

Number as an Inventive Frontier in Knowing and Working Australia's Water Resources

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Abstract: Taking number as material and semiotic this paper considers the enumeration of Australia's water resources. It proposes that a scientific enumeration utilises the relation one/many while an economic enumeration utilises the relation whole/parts. The tension between these two forms of enumeration can be understood as an inventive frontier in contemporary Australian life.

Introduction

We are used to thinking of numbers used in enumerating the real world as helping us to work relations; our relations with goods through the market, or with nature through science for example. This sort of thinking proposes numbers and mathematical objects more generally, as cognitive tools. Learning to use mathematical tools is taken as one of the most important elements of schooling. In my contribution to this collection considering number as an inventive frontier in social, cultural, political and moral life—as an object of anthropological interest, I take numbers rather differently: as materialised relations.

To understand this move we can imagine it by analogy to the differing senses of people having (kin) relations and being relations. Each of us *has* relations—a mother and a father for example. Also each of us *is* a relation in an embodied sense, the relation between our parents. This sense of a person *being* a relation is both material in the sense of being embodied, and semiotic in the sense of expressing a formal relation—that between husband and wife. Taking numbers as material is to see them as enumerated materiality—as river water of a specified ecological value for example; taking numbers as semiotic is to identify numbers as the formal relation unity/plurality.

Rendering numbers in this way enables a vivid picture of numbers as an inventive frontier. It sees them as particulars, in place and time, *in situ* we might say—materialised; realised in specific practical ways. And significantly from an

anthropological point of view, this way of rendering numbers makes them accessible to ethnography. Indeed I learned to recognise numbers as embodied materiality and semiotically as relations by working ethnographically with Yoruba (West African) and Yolngu (Aboriginal Australian) teachers and their pupils as they struggled to learn and teach how to work with numbers, a response treated more fully by Lave in this collection, which we can understand as reflexively engaging the contrasts I make in this paper (Lave, 2009).

Having numbers as ethnographically accessible in adopting such a material semiotic framing eschews the more extravagant claims about what numbers are that we find for example in Platonist, intuitionist, or instrumentalist accounts of numbers (Verran, 2001: 178). However semiotic is an opaque term, being simultaneously both vague and highly technical, and combining it with material modifies the meanings others attribute to it. Semiotic can be read as summoning up the baroque complexity of French structuralist and post-structuralist thought, and alternatively the specific categorical proposals of Pierce's philosophy and its off spring American Pragmatism. Neither of these discourses is a primary reference in my use of semiotic however. While not repudiating these connections, my approach does not use them in justifying my methods. Having been helped to see some of the insights generally associated with semiotics in the Western tradition of thought by my Yoruba and Yolngu friends, I found the work of the later Wittgenstein more helpful in articulating an account of how numbers are ethnographically accessible (see Verran, 2001:179).

His attack upon the idea of a private language, which brought thought [and number] out of the grotto in the head into the public square where one could look at it once it arrived there—as a set of practices...seem[s] almost custom designed to enable the sort of anthropological studies I, and others of my ilk, do. (Geertz, 2000:xi).

Studying “forms of life’ and ‘language games’ as complex clots of signs and collective actions accepts the paradox of worlds as already/always meaningful, recognising that doing worlds as knowable, whether by science or by trading, or for that matter through Yoruba, or Yolngu knowledge traditions, involves engaging with the world as it is here and now. And in doing this I suggest that ethnographers of numbers can usefully adopt Pierce's typology of the working of signs—as iconic, indexical, or symbolic. Purporting to describe the workings of signs vis-à-vis the

collective actions generating the objects associated with those signs, these categories that are not mutually exclusive (see Hoopes, 1991:239). The terms name degrees of reciprocal co-constitution of signs and collective embodied and embedded actions in which objects come to life. Icons are deeply co-constitutive with clots of collective actions that generate entities, whereas symbols and their objects enact a relation of supervenience, objects are accepted as affecting and effecting their signs but not vice-versa. Iconicity, indexicality and symbolism can be understood as ethnographically found forms of the workings of signs (and depending on how one understands ethnography, these names work as icons, indexes, or symbols!).

In anthropology numbers are for the most part treated ethnographically as symbols (Crump, 1990; Mimica, 1988 for example). Although as Rotman shows for zero, using Pierce's typology they can equally be understood as iconic (Rotman, 1987), and as Mauer explains in his paper in this collection on a hypothetical 'finger counting money' (Mauer, 2009), the numbers of finger counting are most usefully understood as iconic and indexical rather than as symbols. One way to understand what I accomplish in *Science and an African Logic* is showing that while rendering number as symbols can accomplish certain important ends like showing the conceptual equivalence of Yoruba and scientific number and removing the stigma of Yoruba number as primitive, numbers can also be usefully understood as icons, and that doing so we can learn how to connect Yoruba and scientific numbers in practice (Verran, 2001).

In this short paper I begin by telling of a situation in which we can understand numbers as working indexically or symbolically. They are being used to represent the ecological health of Australia's creeks and rivers, lakes and billabongs. With an imperceptible shift such numbers are used iconically to constitute a water market. We see the entity 'Australia's water resources' as a complex multiple and glimpse its *in potentia* moral and political capacities. It appears as capable of duplicity, eliding a public good project with one established to deliver the possibility of private gain. I understand that revealing as a form of ontics.

This is the context in which I explore what happens when we understand enumerated entities as materially expressing formal relations in their generalising capacities. Refusing to restrict numbers' semiotic repertoire to that of symbols allows us to

recognise that in working markets, numbers enact generalising iconically in the whole/parts mode (see Guyer in this collection).

In beginning this paper I proposed an analogy between numbers used in enumerating being taken as materially embodying relations and taking humans as embodying the relation between their parents. We can immediately recognise that saying that I am taking a person as a relation does not provide much information about the person, and that startling as the analogy might seem, we can similarly recognise that saying numbers are a materialised relation, viz. the unity/plurality relation, does not tell us much about numbers. Perhaps the first thing we might say in characterising ourselves is whether we are female or male. Similarly the first thing we need to know about a number is whether it takes is the one/many form or the whole/part form. One way to think about the difference between these relational forms is to characterise one/many as potentially containing unity within the plurality of a many, and whole/parts as having plurality contained within a unity. This is a vague (but as we shall see, a useful) way of asking whether a number is a cardinal number and works to conserve value by working the one/many form, or an ordinal number working to conserve order through the whole/part form.

The fact that the last couple of sentences are likely to have puzzled many of my readers alerts us to the fact that thinking about number *as materialised relation* is novel. Just as we need more detail in characterising a person: I have my mother's chin, my father's temperament, so it is with numbers if we are to see how it works as an inventive frontier. In this short paper I show how in shape shifting between the form one/many and whole/part, and in moving between symbolic/indexical and indexical/iconic modes of semiosis, number works in inventive ways in mediating a frontier embedded in knowing and working Australia's water resources as enumerated.

At 2pm on the first Sunday of every month Waterwatch Victoria volunteers gather to test the water quality of Merri Creek on the upstream side of St George's Road Bridge in Melbourne's inner city suburb of North Fitzroy. Their 'Kit', donated by a sponsoring water company, has various sized tubes and bottles, some empty a few already equipped with reagents, conductivity and pH probes, plastic spoons and

bowls, ice cube trays and plastic syringes. Usually by 3.30pm a nice set of numbers has been assembled. The quality of the creek's water emerges as a complicated arithmetical composite of aggregated numbers generated in chemical and physical tests set alongside another complicated arithmetic composite representing aquatic life and derived from estimates of numbers and types of 'bugs' counted in a sample of sludge. Later in the week these numbers are added to the Waterwatch Victoria database by the group's coordinator.

Begun in 1993, Waterwatch is an environmental NGO providing services mainly under contract to governments. It now has many thousands of Australians regularly attending their streams with bottles, thermometers, and pH meters, peering at tiny creatures they have scooped up with a net, trying to identify what they are and count their numbers. In part Waterwatch aims to sensitise citizens to the failing health of our nation's rivers. But more substantively and certainly of significance to the people who do the measuring, the numbers that Waterwatch volunteers produce "fill-in spatial and temporal monitoring gaps", contributing to Australia's on-going environmental audit. In Victoria there are a mere 270 official water monitoring sites; in contrast Waterwatch Victoria collects data from 1454 places.

Animated by the slogan "you can't sustain what you haven't measured", the enthusiasm that pervades Waterwatch evidences Australians' new found commitment to ecological sustainability in the face of widespread and on-going drought. What is much less evident is the way these numbers so enthusiastically generated by volunteers with the best of intentions towards Australia's nature, might contribute to constituting water as commodity, expanding possibilities for 'doing business with water'.

To the chagrin of Waterwatch Victoria's thousands of volunteers who go out of their way to wade about in streams and lakes and understand their labour as generating important information, the numbers they generate in attesting water quality are not added to the official register of water quality in Victoria: the Victorian Water Resources Data Warehouse. That database contains only 'official data' gathered by personnel employed and supervised by state instrumentalities and water companies. Why the *cordon sanitaire*? Surely two databases, separate institutions and websites, is counter-productive in a project assembling and disseminating information on the state of the nation's water resources?

Unlike the 'official data' the confidence limits of the 'community data' are not specifiable. While it has managed to develop a network of co-ordinators providing training in water quality and biological monitoring, the measuring activities of Waterwatch's various volunteer groups are still murky. The provenance of numbers arising in their unreliably disciplined gestures with hands and eyes, probes and tubes, buckets and nets, words spoken and figures recorded, cannot be guaranteed by the institutional location nor by attested skill levels of the number generators. These people who in their spare-time muck about in gum-boots and waders in dams and billabongs, creeks and rivers do not verifiably possess at least the Level III Community Environment Certificate. The numbers they record may cohere well enough to give an alarming general picture of the state of Australia's waters, but their consistency is not quantifiable.

Nevertheless, the expressed hope is that when the level of discipline embedded in the hands and eyes of Waterwatch volunteers can be reliably witnessed and quantified, the data sets will be consolidated. Then the non-equivalence between the two data sets, currently so carefully maintained, will disappear. If and when this does happen, a peephole will close up; a peephole that currently allows us to see some of the inner workings of number as it slips between alternative forms of enumerating.

What does this (perhaps) soon to be closed up peep-hole allow us to see? Among other things it reveals the wonder of numbers' working as the relation unity/plurality. The mis-match between the provenances of 'community water data' and 'official water data' enables us to see that numbering projects like the Victorian Water Resources Data Warehouse hold two distinct moments of numbering in tension. The moments articulate distinct social ends and express the dual forms of numbers' remarkable capacities in enumeration—to develop relations between sameness and difference by working the relation unity and plurality.

We see that while appearing merely as means of assembling information, numbering Australia's water resources serves two separate and distinct purposes. First, environmental monitoring which we can understand as a form of cadastral accounting characterised by a moment of audit and achieved in arithmetic calculation. Second, constitution of an archive to constitute an emergent Australian water market and the possibility of the complex calculation that far exceeds the simple arithmetic involved in cadastral numbering.

Constituting an archive to allow for the working of the complex calculative regimes of the market, the Victorian Water Resources Data Warehouse has to be particular about confidence limits. It must manage risks and provide data only of quantifiable provenance, for much is at stake in the economic-social-political-moral project of constituting and developing an Australian water market. Per capita, for each Australian, the amount of water extracted from the environment and held in storage far exceeds that for citizens of other nations. Australia has in the past invested vast sums, and in today's world this past obsession with storing water is evident as infrastructure which translates water's use value into exchange value. Extracted and stored water is a potential commodity. Extracted, stored *and audited* water is capable of realisation as a commodity. Through its trade, marginal gains, capital gains, can be realised.

The Victorian Water Resources Data Warehouse invisibly manages dual moments of numbering Australia's water resources: on the one hand registering Victoria's water resources with quantifiable accuracy, and on the other contributing to expanding the markets that exploit those resources. To appreciate the flexibility embedded in the sets of numbers that populate the Victorian Water Resources Data Warehouse databases, and to understand why they must be kept separate from the numbers in the Waterwatch volunteers' database, we need to remember that number's remarkable capacities lie in its being the relation unity/plurality, a relation that might be expressed as the relation between one and many, or alternatively as the relation between a whole and its parts. Working number as the relation one/many expresses one form of numbers' generalising; working it as the relation whole/parts mobilises another.

On the one hand the numbers that constitute the Victorian Water Resources Data Warehouse are about knowing the state of Australia's natural resources. This purpose depends on numbers being the relation one to many: single instances of defined measurement are cumulated, and numerals are taken to represent enumerated abstract entities. This is the form of generalising that the Waterwatch volunteers' numbers effect.

Simultaneously the numbers that constitute the Victorian Water Resources Data Warehouse make a whole—a market place for Australia's emergent water trade. This whole, 'articulable water resources', is the water market. Because the confidence limits of the Waterwatch numbers are not quantified, those numbers cannot mix-up

with the official numbers in contributing to generating the water market. The water market has many parts: surface water, ground water, return water, and increasingly reuse water; and each of these parts has manifold subparts. These parts and sub-parts are not given, but continually proliferating as new, derived configurations which are ingeniously designed, while other configurations wither, or are killed off. The whole, the Australian water market is necessarily vague and emergent, but the numbering on which it depends must have quantified and specified confidence limits.

Let me consider in more detail the contrast between the forms of enumerating that the quarantining of the Waterwatch numbers alerts us to. The numbers representing water quality for the purpose of exhaustive environmental audit work the relation one-many; semiotically they are symbols. As part of a precise, specifying and definitive process, both the official numbers of the Victorian Water Resources Data Warehouse and the community numbers of the Waterwatch programme contribute to registering the quality of located water in all Australia's catchments. Ones—specified units of flowing or stored water, with specified space-time co-ordinates and specified physical, chemical and biological properties are collected together as a many. They add up to general picture of the states and places of Australia's waters. In some ways a fantasy of exhaustive cumulation, the purpose of the audit project is nevertheless identified as a common good endeavour: developing better representations of the evidently deteriorating state of the waters that are crucial in sustaining Australia's nature.

Yet sets of consistent 'official' numbers stored in the likes of the Victorian Water Resources Data Warehouse, soon (perhaps) to be supplemented by the vast stores of numbers that Waterwatchers produce, also serve quite different ends. Another fantasy of quite a different type is also sustained by the existence of these numbers: the vague, emergent and unspecifiable notion of 'The Australian Water Market'. Here the sets of numbers are no longer a *representation* but are now *constitutive* of the entity itself. They work as icons.

The wholeness of the Australian Water Market emerges as its continually re-invented and enumerated parts. Water commodities are conjured into existence by various ingenious means of bundling, tracking, partitioning, and so on. These parts of the whole are literally made feasible by the cumulated numbers. Surface water, ground water, return water, and reuse water are phenomena generated in disciplined

interrogation of knowable water in place. Each of these parts of the water market has its sub-parts, each is made separable as a product, a commodity, by the social, literary, and material technologies through which it is born. Ingenious social, and technical tinkering—separating water entitlements from land rights, rebundling water as low, medium, and high security licences, inventing tamper proof flow meters, is continually coming up with new sorts of parts in the vague emergent whole of Australia's water market; multiple water products designed for multiple markets. Here the waters and the numbers are one and the same, equally crucial in constituting the entity, the commodity. The work, the human labour that constitutes the water market's parts as socio-material entities becomes invisible; or it would if only the confidence limits of the 'community water data' were specifiable and the community numbers did not need to be quarantined.

Recognising the origins of numbers' capacities as in carrying human endeavours is important, for the ease with which they enable one project to become quite another is uncanny. We see number working as inventive frontier in the shape-shifting evinced by the official numbers of the Victorian Water Resources Data Warehouse. Numbers, coming to life originally as rule-bound sequences of words, are radically incomplete. In use they are both *agile*, a property deriving from their rule-boundness, and *needy*, a mode bequeathed by their origins in the patterns of events, not in the events themselves. In this combination of needy agility is found numbers' unnerving capacity to continually evert themselves, flipping imperceptibly from their one-many manifestation to their whole-parts form of working, shifting between signing as symbols and signing as icons. In this lies numbers' capacities to simultaneously and seamlessly work relations between sameness and difference and unity and plurality, and to dissemble—eliding projects with very different moral and political resonances.

A one, invoked as a defined unit can be collected together with many other similar units. This plurality can with an almost imperceptible alteration in the criterion of completion invoke a whole. The cumulated defined units of water in many linked locations can with a self-evidently useful alteration in the defining criterion become 'regulated water'. The usefulness of the slide obscures the flip from cumulus to whole, and more significantly the change in numbers' role from representation to constitution. The elision accomplished however, parts can be evoked utilizing differential completing criteria: 'dam water bodies' evoked in one criterion can be the

subject of trade with landholders; 'regulated river flows' evoked through another criterion can be subject to trade as environmental flows, and 'weir pools' through yet another criterion might allow trade in high security water licences.

If not for the glitch: that the numbers so earnestly recorded by Waterwatch volunteers do not have specifiable confidence limits because of the unreliability of the volunteers' gestures with hands and eyes, tubes and meters, words and figures which generate those numbers, the elision of a many—numerous observations/measurements, to a whole—Australia's tradeable water resources, would be less visible. The conflation of a project whose explicit purpose is for the public good: to get a better picture of the rapidly deteriorating state of the waters of Australia's rivers and creeks, swamps and lakes, with a project whose stated purpose is to trade those waters and enable a few to reap private capital gain from that trade, would be more seamless.

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