

Chapter for *Inventive Methods: The Happening of the Social* Nina Wakeford and Celia Lury (editors). To be published by Routledge, 2010

### **Number as Generative Device: Ordering and Valuing our Relations with Nature**

Helen Verran

History and Philosophy of Science,  
School of Philosophy, Anthropology, and Social Inquiry  
University of Melbourne

*The move to market-led environmental policy is obviously not occurring without opposition. Old-guard environmentalists long for the security of command-and-control state policies, while old-guard anti-environmentalists long for the abolishment of environmental bureaucracy and to put it bluntly, the freedom to pillage.* [1]

The number at the core of my paper was 'born' in 1997 in the prestigious natural sciences journal *Nature* with the publication of "The value of the world's ecosystem services and natural capital". Thirteen authors representing a wide range of academic institutions and disciplines, presented data that they claimed allowed calculation of a numerical value for the goods and services produced by the world's natural capital stock. As they calculated it, the numerical value of the goods and services provided annually by the environment was somewhere between US\$16 and 54 trillion ( $10^{12}$ ) which they averaged as US\$33 trillion ( $10^{12}$ ) per year. They compared the value of their newly hatched number to another number: the total of the global gross national product that they estimated at US\$18 trillion ( $10^{12}$ ) per year. [2]

As contemporary ecological economics tells it, either directly or indirectly in the functioning of ecosystems nature produces goods (like food, fibres, water, and minerals) and services (like waste assimilation, nutrient cycling and the means to perform culturally significant rituals like bush-walking). These goods and services provide benefit to human societies. Why try to quantify this way of conceiving nature? The authors justified their value generation exercise, criticised by one economist as a "recklessly heroic attempt to do something that's futile" [3], by noting that "because ecosystem [goods and] services are not fully 'captured' in commercial markets or adequately quantified in terms comparable with economic services and manufactured capital they are often given too little weight in policy decisions" (Costanza *et al* 1997:253). The calculation of this number I'll dub Costanza's number after the *Nature* paper's senior author, was then an intervention in the politics around the move to market-led environmental policy. It was not the value that mattered here, the authors insisted that the calculation of the number was a political act.

In disputing Costanza *et al*'s resort to arithmetic more orthodox economists claim that the number which purports to value the earth's natural capital is nonsense. This is how a small booklet entitled *How Much is an Ecosystem Worth? Assessing the Economic Value of Conservation* published under the auspices of the IUCN (The World Conservation Union), The Nature Conservancy, and the World Bank in 2004 and expressing more orthodox contemporary economics, deals with what I am calling Costanza's number.

"A serious underestimate of infinity"

A landmark paper published in *Nature* in 1997 attempted to calculate the total value of all ecosystems to the earth. By using a range of estimates of the value of

individual ecosystems and scaling them up according to the total area covered by each such ecosystem globally, the authors arrived at an estimate of the total value of all ecosystem services ... This paper has had a significant impact and its results have been widely quoted by scientists and environmentalists. However most economists consider it profoundly flawed both conceptually and methodologically.

For more orthodox economists, valuing ecosystem services relates instrumentally to processes of auditing public expenditure on the environment. According to economics orthodoxy, as a representation of total value of the world's natural capital stock, albeit one that does not claim precision, Costanza's number—is invalid, a step too far.[4] Against their more cautious colleagues Costanza and his co-authors defend the number as leading to good policy "... we do not believe there is one right way to value ecosystem services. But there is a wrong way and that is not to do it at all".[5] As Costanza sees it his number is 'real-politic'.

Such a sentiment is strongly opposed by some natural scientists who decry economists' valuing of nature. They assert nature is valuable in and of itself. The effort that is now being devoted to commodifying nature by calculating the value of the services it provides should be redirected. These environmentalists argue that the basis for policy should be what they name as the 'intrinsic value' of nature. It is a matter of ethics and aesthetics they say; nature has its own intrinsic logic that our policies should reflect. They reject the instrumental anthropocentrism embedded in the processes of quantifying ecosystems services seeing it as 'selling out on nature'. Nature is not arranged for human purposes they argue—not marketable. The market has a very short value time span whereas nature should be conserved in perpetuity. Valuing ecosystems services pits nature against man as competitors providing services, they say. And in fact, they insist, most ecosystems are worth more dead than they are alive.[6]

My critique of Costanza's number is rather different. For me the opportunistic calculation of the purported value of the world's ecosystems services and natural capital in a style designed to appeal to natural scientists exhibits a reckless disregard for of number's remarkable capacities. The paper argues for a particular form of ordering for the purpose of valuing nature as a set of products in a services economy. And so as to 'prove' the reality of that order it makes an audit of the value of the categories being argued for. As is usual in such exercises there is a seamless elision of the dual moments of articulating an order so as to create value, and valuing the categories created in the order to effect an audit. Costanza's number simultaneously effects a startling ontology—nature as a set of products tradeable in an imagined market in environmental services, and warrants that order—makes an epistemic claim, by calculating the values of these products. In conflating these distinct moments of knowledge making Costanza's number reveals itself as a dodgy number. Calculated with the explicit aim of provoking shock and awe, Costanza's number is political spectacle. Perhaps that's why I find Costanza's disconcerting. Should we be concerned about a dodgy number getting such recognition? Or should we just smile or grimace and pass on to other matters? Perhaps the second is the appropriate response but I want to stay with my disconcertment for as I see it, the paper and its (in)famous number exemplify a general phenomenon. Modernity itself seems to be afflicted with an on-going blindness when it comes to the embedded semiotic functioning of number. In my chapter I use this dodgy number and the controversy around it to begin to develop familiarity with number as a

generative device. I aim to sensitise researchers in the social sciences to what is involved in using numbers in informed good faith.

### *Developing a Feel for Number*

I treat number as a material-semiotic device which is a quite different way of thinking about numbers than treating them as either universal abstractions or as culturally relative social constructions. I developed this way of working with numbers when I needed a way to think about how the numbers of science were simultaneously different from and the same as number I met in Yoruba markets in the 1980s. This way of thinking about numbers takes them as inseparable from the practices in which enumerated material entities come to life, and as semiotically agential (Verran, 2001). It recognises that the workings of numbers are deeply embedded in and constitutive of the real—they lubricate its happening. Expressing formal relations working the distinctions same/different and unity/plurality numbers partially configure the on-going emergence of our worlds.

Numbers participate as order—enumerated entities are the real. Yet numbering is also engaged in representing order in a specific way—as value. Numbers sometimes work in ordering and at other times in valuing—it depends. And because it depends and because often those who love numbers are unaware of what they depend on, we find dissembling in numbering: ends disporting themselves as means; ordering in the guise of mere valuing.

I argue that Costanza's number fails to recognize and respect the difference between number's working as ordinal number to conserve order and as cardinal number to conserve value. The way the number is presented in the *Nature* paper hides a conflation of the deductive working of number's generalizing where parts are derived from general, vague wholes in processes effecting ordering—the form of number use familiar in macroeconomics, with the inductive form of number's generalizing associated with valuing by engaging a specific one-to-many relation—the ways numbers are engaged with by most natural scientists.

Of course Costanza's number is not unique in this, but it's not the conflating that is the problem. If we know what we're doing, flipping between ordering and valuing is generative. The danger lies in the fact that many who love numbers and use them constantly cannot recognize the difference between these two moments of numbering and hence are unable to discern when conflation is occurring. That we don't know we are conflating number's dual moments of generalising *is* a problem. Costanza's number and indeed much of the controversy associated with it, is exemplary in exhibiting this blindness and it helps me demonstrate number's duality, a step towards a more realistic recognition of number as a generative device.

I use Costanza's number as a means for showing what a feel for number is. Or to use Marilyn Strathern's term I evert it to show what is inside in a move that both decomposes and recomposes.<sup>[7]</sup> I display the number's insides, suggesting that all numbers can and should be read in this way if we are to work with numbers in informed good faith. If social scientists are going to use numbers in intervening in the social they need to have a feel for their tools of trade. Presenting Costanza's number and its controversies I begin with a brief history of the family of numbers to which I see it as belonging. I explain why Costanza's number is more controversial than its siblings. Next I consider some of the details of the number's constitution. Using fine-grained textual analysis I show just where in the paper the elision of order and value occurs. In

the next section I introduce another number, the Australian, Fire Danger Index which I claim is unlike Costanza's number in that it explicitly dwells in the mess of the world. It helps me be more explicit about what is left out in Costanza's number and more clearly articulate what informed good faith in using number might be.

### *A Family of Iconic Numbers*

In 1997 Costanza's number attempted to join an expanding family of iconic numbers central in aggregate, or macro, economics, however ten years later its membership of that family is still contested. The members of this rather exclusive family of numbers have been designed to articulate changes in relationships between various economic flows and 'real world' processes. They are all temporally dynamic (rates of flow) and for that reason can seem counter intuitive. All were born in controversy but Costanza's number is probably most controversial. These iconic numbers name ordering concepts like 'national income' or 'gross domestic product', or more controversially in the case of Costanza's number, 'natural capital'. Recently a report 'birthing' a new member of this family of numbers was published by the UK government. Sir Nicholas Stern's number values the costs of reducing the stocks of greenhouse gases.[\[8\]](#) With Stern's number something previously considered as external to economic activity and hence of no interest to economists has been articulated. But like its older siblings, at the time of its birth we are seeing much disagreement over exactly what conceptual and mathematical processes should be used constitute the number naming the cost of reducing the world's (unwanted) stock of greenhouse gases.[\[9\]](#)

This family of iconic economists' numbers can be understood as heirs to the project of political arithmetic that came into being along with modernity. In adopting the label of 'political arithmetic' for the process which gives rise to and surrounds the use of Costanza's and related iconic numbers, I am linking the project of macroeconomics to that of William Petty, one of the 17<sup>th</sup> century founders of the Royal Society of London whose best known work *Political Arithmetic* was published in 1691.

Petty promoted his method, which he called political arithmetic, as an explicit antidote both to the excesses of rhetoric and to the theoretical disputes that had provoked the English Civil War. Arguments based on "number, weight, and measure" he proclaimed, would compel assent as surely as mathematics did—especially if the King was willing to back the knowledge that the supposedly disinterested numbers expert produced.[\[10\]](#)

As Mary Poovey tells the story of this arithmetic, the claim to disinterestedness with which William Petty promoted his numerical cadastral descriptions as 'mathematicals' in the second half of the seventeenth century, was exposed by Scottish moral philosophy's experimental philosophy and conjectural history. But as she also makes clear, the political economy of Adam Smith recovered Petty's cleverly constructed illusion of the disinterestedness and self-sufficiency of numbers.

In the twentieth century a new incarnation of political arithmetic emerged. The still expanding systems of national accounts now calculate a bevy of numbers which value the various categories of a national economy. But the categories now routinely valued first came into existence as contested numbers. The senior member of this family of grand economic numbers is gross

national product (GNP). As a number, GNP, or we could call it Kuznet's number, was born at the end of the 1930s in the work of a private research organisation under commission from the US Department of Commerce.[\[11\]](#) Conceived in the pain and confusion of the great depression and seen by all as 'a good thing', at the time of its birth there was much disagreement over exactly how the number should be algorithmically constituted. By the end of the 1930s this newly hatched number had become the new actuality, the very stuff of the US and other national economies, generating new material, institutional, and textual practices of economic management. In the second half of the twentieth century the newly articulated entity 'the national economy', named as GNP, intervened decisively in a well established debate on social development to effect a practical equivalence between society and the monetary economy so that now development *is* growth in GNP.

Should we be surprised that as ordering concepts these macro-economic numbers help us focus on troublesome aspects of our world, and that they come to life at particular socio-historical junctures as expressions of social concern about the state of the society or of nature? Just as GNP grew from the view that representing the state of flows of economic activity in society more precisely was unproblematically a good thing, especially as recovering national economies shifted from producing civilian goods to producing war goods, so too there is the sense that more precise representation of the flows natural processes surely a good thing. Very often the orders engendered in these numbers are controversial amongst economists who contest them *as* orders.[\[12\]](#)

Costanza's number differs from these economists numbers in that an order is argued for as a value using the logic of natural science. Social order conceived as an economy producing goods and services is taken as a template for a natural order similarly imagined: a natural good and services economy. Rendering flows of natural processes as flows of economic activity, they specifically make analogy between the value of "human production" and the value of "natural production" in defending their *Nature* paper.[\[13\]](#)

One way to understand the critiques of both economists and natural scientists is to see that the paper of Costanza *et al* is a rhetorical failure; a failure which turns on the phrase 'natural capital'. Economists are outraged at this rhetorical flourish because it deprives 'capital' of its conceptual specificity. Economists cannot do without capital meaning something specific like 'resources, including financial, mobilized in producing goods and services for a market'. The metaphorical use of capital embedded in Costanza's number is a step too far for most economists. Natural scientists on the other hand find their nature far too reduced. The narrow specificity it gains in being linked to a metaphorical use of capital means it is not the nature of natural science. Ontologically 'natural capital fails in both economics and in natural science—although for different reasons. Why then is the paper and its number so (in)famous? Part of the answer to that question surely relates to the 'numberliness' in which the dubious analogy embedded in 'natural capital' is presented.

While the analogy between an economy and some elements of natural process might make vague intuitive sense, in practice it is dangerously simplistic, and environmental policy based on it is flawed at the level of conceptual design. In the end Costanza's number does a disservice to the market-led environmental policy movement that it sought to promote. But, and this is where

Costanza's number understood as an aspect of the endeavour to 'sell' market-led environmental policy connects up with my attempts to make numbers our familiars, it is largely number's capacity to seamlessly elide ordering and valuing that makes the analogy embedded in Costanza's number seem so unproblematic.

Before I go on to examine the conceptual design of Costanza's number in more detail I want to consider the sense in which numbers like Kuznet's and Stern's, and the numbers of macroeconomics more generally are iconic, for I mean that adjective in more than the sense of being emblematic. In a religious sense an icon is precious because in the actual practices of many religions the image *is* the god or spirit pictured, and is treated as such. This sense of the term is captured in the Peircian typology of signs where his example of an icon is the lead pencil streak that is simultaneously mark on a page and geometrical line.<sup>[14]</sup> Just as lead pencil streaks are icons in geometry, numbers like Kuznet's and Stern's numbers are icons in economics. In generative economic analysis number and the category numbered are treated as one and the same.<sup>[15]</sup>

Such economic categories are in practice vague and emergent, and the number actually works as a name. In the case of Stern's number—numbering the cost of greenhouse gases, there are two equally vague parts: the cost of abatement, of curbing emissions, and the cost of damage from climate change. Stern's number is the difference between them—the relative rates of change in these two numbered, that is named, categories. In texts—both spoken and written, Stern's number works in the same way that a pencil streak on a page of a student's geometry book works as a geometrical line.

So is Costanza's number an icon? One might argue that the individual numbers for the values of the many and varied specifically located ecosystem services that economists have invented and named over the past fifteen years of so are icons. Implicitly each of these numbers is an argument that a specific located order of natural processes can be construed as economic categories. This helps us see that the numbers Costanza *et al* recklessly added together are not only invalid extrapolations of values that have very specific referents, adding them together ignores the semiotic character of those numbers as icons. Totalling iconic numbers is to pile icons randomly one on top of the other, so Costanza's number can be understood as attempting to convince us that the pile itself adds up to something more than a pile of assorted icons. As spectacle or stunt the piling-up seems to work, but as a value of 'natural capital' it does not.

*Ecosystem Services: Many Different Products in a Services Economy or Plural Instantiations of a Single Measure?*

In their paper Costanza *et al* are proposing a novel order: nature as a service economy. As evidence of the naturalness and usefulness of this order they present values for each of the sub-categories they propose. When looked at this way their evidence is very far from compelling. So thin and so unlikely does the valuing appear, that it reveals the ordering the authors propose as wanting. Looked at from the point of view of those who are familiar with numbers and how they work, and who understand that the values presented here are evidence for the categories they value, the order implied in the term 'natural capital' appears a preposterous folly.

I move on now to considering some details of how Costanza's number is constituted. From my point of view the nub of the problem is this. In the *Nature* article the total value of the earth's

ecosystem services is presented as if it is the total of seventeen paddocks of differing areas joined together to make a mega-paddock—total natural capital. It suggests that ‘ecosystem service’ is self-evidently a unit of natural capital, just as many regard hectare as self-evidently a unit of area. At the same time it claims that to the extent that they are realized, each ecosystem service is a unique category of product in a (mythical) natural services economy: the table listing ecosystem services articulates an order. Each environmental service product is a category, a whole with emergent parts.

In the *Nature* paper Costanza’s number comes to life in an inductive argument propounded in the style of a naïve scientific realism familiar in the natural sciences. The paper by Costanza *et al* has the classical structure of a scientific report with introduction, methods, results, interpretations and conclusions. The methods section provides detailed information on the algorithmic methods used, and in addition we learn something about the social process of the two stage methodological procedure of the number’s devising. Data initially assembled by one of the authors identifying and extracting appropriate literature sources was intensively workshopped: “We conducted a thorough literature review and synthesized the information along with a few original calculations during a one-week intensive workshop at the new National Centre for Ecological Analysis and Synthesis (NCEAS) at the University of California Santa Barbara.” (Costanza *et al*, 1997: 258).

In the paper the number is presented as a one-many generalization based on seventeen sub-totals of a singular unit ‘ecosystem services’. Here’s a short description of just four of those seventeen, more or less randomly selected. The first named in Costanza *et al*’s list is “Gas regulation”, defined as “regulation of atmospheric chemical composition” and exemplified by the following: “CO<sub>2</sub>/O<sub>2</sub> balance, O<sub>2</sub> for UVB protection, and SO<sub>x</sub> levels”. There are of course many more conceivable parts to the category, the vague whole ‘gas regulation’. Passing down the list, fifth is “Water supply: Regulation of hydrological flows: Provisioning of water by watersheds, reservoirs and aquifers”. Tenth is “Pollination: movement of floral gametes: Provisioning of pollinators for reproduction of plant populations”. The last named, possibly the most counter-intuitive, is “Cultural: Providing opportunities for non-commercial uses: Aesthetic, artistic, educational, spiritual, and/or scientific values of ecosystems” (Costanza *et al*, 1997:254).

In this process of adding up there is one issue that the authors are at pains to explain away. Some natural processes—like flows of the water cycle, are counted twice or three times. The authors claim this does not invalidate their counting: “for example some of the net primary production in an ecosystem ends up as food, the consumption of which generates respiratory products necessary for primary production [and these are counted as separate ecosystem services]. Even though these functions and services are interdependent, in many cases they can be added [together] because they represent ‘joint products’ of the ecosystem” (Costanza *et al* 1997:253).

A conspicuous element in the paper by Costanza *et al* is a tabular matrix with squares for values for seventeen proposed ecosystem services across twelve earth biomes (open ocean, coastal, forest, grass/rangelands, and so on). Of the two hundred and four squares so generated a mere sixty have a number. Those biomes that are most complete are of course those like forest and rangeland—the bits of the environment most fully integrated into the (social) economy. Should

we be surprised? Imagine the institutional effort and money that would be required to fill the boxes. In natural science's time-honoured style of managing such "methodological horrors"[\[16\]](#) it is implied that this is an unfortunate circumstance that will with effort be put right in time: "additional effort in studying and valuing a broader range of ecosystem services" is needed (Costanza *et al*, 1997: 253).

The numbers that are exhibited in the matrix are working as symbols. They are values representing categories that Costanza *et al* are arguing for in proposing an order. In the Peircian typology of signs symbols are those types of signs that need a theory (a set of articulated categories) to be made explicit if they are to be meaningful. But the theory that makes them meaningful is exactly what is at stake here. The numbers lined up in rows and columns are (very slight) evidence for a set of categories precipitated by the 'theory' Costanza *et al* are arguing for. In a semiotic sense the problem here is that these numbers are being presented as simultaneously both icons and symbols. Ordering is being elided with valuing.

How is it done? Like most tricks it's done with words and misplaced confidence. As I read the *Nature* paper Costanza *et al* make use of the same commonplace illusion that William Petty mobilized some three hundred years ago: the comforting idea that numbers carry within themselves everything that is needed to interpret their significance.

At two crucial places in the paper words serve to mislead. The first occasion is in the paper's title 'The value of the world's ecosystem services and natural capital'. I read this as implying 'ecosystem services' is analogous to 'hectare and 'natural capital' to 'total area', implying: This paper is about (using numbers in) valuing. Next near the top of the second page of their article the authors begin a section describing the ordering system at the centre of ecological economics. In this section heading the central terms are reversed 'Natural capital and ecosystem services'. In beginning to define their analytic categories Costanza *et al* readily admit that it is meaningless to try to value and hence quantify natural capital: zero natural capital is zero humanity, or to put it another way, natural capital is infinite and hence cannot to be valued. "It is not very meaningful to ask the total value of natural capital to human welfare, nor to ask the total value of massive, particular forms of natural capital. It is trivial to ask what is the value of the atmosphere to humankind, or what is the value of rocks and soil infrastructure as support systems" (Costanza *et al*, 1997: 255). Yet in their paper they do ask about the quantified value of natural capital and by applying seemingly valid algorithmic processes they do get and give an answer: \$US 33 trillion. How do they achieve the seemingly impossible task of giving an actual and evidently quite meaningful monetary value for what they themselves announce as a meaningless category—even if they slip from meaninglessness to 'not very meaningful'?

Look at these two consecutive sentences. The first occurs at the end of paragraph five arguing that the only way to imagine valuing natural capital is to model or represent it as an artificial biosphere: "Biosphere I (the earth) is a very efficient, least-cost provider of human life-support services" (Costanza *et al*, 1997: 255). The second sentence begins paragraph six arguing for the absolute importance of natural capital for humans: "Thus we can consider the general class of natural capital as essential to human welfare"(Costanza *et al*, 1997: 255). In the space between these two consecutive sentences a many, "human life-support services"—a plural set of units of ecosystem services which can be valued, has become a whole: "a general class". We have moved

seamlessly from value to order. Several 'services' that can be represented and valued become in the next sentence the order of the world itself. Something that has been previously named as entirely a fiction and necessarily of incalculable value, is through numbering confirmed as on specifiable value and real as a specific 'instrumental many' becomes a vague 'metaphysically potent whole'. That's how the ill-designed device that is Costanza's number domesticates 'ecosystem services' as a unit of 'natural capital' and portrays the relation as just a complicated version of the process by which hectares measure area.

*Indexical Numbers: seeing what's overlooked in iconic numbers and denied in symbolic numbers*

There is a sense in which giving a reading of the rhetorical strategies of the 1997 *Nature* paper by Costanza *et al* as an answer to the question of 'how is it done?', is superfluous. How the authors delude themselves and others about what they accomplish in that paper, and why they think it important, is of secondary importance here. I have used the paper and its (in)famous number as an exemplar to show that numbering accomplishes both ordering and valuing eliding them with seeming ease. I take the moral of the story of Costanza's number to be this. In these seemingly reckless neo-liberal times informed good faith in using numbers is important. But first I want to alert readers to a domain of number use that is almost entirely absent in the paper of Costanza *et al* although in a paper published in *Nature* this is exactly the domain of number use that we might expect to feature most prominently.

Informed good faith in using numbers is in part being familiar with the difference in using them as icons and using them as symbols—recognising that in the first, generalizing proceeds as a whole-parts process, and in the second as a one-many procedure. But it's also more than that. When most of us use numbers we are using them neither as icons nor as symbols. Most of the time most of us use numbers indexically. Indexical signs are Peirce's third semiotic type. Indexical numbers dwell in the mess of the real and through them generalizing can proceed simultaneously as whole-parts and one-many. This is how number is generative and we need to be familiar with its possibilities.

Engaging with numbers indexically involves explicitly working with what using them as icons blithely takes for granted, and using them as symbols insistently denies: the need to wrestle with the always and already overwhelming, blooming, buzzing real. Some numbers are so open about this they call themselves indexes not worrying about letting show the messy work of rendering them. Such are two numbers that currently have a high profile where I live just outside Melbourne where bushfires raged last summer. Like many other things these numbers have been severely challenged by those fires.

What's clear about the McArthur Forest Fire Danger Index (FFDI) and the Grassland Fire Danger Index (GFDI) is that a tremendous amount of work has gone into constituting them as naming an order of danger, *and* that this work must continue if they are to continue to work as live numbers. Coming up with values for these clearly highly contrived categories manages to mix up and integrate things that are quite incommensurable. If the elaborate communicating infrastructure embedded in the number fails or is compromised—the number will die. This is how Chapter 5 - 'Information' of the *2009 Victorian Bushfires Royal Commission Interim Report*[\[17\]](#) accounts these sprawling, messy, and seemingly uncontrollable numbers.

5.1 These indices are calculated by reference to fuel [wood and grass] characteristics and weather in order to generate a numerical index.

5.2 The FFDI and GFDI indicate expected fire danger and are regularly calculated by the Bureau of Meteorology (BoM) for the use of fire agencies.

5.3 The FFDI is calculated with 'inputs' of drought, recent precipitation levels, temperature, relative humidity, and wind speed. The FFDI is calculated on the basis of a normative fuel load

5.4 The GFDI is calculated using the 'inputs' of curing or fuel moisture, temperature, relative humidity, and wind speed.

5.5 The FFDI and GFDI are together referred to as the fire danger index (FDI). The FDI was originally calculated on a scale 0 to 100. The fire danger rating of extreme corresponds to an FDI of 50 and above. [But, as the Regional Director of the BoM] explained, [while] the FDI was originally designed only to 'go up to' 100. Computing models now allow the FDI to exceed this

The opposite page in the document has a table of 'Fire danger indices forecast for 7 February 2009'. It shows that in the vicinity where I live the forecast FFDI was 142 and the GFDI was 186. The point of exhibiting these fire danger index numbers is not so much to demonstrate the ways numbers can be mapped onto experience—although that is part of number's indexicality. The significant element I want to bring to the fore in indexicality is the enormous amount of work that is embedded in each value of the FFDI and the GFDI. For these numbers to come to life and to stay live, there must be an elaborate network of smoothly functioning institutions with trained and willing workers, complex technical procedures and material arrangements and routines, and multiple texts of differing genres must be intercalated. And as always there's a slight surprise in the collective action. The order of the fire danger indices exceeds its own definitions in contriving values in showing it has the somewhat surprising capacity to measure up to nearly 200. Working numbers indexically has us taking account of the here-and-now and allowing a generative mutual interrogation of ordering and valuing.

Where the stunt that is Costanza's number works to conflate iconic and symbolic forms of number, actively hiding its partiality and promoting the illusion of disinterestedness, the equally arcane, but far less pretentious number the Australian Fire Danger Index recognizes its partiality showing off its generative capacity for unexpected excess, showing how processes of valuing call forth an explicit move to re-design, to re-order. The FDI is exemplary in showing how number intervenes in the happening of the real—and vice-versa.

In making the contrast between Costanza's number and the Australian FDI number I do not want to be seen as claiming that those who work with ecosystems services and accept market-led environmental policy choices are given to using number in ill-informed ways and, motivated by a misplaced enthusiasm, use them in bad faith. Nor do I want to be seen as claiming that in contrast those who exercise a logic of environmental care like those responsible for developing and maintaining the Australian FDI number, exhibit an admirable sensitivity to number's dual moments allowing their number to develop as part of the complex socio-material domain of Australian bush-fires, do so wittingly.

It is clear that on February 7, 2009 the behaviour of the numbers was as surprising as the behaviour of the fires. And it is equally clear is that the categorical order of ecosystem services has long since escaped the narrow conceptions of economic ordering. What was originally proposed as a rather strict analogy between nature as a service economy and the capitalist economy has become ten years later a vague guiding imaginary. As Morgan Robertson whose opening paragraph I quoted in beginning this paper puts it

It is apparent that nothing approaching “a market” in the strict economic sense will develop in the foreseeable future... [yet] in some cases (but not all), the move towards ecosystem service markets has opened up an entirely new field of action... often in spite of, rather than because of, the power of orthodox economic principles... finding both progressive political possibilities and positive environmental outcomes in the playing out of market-based policies. It is clear that markets are not going to go away, but neither is their future to be predicted by mere economics. Their potential for surprise is enormous.[18]

### *What to Make of my Everting?*

In portraying numbers' working as a device in the clotting of the real I am seeking to develop an informed familiarity, and a concern to work with numbers in good faith amongst social science researchers. My hope is that in separating out the dual moments of numbers' generalising as working either whole-parts or one-many relations and relating this to numbers' semiotic capacities I have achieved a beginning in sensitising readers to what is involved in respecting numbers. By explaining my dismay over the bad faith that Costanza's number embeds, and my disconcertment at the excess and spilling over of the Australian fire danger index in moves designed to decompose and recompose my aim was to change the ways social science researchers feel towards and 'do' their own numbers.

Are your numbers symbols representing value in a moment of audit? Or alternatively are you working like an economist in using your numbers as icons arguing for a new order of the social? Perhaps your numbers are indexes displaying value in an on-going project of ordering and re-ordering effected partly in response to values that become calculable through the ordering moment? In drawing attention to the ways your numbers work as indexes are you seeking to intervene to promote re-ordering, perhaps to effect a more just or more discriminating order? The social sciences are distinguished by a multiplicity of forms of number use. All three forms of numbering are common and are valid usages. My claim is that researchers in the social sciences should know what they are doing with their numbers and how, and most importantly be able to articulate why they want to work with numbers in those ways. That last requirement could be claimed as a distinguishing mark of good social science. Using numbers skillfully in articulating problems in terms of how social ordering might be cahnged to effect distributive justice, in terms of asking who benefits from particular orders and how, and where such orders might be redesigned can be achieved only by using numbers in informed good faith.

1

---

[1] Morgan Robertson, “Five Hidden Challenges to Ecosystem Markets”, Downloaded from <http://ecosystemmarketplace.com/pages/article.opinion> 12/7/2009

- [2] Robert Costanza, Ralph D'Arge, Rudolf de Groot, Stephen Farber, Monica Grasso, Bruce Hannon, Karin Limburg, Shahid Naeem, Robert V. O'Neill, Jose Paruelo, Robert G. Raskin, Paul Sutton and Marjan van den Belt (1997) "The value of the world's ecosystem services and natural capital" *Nature* Vol 387, 253-260.
- [3] Trudy Cameron quoted in "Audacious bid to value the planet whips up a storm", *Nature* Vol 395 October (1998) p.430
- [4] Nancy Bockstael, A Myrick Freeman, Raymond J Kopp, Paul R Portney, V Kerry Smith "On measuring Economic values for Nature" *Environmental Science and Technology* 34 (2000), pp.1384-1389.
- [5] Costanza *et al* in reply to D. Pearce, "Auditing the Earth. The value of the world's ecosystem services and natural capital", *Environment* 1998 40(2) 23-28.
- [6] Douglas McCauley, "Selling out on nature" *Nature* 443, (2006) p 27-28
- [7] Marilyn Strathern, "The Decomposition of an Event" *Cultural Anthropology*, Vol 7, no 2, pp 244-254 (1992)
- [8] *The Stern Review on the Economics of Climate Change*, Cambridge University Press, 2006
- [9] Freeman Dyson, "The Question of Global Warming" *New York Review of Books* Volume 55, Number 10 June 12, 2008; Robert Mendelsohn, "Is the *Stern Review* and Economic Analysis?" *Review of Environmental Economics and Policy* volume 2, issue 1, winter 2008, pp.45-60.
- [10] Mary Poovey *The History of the Modern Fact. Problems of Knowledge and the Sciences of Wealth and Society*. University of Chicago Press, Chicago (1998), p. xviii.
- [11] Simon Kuznets produced three pioneering papers devising GNP across the years 1938-1946. The concepts he developed were subsequently extended and converted into the US National Income and Product Accounts.
- [12] See for example Robert Mendelsohn, "Is the *Stern Review* and Economic Analysis?" *Review of Environmental Economics and Policy* volume 2, issue 1, winter 2008, pp.45-60.
- [13] Robert Costanza, Ralph D'Arge, Rudolf de Groot, Stephen Farber, Monica Grasso, Bruce Hannon, Karin Limburg, Shahid Naeem, Robert V. O'Neill, Jose Paruelo, Robert G. Raskin, Paul Sutton and Marjan van den Belt, "The value of ecosystem services: putting the issues in perspective", *Ecological Economics* 25 (1998) 67-72.
- [14] Hoopes James, (ed.) (1991) *Peirce on Signs. Writings on Semiotic by Charles Sanders Peirce*, University of North Carolina Press: Chapel Hill p.239
- [15] See D. MacKenzie, F. Muniesa and L. Siu (Eds.), *Do Economists Make Markets? On the Performativity of Economics*, Princeton University Press, 2007.
- [16] Steve Woolgar, *Science the Very Idea*
- [17] *2009 Victorian Bushfires Royal Commission Interim Report*
- [18] Morgan Robertson, "Five Hidden Challenges to Ecosystem Markets", Downloaded from <http://ecosystemmarketplace.com/pages/article.opinion> 12/7/2009