is 'in most cases (. . .) a matter, not primarily of getting somewhere [spatially] but of getting somewhere socially, in that one attempts

to meet a certain person, to collect a certain fruit, or do a certain job'. In urban studies, Lynch's (1960) seminal *The Image of the City* stresses that '[e]very citizen has had long associations with some part of his city, and his image is soaked in memories and meanings' (Lynch, 1960, 1) and that 'the need to recognize and pattern our surroundings is so crucial, and has such long roots in the past, that this image has wide practical and emotional importance to the individual (Lynch, 1960, 4). Lynch (1960) explains that there is comfort and security in knowing one's surroundings but that there can also be value in getting lost and surprised. The one caveat he gives is that 'there must be no danger of losing basic form or orientation, of never coming out' (Lynch, 1960, 6). Spatial representation is crucial for orienting ourselves in new surroundings, and these representations are always tied to experience. It is important to be aware that people, places, and other elements do get lost in these representations, unable to locate themselves, or to be located, thereby becoming marginalised or ignored in decision processes. The de-location of Aboriginal Australians through the *Terra Nullius* doctrine is a case in point, as is the de-location of researchers, business, the military, and policymakers in GIScience, where invoking 'participation' and 'community' as particular kinds of GIS belies blindness to the communities and participants that are already engaged and influential in the mapping exercise. Participants have become lost in a spatial representation that has rendered important processes invisible.

Howitt and Suchet-Pearson (2006b) approach the problem of consensual Ontology by speaking of Ontological pluralism, which may also be useful in GIScience. Agarwal (2005, 502) says that 'there is no comprehensive ontology for the geo-spatial domain, and it is recognized that there are no definitive methods for ontology derivation available to the geographic community', which is echoed by Herre (2010, 298) saying, 'one may doubt whether a final and uniquely determined top level ontology can ever be achieved'. A particular human experience and way of knowing may be 'real', but there is no global consensus, which drives (Howitt, 2011) to call for a 'radical contextualist' approach, and (Jackson, 1989) to call for 'radical participation' in fieldwork. The aim being not to relativise but to work through 'situated engagement' (Suchet, 2002) that is cognisant of the procedural vulnerabilities (Veland *et al.*, 2013) inherent in research

and policy as we work from implicit assumptions about what is real and important. GIS ontology and relational Ontology in this way importantly share the premise that there is no 'ultimate truth' that can be described, only representations, engagements, and creations of realities, revealed through geographic information praxis.

Practising geographic information science in Yorta Yorta Country

In Australia, the court process for Native Title claims relies on documentary evidence to establish proof of historical and continuing cultural ties to place, and GIS is one of 'the master's tools' that need to be employed in order to present claims in a way that is understandable to the courts. As a purely technical tool, GIS may not be very different from other forms of spatial representation, such as painting or photography, but its presence in Indigenous contexts is relatively new and remains strongly attached to non-Indigenous institutions. A significant impetus to engage with GIS, despite the potential costs, comes through the legal context of having land rights and sovereignty recognised by colonial governments. In these processes, the 'hidden' strings that connect technology with social context are revealed as GIS lends itself better to the legal and practical domains of colonial governance than do traditional narration of space and place through traditional mapping practices (e.g. painting, singing, walking, or Dreaming Country).

The Yorta Yorta people have learned, through bitter experience, the tendency of non-Indigenous partners to misconstrue the meaning of Indigeneity. Through at least 18 separate claims to land and compensation between 1860 and 1994 (Lynch *et al.*, 2013), the Nation has engaged with the judicial system to claim their history and continuing presence. These court hearings culminated in Federal Court Justice Olney's 1998 decision that 'the tide of history' had washed away their traditional laws and customs. Appeals to the High and Federal Courts in 2001 and 2002, respectively, on the basis that the Courts understood Indigeneity as 'frozen in the past', have failed (Strelein, 2009).

Their claim might have had more traction in a more remote part of Australia. The life source and the spirit of the Yorta Yorta people lie in the Murray–Darling Basin, which is central to an agricultural industry worth more than AU\$9 billion per year. Going some way towards recognising the presence of the Yorta Yorta Nation, the

Victorian Government Premier in 2004 signed a co-management agreement covering public lands, lakes, and rivers, which permits some input in decision making over traditional lands. Moreover, there is need for novel perspectives on decision making. The basin suffers critical loss of biodiversity and crops through droughts, floods, and salinisation. Lynch *et al.* (2013, 115) argue, 'claims for "business as usual" in the agriculture sector, and particularly with regard to irrigation, can no longer be supported as appropriate, or even valid'. Work such as that by Weir (2009; 2012) and Wilcock *et al.* (2013) attempt new ways of understanding processes of change in the Murray–Darling by drawing on Indigenous knowledge, critical scholarship, engineering, and ecology.

A determination to 'see with both eyes' (*Nhawul Bultjubul Ma* in Yorta Yorta language) was the impetus for the YYNAC to partner with university researchers to create a GIS containing their ancestral knowledge. The collaboration involves partners formerly from Monash University, and currently at Brown University, with interest and expertise in Indigenous GIS and Intellectual Property Rights. At the time of meeting with Monash University, a Yorta Yorta Climate Change Committee had been in operation for 12 months, and the YYNAC asked for an introduction to the 'science world' for assistance. Kate Auty, Commissioner for Environmental Sustainability in the state of Victoria, a former barrister and magistrate, and long time collaborator and friend of the Yorta Yorta, acted as an intermediary in this process. In 2008, a Use and Occupancy mapping was completed by YYNAC, but they felt further information from themselves was required, and the role of technology and culture had to be developed. Through the Elders Council, it was then discussed, 'How do we use the tools that are used against us or strip away our rights' to empower us. The GIS collaboration presented in this paper then developed after Monash University researchers, including A. Lynch, were approached by Yorta Yorta representatives, including L. Joachim and Damian Morgan-Bulled. The group met at intervals over a period of time, exploring ways that they might work together, which evolved to become a successful project proposal.

It is hoped that the resulting GIS may prove a valuable means of conveying Yorta Yorta values, perspectives, and practices in a manner that can better engage water managers in finding common goals, and in this way achieve sustainability in

the river basin. The Nation has, through its history of erasure by colonial interests, found that conceptual maps of Yorta Yorta space take on a life of their own once in the public sphere, such as Justice Olney's interpretation of Yorta Yorta ancestry in the Murray–Darling Basin. Critical to their engagement with GIS has therefore been to first spend time working with and adapting the technology, finding how best to create ontologies of semantics, symbols, data points, and relational terms in a way that works with Yorta Yorta perspectives and values. The Nation and their partners will then have powerful narratives with which to introduce their spatial representations, and with these, be able to meet and discuss alternative understandings of the Murray–Darling Basin as the Nation's GIS-generated maps enter the public domain. Achieving an IPRA and a GIS Protocol to manage relationships were therefore key outcomes of the collaboration between the YYNAC and university partners.

Approaching Yorta Yorta knowledge through GIS technology is also a way of strengthening relationships between older and younger generations of Yorta Yorta people. Weir (2009) writes that young people no longer go to the old meeting places along the river in South Australia to go fishing and hunting, and so are not socialised into the 'river life and the life of country'. The Elders, she says, remember the river flowing clear and have seen the devastation happen. They see an urgent task to pass on the knowledge of the life of the river to the younger generations before it is too late, and the memory of the 'old' river is gone. Yorta Yorta woman Monica Morgan shows the sense of responsibility and care that urges the Elders to also teach non-Indigenous Australians about respect for the variability and flow of the river before it is too late (Weir, 2009, 148):

Who else is going to give them the knowledge about protecting country, but those traditional owners who have understood and lived with their country and passed it from generation to generation? Then they're all going to lose, and we're going to lose along with those people.

This notion of a shared fate is central to current moves to communicate across Indigenous, irrigator, tourism, government, and other interests to solve the environmental crisis in the Murray–Darling Basin (Murray Darling Basin Authority, 2013). Although decision making over water management in the Basin is highly complex, with multiple and often conflicting

perceptions on the role of water, the shared need for novel solutions ensures the policy process continues.

The GIS project involved youth accompanying Elders along trails and to places in Country, recording their stories, Dreaming, and memories. For this purpose, university collaborators trained Yorta Yorta youth in the use of GPS tracking devices and voice and video recorders. These skills provide younger members of the Nation with research and mapping skills that can help their careers. In collaboration with GIS technicians, Yorta Yorta youth then enter these data into a GIS database. In Yorta Yorta tradition, like most other Indigenous Australian cultures, families, clans, and individuals have rights and responsibilities to certain Dreaming, or accounts of knowledge about how they themselves are connected with Country. This also filters through to gender-specific knowledge and practice and rites of passage related to gender and broader families, clans, and overall Nation. These stories are inherited through birth and initiation ceremonies and cannot be told, or often even known about, by others. When using GIS, therefore, password-protected layers for each member are necessary. These layers are created in collaboration between the GIS technician, and a youth participant who has a voice recording and GPS coordinates that have been collected with Elders on Country. These layers are then visible in the GIS, but in order to view the associated knowledge, the program will ask for a password. This GIS is still in development, and the Yorta Yorta people are in the process of making decisions about how such passwords and access to GIS layers of knowledge fits within practices of initiation as new generations of Yorta Yorta Elders become custodians of ancestral knowledge.

Developing an IPRA

Striving to set clear rules for the relationships that came with the GIS project, the collaborators developed a clear framework of principles for how the technology, technicians, researchers, and even the Internet, were to engage with Yorta Yorta knowledge and practices before data collection commenced – setting the limits for whom the participants in knowledge production about Yorta Yorta country can be. The GIS Protocol (YYNAC, 2012a) specifies principles for developing the GIS framework, and details how the knowledge, data, and images that are collected or accessed as part of this project will be stored, protected, and presented under the custodianship

of YYNAC. The full protocol, the contents, management strategy, and access control of the database were designed through discussion with the YYNAC (YYNAC 2012b). This Protocol includes the following key principles:

The collection of Yorta Yorta traditional knowledge is a priority within this framework, and continual maintenance is a cultural protocol and a digital form of security.

1. YYNAC is to be consulted on the GIS database at all stages of planning, design, and development.
2. The ownership and copyright of cultural data and Indigenous knowledge contained in the GIS database is always held by the Yorta Yorta person from whom it was collected.
3. The right of Yorta Yorta people to keep secret and sacred their cultural knowledge will be respected.
4. YYNAC has the right to determine the contents of the GIS database, the accessibility to the database, and the way in which the data and information are to be accessed, presented, and delivered.
5. YYNAC has the right to control exploitation of their cultural and intellectual property contained in the GIS database.
6. An approval process and intellectual property agreement with YYNAC will be implemented for the use of the GIS database.

An IPRA clarifies what the technology is, and is not, and in this way ensures users, decision makers, and researchers have realistic expectations of what the software can help achieve. Yorta Yorta man Lee Joachim summarises his engagement with GIS:

IPRA is our right to ensure the ‘unheard’ are not interpreted in a disrespectful, siloed manner, which is what Western theory does. The Yorta Yorta belief system is vested on an understanding that we are the earth and the earth is we. People exist in the world in a kind of environmental socialism where all are equal and related in irreducible and reciprocal ways. Bundil created the Yorta Yorta, and the people have Bundjil, with an ability to speak with Country through environmental language.

By engaging with GIS, the Yorta Yorta will contribute visual representations and narratives that contribute important understandings of the environmental crisis facing the Murray–Darling Basin and connect older and younger generations

through knowledge sharing. The careful engagement with GIS through an IPRA will ensure the knowledge produced is just to the lives the geographic database represents.

Concluding comments: towards a geographic Information Praxis

This paper argues that GIScience is always participatory and relational – not just in Indigenous contexts. Nadasdy's (2007) challenging premise is that any particular experience of what the world constitutes – the categories, labels, and symbols used – may be Ontic. The problem is therefore not that categorising knowledge into GIS ontologies, through, e.g. *endurant–perdurant* or other, 'should not' be used. Rather, the issue is to be cognisant of the relationships that are engaged as ontic categories are encoded, and whether the knowledge they produce is just to the lives they engage. Alessa *et al.* (2011) say Indigenous GIS will mature through careful place-based engagement in GIS. This place-based engagement is akin to that envisioned by Schuurman and Leszczynski (2006) in their paper on *Ontology-Based Metadata*. Their common concern is 'taking practice seriously' (cf. Slife, 2004).

GIS has been critiqued for its limited potential because it de-emphasises or ignores concepts that are of central importance to Indigenous cultures, including the ubiquity of relatedness, the value of non-empirical experience, the need to control access to levels of geographical knowledge, and the value of ambiguity (Fox, 1995; Rundstrom, 1995). Like Chambers *et al.* (2004), we suggest that these limitations may be more apparent than real and that indeed GIS and other geospatial technologies can be developed that are respectful of culture, social systems, and traditional methods of transmitting Indigenous knowledge. However, the incorporation of Indigenous knowledge in modern geospatial technologies must be predicated on the outcomes of deliberations by Indigenous peoples themselves, in order to address important issues such as rights and access, fluidity, and boundary (Laituri, 2002). This is particularly important in the case of Indigenous Australian cultures that have strict demarcations around knowledge access. This paper shows that the need for a formalised restriction of knowledge access in the creation of GIS relates to the inherently participatory and relational nature of all mapping.

Participation in social relationships in the engagement of GIS is inevitable; be it through

peer review, focus groups, court rooms, board meetings, or others. Invoking the terms participatory or community based may give the impression that there is a kind of GIS that is *not* participatory. There is benefit in rather asking questions about what kinds of participation GIScience is engaged in; who represents what, when, and how. The significance of this is to recognise the science and technology of GIS as a practical exercise that comes with strings attached to myriad social relationships, with important consequences for effective knowledge integration and decision making. Pretending otherwise will continue to create situations where GIS is presented as an objective and 'global' tool, whereas those mapped are rendered invisible and marginalised. As the literature widely argues, this is neither a productive nor a just use of an excellent mapping resource.

It is time to stop being caught up in determining whether or not GIS emerged from a particular culture, and instead ask how science and technology travel (Anderson, 2002). GIS comes with strings attached to myriad contexts that continue to contribute to the current state of the art of the technology and its applications. Researchers, courts, business, governments, military, local communities, lobby groups, etc. make up the intellectual heritage and peer group for GIS research and applications, such that the technology and methodologies are irreducibly linked and influential in any application of GIS. The significance of this observation is that GIS can never be assumed to be an objective tool whose application in specific circumstances is simply technological. IPRA's are important tools to make the social relationships explicit, so that these relationships can be navigated carefully as worldviews meet and negotiations are made over what exists and how we know.

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NOTE

1. Kant divided the world into phenomena observable to all, and noumena, which could only be observed through dispassionate and objective analysis.

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