Ex-orbitant globality

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Abstract
Social theorists drawing on the study of complex dynamical systems to address global processes tend to evoke an `immanent' globality devoid of a constitutive otherness or outside. However, as well as dealing with the internal dynamics of systems, complexity studies point to the mutual implication of systems and their surroundings: a concern which resonates with the interest in the convolutions of the inside/outside relationship prominent in post-structural philosophies. Looking at theories about the dynamical characteristics of the solar system, galaxy and universe, this paper develops the idea of an `ex-orbitant' globality that treats the earth as a system in active and ongoing interchange with its cosmic environment. A sense of the inevitable excess and unpredictability that attends this openness to the cosmos and to further `other-than-human' influences, it is suggested, has repercussions for the way we respond to environmental change - injecting an element of `abyssal' undecidability into all our deliberations.

Keywords
cosmology, otherness, complexity, globalization, responsibility

Openings

For all its commonality and humble scale, a dip in the landscape filled with water can be a site where events of great complexity play themselves out. A pond is an ecological system of rich interconnections, its varied elements meshing into arrangements with properties not found in its parts alone. Alongside the buzz and burble of aquatic life, there are other physical forces at work in a pool of water that are no less `noisy' and turbulent. The pattern of ripples created by a falling branch, for example, constitutes a break in symmetry that is composed of a whole range of contingencies - variable factors that render any return to the initial conditions of the pond infinitely improbable. The eccentricities of the pond's edge, small fluctuations of temperature, and the greater flux of gravity, electricity and magnetism all lend a unique history to ripple's unfolding (Briggs and Peat, 1989: 148). But even were we to take account of all terrestrial variations - of every earthly influence on the pond - its openness to a far greater realm of irregularities and instabilities would ensure that these radiating ripples take a path that can neither be repeated nor undone. As John Briggs and David Peat explain:

> Any ultimate coordinating of events around the pond is made impossible by the fact that all systems are open to the rest of the universe…. Even the movement of distant stars will produce minute changes in the gravitational field experienced on earth. While these fluctuations will be beyond any hope of measurement on earth, nevertheless they will always destroy initial correlations (1989: 148).

By this reasoning, the pond and all the life it supports evolves through a succession of time-irreversible events which are in turn entwined in the no-less irrevocable movements of the world around it, all the way up to the level of the universe (Briggs and Peat, 1989: 148-9; see also Prigogine, 1996: 18). But the dynamics of the cosmos do not always make themselves felt as subtly as might be gleaned from Briggs and Peat's description. It now appears that meteor impacts have changed the course of life on earth, most notably at the end of the Cretaceous era when the massive die off of dinosaurs helped open the way to the ascendance of smaller, warm-blooded creatures. While the more general role of meteorite bombardment at other crucial junctures of our planet's history remains hotly contested, as we will see, there is a move across a range of scientific disciplines to reconsider the interplay of cosmic and terrestrial processes. Recent developments in both earth science and astrophysics point not only to the dynamical and self-organizing qualities of the earth's biosphere, but also raise the possibility that the universe in its entirety shows a tendency for chaotic, nonlinear and evolutionary behaviour.

At first glance, the idea of the earth as an open system in interchange with a dynamic cosmos seems to resonate with the recent uptake of the study of complex systems in social thought, and in particular, with the idea of complex globality (see Urry, 2003). Social theorists who are not afraid to adopt language or procedures from the natural sciences are finding it useful to think about a fully globalized condition of social life using concepts of complexity or self-organization. This borrowing from the study of complex dynamical systems, whether explicit or not, offers a purchase on processes and events which are constituted through conditions of intense interconnectivity. It enables theorists to acknowledge the unmanageability of the contemporary world while also holding open the possibility that novel forms of organization or structuring might emerge spontaneously out of a sea of dense and disorderly interaction.

On closer examination, I would suggest, there is a discrepancy between formulations of global complexity now emerging in social thought, and the positing of our planet as an open and dynamical system by sectors of earth science and astrophysics communities. And small variations in initial conditions, as the study of chaos and complexity informs us, have a habit of amplifying in rather momentous ways. Whereas social scientists affirm that a fully integrated global condition implies an open or unpredictable future, they tend to couch this futurity in terms of a world without a discernible outside or beyond. This notion of planetary `immanence', however, does not necessarily mesh comfortably with a sense of the essential openness of the earth to the surrounding cosmos. Taking literally the idea that our planet is in constant interchange with the wider systems that encompass it, I want to develop the idea of an `ex-orbitant globality' that extends the destabilization of regional or national boundedness by social theorists to the perimeters of our planet.

A sense of global ex-orbitance, I argue, leaves an opening for events that might irrupt from beyond the realm of the human and the humanized, with important repercussions for the way we address a range of issues and problems concerning the variability of earth processes. Especially with regard to the current environmental predicament, and the issues of responsibility it raises, ex-orbitant events point to an excess that can never be contained or accounted for, thus injecting an element of abyssal undecidability into all our deliberations.

Whole Earth, Global Nature

At a scale somewhere between a small pond and the universe at large is a system which has become paradigmatic for thinking about complexity and self-organization. The living earth - or biosphere - is perhaps the most widely known example of a system which is at once constantly self-transforming and stable in the face of change, one with properties exhibited by the whole that exceed the sum of its many diverse components (Levin, 1999: 2; Prigogine and Stengers, 1984: 175). One of the ways that the notion of the biosphere as a self-organizing system has gained popular currency is through the Gaia hypothesis: a scientific theory couched by `geophysicist' James Lovelock that credits the collective role of biological life in the generation and maintenance of the earth's atmosphere. Lovelock argues that the totality of the earth's life-forms, acting in vast and unknowing concert, manipulate the atmosphere in an ongoing way, keeping it at an `improbable' point far from chemical and thermal equilibrium with its surrounding cosmic environment (1987: 6-7, 1989). By this logic, he claims, we may not need to scrape away at the surface of neighbouring planets to gauge their liveliness or lifelessness. Much the same could be gleaned by analysing their atmospheres for the tell-tale signs of a far-from-equilibrium state: the emergent global property of coupled interactions between life and its milieu (Lovelock, 1987: 1-7).[1]

As Lovelock recounts, photographs of our planet taken by astronauts, together with new information about the earth's atmosphere provided by journeys into space, played a part in the formulation of the Gaia hypothesis (1987: ix-x). Much has been written about the importance of the `whole earth ' image, particularly in relation to the escalating environmental concerns of our era (see Cosgrove, 1994; Sachs, 1999: ch 7; Franklin, 2000: 27-32). While the juxtaposition of dark empty space and a small radiant planet has often been taken to signify the fragility of earthly life, it is notable that Lovelock emphasizes the great resilience of the biosphere. Life as a whole, he argues, has weathered such cataclysms as repeated meteor impact, major volcanic episodes and atmospheric transformations wrought by life itself, during the course of which `the resident species suffered catastrophe whose scale was such as to make a total nuclear war seem, by comparison, as trivial as a summer breeze is to a hurricane' (Lovelock, 1988: 154, 125). In a related vein, `whole earth' environmentalist thinking has often stressed the threat posed by humankind to all life on our planet, whereas Lovelock and his collaborators have noted that the homeostatic mechanisms of the Gaian system are robust enough to render any conceivable human-induced change as no more than a temporary setback to the system as a whole (Lovelock 1987: 40). Humankind, as biologist Lynn Margulis and science writer Dorian Sagan conclude, is `a tiny and unessential part of Gaian system (Sagan and Margulis, 1984: 71). Unexceptional though we may be, Lovelock reminds us that the very fact that the earth system is poised far-from-equilibrium leaves open the possibility that human beings, like other form of physical agency, could conceivably nudge the system into another phase of abrupt and catastrophic transformation (1988: 154).

While aspects of the Gaia hypothesis remain contentious, the notion of the biosphere as a complex self-organizing system has wide scientific support, alongside its popular appeal. As it catches the attention of social thinkers, the earth conceived as a single, densely interconnected entity is at once an idea that invites critical reflection and an inspiration for rethinking the contemporary social and geopolitical condition. Suspicious of any sense of the givenness of `global nature', some social theorists have

focussed attention on the practices or performances through which the earth is now being constituted as an integrated whole (Franklin et al, 2000: 6-1; Urry, 2003: 6). At the same time, in both explicit and implicit ways, the notion of a complex, self-organizing globality is proving useful for exploring aspects of social life which seem to defy containment by more conventional social science categories such as `society' or `the nation state'. More specifically, the concept of global complexity is being deployed to address events and processes that escape the jurisdiction and governance characteristic of discrete socio-political units, along with the often related issue of agents and incidents that spill over the boundaries formerly constitutive of the social and the natural (Macnaghten and Urry, 1998: 153).

This uptake of dynamic systems thinking into the social sciences, both at global and more localized scales, has a distinctly dark side. In a manner that Ulrich Beck's risk society thesis has brought into focus, many of the ordering and controlling imperatives that were once definitive of modernity are now known to unleash cascades of unforeseen consequences: by-products that arise out of the sheer complexity attained in our interchanges with the biophysical world (Beck, 1992). In the light of evidence of climate change and other environmental or technological problems that play heedlessly across geopolitical boundaries, these `emergent' forms of disorder and potential catastrophe assume a planetary scale. Under such conditions, Beck asserts that `(r)isk society, fully thought through, means world risk society' (1999: 19), while Phil Macnaghten and John Urry proclaim that ` global nature ….seems literally out of control' (1998: 274).

And yet `spiralling global disequilibrium' is not without its compensations (see Urry, 2000: 209). As scientific studies of complexity assert, the same richness of interconnectivities and feedback loops that prompt a complex system to behave in disconcertingly unpredictable ways can also render it capable of spontaneously generating new levels of organization. In other words, new properties or structures may emerge from the reconfiguring of the relationship between elements of the system without need of external intervention or `top down' imposition (Davies, 1987: 198; DeLanda, 2002: 28). In this regard, alongside their deployment of complex systems thinking to depict the breakdown of social or technological mechanisms of control, some social theorists are also willing to use the language and concepts of complexity to talk about more constructive or hopeful possibilities. Thus the dense networks of communication and interaction that can undermine established forms of governance are also being conceived as generative of novel modes of association and organization. And it to these new patterns of politicization emerging `from the bottom up' that we might turn to find encouraging signs of an engagement with global forms of disorder on its own unruly and dispersed terrain (see Macnaghten and Urry, 1998: 274; Urry, 2003: 72; Beck, 1999: 37-8; Hardt and Negri, 2001: 65).

Global Immanence

For those social theorists who find something to affirm in the emergent properties of the complex global system it is not just a matter of choosing to see potential in connections and circuitries that otherwise convey destructive or oppressive charges. There are simply no other options on offer. A fully interconnected planet, it is argued, is one in which there is no outside (Urry, 2003: 102): no resistant or oppositional groups that evade implication in the geo-political system, no regions or reserves yet to be economically incorporated, no vestiges of nature that are not already symbolically

and materially entangled with global social processes. If there is to be transformation, by this logic, it can only come about through a realization of possibilities that inhere in the system itself.

Perhaps the most influential explorations of the `immanent' potentiality of the global system to generate its own alternatives is Michael Hardt and Antonio Negri's *Empire* (2001). *Empire* depicts a fully planetarized capitalist system that constitutes itself out of boundless and decentered networks of exchange and communication. But it is a system that cannot attain equilibrium, one that struggles to contain the vital energies and productive powers it unleashes. Ordinary living, working human beings, under these conditions comprise `a multiplicity, a plane of singularities, an open set of relations', which is to say that they carry the ever-present possibility of a creative self-transformation that could decisively reconfigure the system from within (Hardt and Negri, 2001: 103, 83). In this way, Hardt and Negri partially resuscitate the Marxist dream of overturning capitalism, turning to a dynamic of spontaneous reorganization of energies and elements within the system in place of the old dialectical model of opposing forces.

While *Empire* is not explicit about any debt to theories of complexity, it would appear that Hardt and Negri inherit a great deal from the prototypical dynamical systems theory that informs the philosophy of Giles Deleuze, on whom they draw heavily. As a number of commentators have noted, the version of immanence espoused by Deleuze, most overtly in *Difference and Repetition* (1994), fuses scientific understandings of the self-organizing capacity of the material world with a critique of philosophies of transcendence. As Manuel DeLanda explains, Deleuze makes use of insights from the fields of mathematics, physics and biology to formulate `a morphogenetic account (that) gets rid of all transcendent factors using exclusively form-generating resources which are immanent to the material world (2002: 10; see also Ansell Pearson, 1997: 11-12; Goodchild, 1996: 68-9). As was the case for Deleuze, and Nietzsche before him, Hardt and Negri's dismissal of transcendence is not only a disavowal of any God-like presence presiding over the world as if from beyond, it is also the refusal to ascribe to `Man' any corresponding exteriority to nature (2001: 91-2). More than ever, they argue, the ground for such dualities has eroded. In a formulation that is becoming a familiar fixture in critical social thought, Hardt and Negri proclaim that the modern division of the realm of the social from the external order of nature no longer holds (2001: 187; see also Jameson, 1984: 77-8; Beck, 1992: 81; Giddens, 1994: 77). Modernization has internalized the outsideness of nature to the extent that `all of nature has become capital, or at least has become subject to capital' (Hardt and Negri, 2001: 272). In this regard there can be no recourse to any domain independent of the terrain of humanity. Hardt and Negri conclude `(w)e should be done once and for all with the search for an outside' (2001: 46).

Far from signifying a final state or an end to history, for Hardt and Negri and other theorists of what I am calling `global immanence' the absence of uncolonized domains or oppositional forces is recast as a condition of potentiality. Conceived as an unthinkably complex intertwining of hybridized social and biophysical elements, our intensively globalized world is rendered open to the future: a reservoir of unknown and unknowable possibilities. Yet for all that this affirming of openness may inject a welcome dose of hopefulness to contemporary social thought, there is something paradoxical in the way that it is predicated on a reinstatement of limits and enclosure.

While an argument is made for the constitutive openness of individual societies or polities, what seems to be being posited at the planetary scale is a closure far more hermetic than was ever imagined in the case of any nationally-delimited territory.

There are good reasons to try and encompass all conceivable events and process within a single horizon. In theories of global immanence, the insistence that there is no longer any nature which escapes human inscription or assimilation expresses an intention to come to terms with the unprecedented extent of our social entanglement with the biophysical world: it is a call for `modernity … to accept the contingencies and ambivalences of living in a world of its own making (Ó Tuathail, 1999: 29). Acceptance, in this sense, is about taking responsibility for precipitating changes in local or global conditions, even or especially when these transformations were unanticipated. Joost Van Loon usefully reads global risk society and related visions of a universally defiled nature as theories of the excess of technological modernization. The proliferation of unruly hybrids and other `bads' that risk society theory depicts, he argues, can be seen as the `abjection' of the modern quest for control - the remainder that comes to undermine the system as a whole (2002: 21-5). The attempt to account for these abjects, to bring them back into the sphere of calculation and liability, is emerging as one of the pre-eminent ethical and political tasks of the present. An imperative that the ill-effects of any form of material actions should not be foisted onto others, especially those who are spatially or temporally distant, impels a calculus from which no harmful elements, culpable actors or threatened parties should be excluded. And such a project, as we will see, cannot help but have all-inclusive or universal aspirations.

But what happens when we take the excessiveness of our modernity and install it as the new universal condition? What are the implications of extending our responsibility for transforming the world to such an extent that it encompasses the globe as a totality? When confronted by claims of the self-enclosure of any political or social entity, we have learned to ask what is being excluded or marginalized by the act of demarcation: what is being disavowed on the inside and what is being banished to the outside. The reassertion of an absolute interiority and boundedness at the `higher' systemic level of the globe, I would argue, invites a similar interrogation. What is being passed over, we need to ask, by the assertion of the `end of otherness'; what repression or refusal resides in the idea that `nature' - western thought's primordial other - has been irretrievably lost?

Arguably, this manoeuvre inverts the traditional recourse of western metaphysics to a stable and pure nature, establishing human-induced impurity and instability as the new defining and inescapable horizon. And as Jacques Derrida has cautioned, the inversion or premature erasure of deeply ingrained binaries is a risky strategy, prone to falling back into the thrall of the very imperatives it would overturn (1981: 5-6). In the case of social theorists' pronouncements on the end of nature, we might wonder whether this assumes an access to the `real' in every one of its permutations - a pure presence of impurity - that perpetuates many of the assumptions behind the belief in the primordial presence of a pristine nature. Unequivocal claims for a global condition with no outside, it would appear, require a viewpoint that is itself removed from the relationalities it presides over: a perspective which is free of the occlusions, partialities and doubts that we might expect from any observer mired in conditions of unfathomable complexity. Paradoxically, such attempts at enclosure depend on the

very outside they refuse, and as William Rasch warns, they are irrevocably marked by this disavowal.

> For every inside that succeeds in seeing itself from its own outside, there is a further outside that can be discerned, distinguished, and designated. The inside turned outside is recaptured as an inside …. And so immanence becomes the closed system of a world whose contingency is not contingent. We are left with a systemic solipsism (2000: 80).

Dynamic Cosmologies

Notions of universal hybridization, connectivity and incorporation characteristic of theories of immanent globality imply that any event, in advance of its unfolding, is already circumscribed by conditions of our own making. We can only ever be taken by surprise, it seems, by elements and entities which have taken at least one turn through the appropriating circle of socialization or humanization. In this context, it is not so much the remainder of human intervention in the material world that is suppressed, as the possibility of an excess that does not always already bear some imprint of the human. But where does this leave worldly contingencies and ambivalences which may *not* be of our own making? Are there not also forces and processes with the potential to escape the closure of a fully subsumed nature, we might ask? Can we be so sure that there is no unassimilated materiality capable of veering in or rearing up and catching us unaware?

The discounting of a constitutive outside to the contemporary global condition, I want to suggest, sits comfortably neither with Deleuze's notion of immanence nor with the scientific understanding of dynamical systems he drew upon. If social scientists are going to adopt the language and concepts of complexity studies, I would argue, we will need to attend not only to the internal dynamics of systems, but also to their relationship with their exterior - the other systems that comprise their environment. And if we are to explore complexity at a global scale, this implies some consideration of what it means to inhabit a planet that is not closed to its surrounds.

To conceive of the earth as an open system is not to overlook its capacity to act as an integrated entity and its ability to generate changes of state internally. `The more complex a system', as Deleuze noted, `the more the *values peculiar to implication* appear within it…the more repetition finds itself interior, the less it depends upon external conditions' (1994: 255-6). But this is not the same thing as imputing immanence to any single system, and certainly not to the earth. The Deleuzian `chaosmos' - the universe which spontaneously generates its own organization out of disorder or chaos - is too heavily indebted to the excessive solar economy of Georges Bataille and the monstrously energetic cosmos of Nietzsche to be limited to the horizons of our own planet (see Deleuze, 1994: 57, 199). Human life and thought, in this regard, is open to all the events and processes that make up surrounding world, and this opening knows no limits. As Deleuze and Guattari put it: `the earth … belongs to the Cosmos, and presents itself as the material through which human beings tap cosmic forces (1987: 509; see also Deleuze, 1994: 121, Guattari, 1995: 108).

Clearly, for Deleuze and Guattari, the idea that all definitive forces are immanent in the material world meant something other than their confinement within the

perimeters of the planet we happen to inhabit. Though bolder than most in this assertion, they are not alone in gesturing ex-orbitantly. It has been pointed out that the abiding interest in the complications of the inside/outside relationship amongst post-structuralist philosophers has close ties with the epistemic shift in several fields of sciences and technology during the 1960s. That is, with the turn away from a concern with stable and closed systems towards complex, open and self-organizing systems (Johnson, 1993:143). The interplay of openness and closure was brought into focus particularly through consideration of living organisms and biological cells, which came to be seen at once as individualized and as inseparable from the flows of energy and matter that sustain them. For post-structuralist thinkers, this sense of a mutual enfolding of outside and inside chimed with their own dissatisfaction over the ultimate closure and self-referentiality imputed to language and other socio-cultural systems in structuralist thought (Johnson, 1993: 151). Along these lines, Deleuze and Guattari's sense of successive openings that enfold the smallest events of life in the cosmos as a whole has a parallel in Derrida's depiction of `texts' opening groundlessly, endlessly, exorbitantly to the textures of the world beyond them (Derrida, 1981: 333-4, 1976: 157-164).

The significance of new ways of conceiving of living systems in relation to their surroundings is evidenced in the allusions made by both Deleuze and Derrida to contemporary developments in the biological sciences (Deleuze, 1994: 118, 214; Derrida, 1976: 9). In the work of Nobel Laureate chemist Ilya Prigogine, the capacity of living organisms to power their own growth and self-transformation by taking in matter and energy from their environment has been presented as part of a much more general principle in which the `(t)he interaction of a system with the outside world, its embedding in nonequilibrium conditions, may become …the starting point for the formation of new dynamic states of matter' (Prigogine and Stengers, 1984: 143; see also Prigogine 1996: 65). In making a case that the universe was in part made up of irreversible and inherently constructive processes, Prigogine played an important role in bringing `a new, cosmological dimension' to the notion of dynamic and non-linear systems (Prigogine and Stengers, 1984: 231; see also Prigogine, 1996:174). Far from heading towards thermal equilibrium, as nineteenth century cosmologists proposed, Prigogine's cosmos is characterised by spontaneous symmetry breaking which gives rise to new structures or levels of organization (Prigogine and Stengers, 1994: 229-231; see also Deleuze, 1994: 20).

While this notion of a creative and self-organizing universe has yet to be accepted into mainstream cosmology or astrophysics, it is receiving growing attention (see Davies 1987: ch 9; Briggs and Peat, 1989: 148; Smolin, 1997). Reminiscent of Deleuze and Guattari's abyssal implication of self in the cosmos, physicist Lee Smolin offers a contemporary take on the idea of a succession of embedded systems.

> It …seems that our life is situated inside a nested hierarchy of self-organized systems that begin with our local ecologies and extend upwards at least to the galaxy. Each of these levels are non-equilibrium systems that owe their existence to processes of self-organization, that are in turn driven by cycles of energy and materials in the level above them. It is then tempting to ask if this extends further up than the galaxy. Must there be a non-equilibrium system inside of which sits our galaxy? Is there a sense in which the universe as a whole could be a non-equilibrium, self-organized system? (1997: 159).

Such a vision of the cosmos is beginning to take hold at the interface of physics and biology, a juncture forged not only from a general concern with analogies between living and non-living systems, but from a more specific interest in the question of how the universe has given rise to the `astonishing' levels of organization that characterise biological life (Davies, 1987: 138; Smolin, 1997: 104, 136). Like Prigogine before him, Smolin offers a powerful counterpoint to the idea of a living earth alone in a cold, lifeless universe, developing in its place a view of an inherently creative cosmos that is ultimately hospitable to life (1997: 16). Developing this line of thought, he focuses on the role of stars - clustered into galaxies - in keeping regions of the universe in a condition far from equilibrium, and in this way powering the organization of matter into new forms (1997: 28-9, 118). Giving due deference to what is still unknown about the way they work, Smolin depicts galaxies themselves as immensely complex systems, constantly engaged in the circulation of energy and material with the interstellar medium which surrounds them (1997: 118, 122-4). Our own planet is conceived as a participant in the vast and productive self-organizing cycling of elements in one such galaxy; the earth inheriting the organic elements necessary for its own self-organization from the greater system of which it is a small part (Smolin, 1997: 34, 159).

The Earth as an Open System

While the formation of the biosphere as a complex self-organized system in its own right affords the earth a degree of closure from the space around it, Smolin reminds us that our planet does not cease to participate in a dynamic solar system and galaxy (1997: 155). To what extent galactic or cosmic processes impact on the living earth, however - and how exactly this might occur - remains deeply contentious, but is a question of growing interest. There are expanding bodies of work dealing with the irregularities in solar radiation received by the earth and with meteor or `bolide' bombardment; fields of inquiry which cast new light on the implication of our planet in its cosmic environment - though not necessarily in ways that require adherence to the notion of self-organizing universe (see Calder, 1997, Murad and Williams, 2002). The discovery of `near-earth objects' has been preceding at exponential rates over recent years, and there is evidence to suggest that at least one asteroid passes within a hundred thousand miles or so of the earth, undetected, each day (Smith: 1994: 172). Asteroids and comets on collision course that break up in transit through the earth's atmosphere, along with impacting meteorites and more continuous showerings of cosmic dust deliver an estimated 40,000 metric tons of extraterrestrial matter to the earth's surface each year, an influx that includes new stocks of organic molecules (Williams and Murad, 2002: 1, Davis, 1996: 75).

While researchers attest to the extreme difficulty of recreating the early conditions of our planet, there is much speculation about the role played by incoming materials in the emergence and establishment of life. On the juvenile Earth, as Chyba and Sagan suggest: `"catastrophic" exogenous sources would have produced transient, extremely high concentrations of organics in the terrestrial oceans' (1997: 166). As well as providing nutrients for primitive life, it has been proposed that impacting comets or asteroids may have helped create the environments in which life first emerged. Water collecting in craters would have been heated by the energy released on impact, it has been argued, generating hydrothermal systems that may well have played host to the very earliest heat-loving or thermophilic organisms (Osinski, 2003; Oro and Lazcano, 1997; Mautner et al, 1995; Horneck, 1995).

While potentially supportive of primordial pond life, major impacts have also been drastically deleterious of established ecologies. There is accumulating evidence that a massive meteorite hit some 65 million years ago played a decisive role in the die off of dinosaurs and numerous other groups of animals and plants that signals the end of the Cretaceous era (Napier and Clube, 1979; Clube, 1989; Benton, 2003: 121-2). For all the immediate destructiveness of major meteor hits, it has been argued that catastrophes of this scale operate as a major stimulus to the evolution of biological life, precipitating irruptions of biological diversification (Shaw, 1994: 237, 245-6; Awramik, 1981: 88-9). But however we weigh up the overall cost or benefit of such cataclysms, theorists of the punctuated equilibrium school of evolutionary biology stress the point that they change the course of evolution profoundly and irreversibly (Gould, 1989: 51, 54; Smolin, 1997: 150-151). And in this sense, all biological life on the planet, our species included, live with and through the consequences of catastrophic events deep in the geological past.

While this sort of `neo-catastrophist' approach to life on earth may content itself with a vision of random bolide impacts, there is an variation on the theme which begins to draw us back to the idea of an earth that is implicated in a complex and dynamical cosmos. Episodes of bombardment, it now appears, may not be as haphazard as formerly presumed. Astrophysicists have recently found evidence of occasional chaotic outbursts in the orbits of Saturn and Jupiter which could trigger changes in the path of asteroids, catapulting them into earth-crossing orbits (Chown, 2004; Varadi, Runnegar and Ghil, 2003). As well as offering a potential explanation for the extinction event at the Cretaceous-Tertiary boundary, a periodic dynamical transition in planetary orbits of this nature has been linked to a die-off of even more cataclysmic proportions 250 million years ago - at the close of the Permian era. As Varadi, Runnegar and Ghil suggest, a greater understanding of the role of chaos in the orbital evolution of our solar system could also extend our understanding of both long and shorter term climatic change - by helping to explain the eccentricities in the earth's orbit that effect the amount of solar radiation the planet receives (2003: 621-2).

Evidence provided by increasingly sophisticated computer modelling of chaotic outbursts in the solar system, in this way, adds its small contribution to a much more ambitious and speculative perspective on the dynamical cosmos. In a provocative article aimed at opening the eyes of a non-specialist audience to the importance of cosmological processes, Mike Davis (1996) goes so far as to suggest that a paradigm shift is underway which is linking up astronomical and earth sciences. Drawing on extreme positions like that of geologist Herbert Shaw and astronomers Victor Clube and William Napier, Davis picks up on the idea of periodicities in asteroid showering, extending its explanatory power beyond single impacts to a cumulative effect that encompasses most of the major events in the earth's geological history. As well as their immediate effects, Shaw and others point to the addition to the earth's energy budget delivered by impacting bolides, a massive boost which they believe may have played a pivotal role in periods of global climate change, the formation of the East Antarctic ice cap, the onset of major bouts of seismic and volcanic unrest, accelerations in plate tectonic movement, and the periodic reversal of the earth's magnetic field (Shaw, 1994: 245-59, Napier and Clube, 1979: 458; Napier, 1989; Davies, 1989: 9). As Davis would have it, the shift to an `open system' view of our planet could be leading the way to a revolution in earth sciences based on the

`acceptance that terrestrial events, at a variety of time scales, form a meaningful continuum with extra-terrestrial processes' (1996: 63).

Worlds of Excess

The concepts and language of dynamical systems that social theorists are now using to engage with issues of a complex globality, I have been suggesting, have more `ex-orbitant' connotations in other fields, drawing us well beyond the bounds of our own planet. The growing interest in issues of complexity and self-organization in the physical sciences can be read in terms of a shift away from both the clockwork universe of Newton, and the entropic world of nineteenth century thermodynamics (Davies, 1987: 197-199; Prigogine and Stengers, 1984; 57-63, 129). By contrast with the classical notion of a universe of predetermined forces, and the thermodynamic vision of a one way slide into featureless equilibrium, the new view affords the cosmos an ongoing capacity to give rise to new structures, processes and potentialities, a break with determinism that implies, as physicist Paul Davies points out, that `the universe is intrinsically unpredictable (1987: 200). If applied consistently, this propensity for unforeseeable change resonates at the scale of the cosmos as a whole, the galactic level, the solar system, the earth's biosphere, all the way down to the ecology of a small pond.

While each system may be open to the wider system in which it is nested, we should keep in mind that at each level systems have their own internal dynamics, and are therefore capable of radical transformation that may depend on inputs of energy from their exterior but does not require direct external forcing or triggering (see Scheffer et al, 2001: 591). In this sense, the tightness of coupling between the earth and its cosmic environment depicted by Mike Davis, though it may be profoundly challenging to the `terrestrial chauvinism' of much orthodox earth science, is by no means a necessary corollary of complex systems theory. Indeed, for most of the events explored by the `coherent catastrophists' of Davis' account, there are alternative explanations which hinge on the internal dynamics of our planet. In the case of the massive wave of extinction at the end of the Permian era, for example, some researchers have pointed to strong evidence that major and prolonged volcanic activity may be the culprit (Benton, 2003), while others remain more generally dubious about the role of asteroid showers in exctinction episodes (Loper and McCartney, 1990, Wolfendale and Wilkinson, 1988).

More important than pinning down the direct role of meteor impact or other external influences on the biophysical processes of our planet, however, may be the more general acknowledgement that abrupt or discontinuous transformation is something we should expect: the recognition `that from time to time there will be large avalanches of changes which sweep through the system' (Smolin, 1997: 151). I have been drawing attention to the possible implication of Earth processes in a wider systemicity that takes in extra-terrestrial factors because this makes the point most dramatically that human agency need not always play a significant part in the dynamics of the biophysical world. Taking account of events at the scale of the cosmos, galaxy or solar system that potentially impact on our planet, even if their precise role remains contentious, raises questions about the extent to which `nature' can be said to have `ended' or been fully incorporated in the human social realm. Such a vision of our planet as a system which is at least partially open to its cosmic environment seems consistent with the general tenor of the study of dynamical

systems which social theorists of a complex globality are drawing upon. Yet at the same time, I have suggested, it challenges the notion of the interiorization or loss of otherness of nature that is characteristic of theories of an immanent global complexity.

What makes the forces and events of a generative cosmos excessive, however, is not just their advent in a domain beyond the earth. If there is a sense in which these processes can be seen as other to the human, it derives less from a simple spatial outsideness and more from the manner of their becoming - from their openness to futurity. In a dynamic and self-organizing state, this open-endedness is most pronounced at the point of bifurcation: the critical or singular moment when as system has the potential of entering one of two or more available states (DeLanda, 2002: 38, Deleuze, 1994: 189). In this region, even the smallest fluctuation in the environment of the system may prove pivotal in deciding which direction change will take. And because of the randomness of these instabilities or irregularities it is impossible to determine the outcome in advance. As Nicolis and Prigogine put it: `(c)hance alone will decide which of these solutions will be realized' (1989: 14).

As it passes through successive bifurcations, each complex system acquires its own individual and singular history, as in the case of the pond with its unique refraction of ripples. But while some of the multitude of fluctuations that impact on ecological and other earth systems issue from beyond the planet, as we have seen, much of the concatenation of forces influencing changes of state will also be terrestrial (see Scheffer et al, 2001). Whether their scale is quantum or tectonic, the subtle and not so subtle interplay of forces ensures that the outcome of a transformation in any of the earth's complex biophysical systems contains an irreducible element of unpredictability. In the words of Manuel DeLanda:

> nonlinear models…as well as nonlinear causes and their complex capacities to affect and be affected, define a world capable of surprising us through the emergence of unexpected novelty, a world where there will always be something else to explain and which will therefore remain forever problematic (2002: 155).

For Deleuze, the excessiveness of the world - its persistent otherness - resides not in the shape or extent of the forms we see around us, but precisely in this capacity for the generation of something other than what currently exists. (1994: 218-212; see also Ansell Pearson, 1997: 4). Likewise drawing similarly on systems theory, Derrida makes the related claim that it is `the singularity that is always other '(1992: 929). By this logic the loss of a discernible otherness to nature makes little sense as long as material forces of differentiation and inventiveness persist. Even if it were to be imagined that the surface of the earth had been overwhelmingly compromised by human agency, singularities or bifurcations would still have the potential to give rise to new forms that would be other to the known and familiar.

Just as there are inventive and differentiating forces at work that confer a unique history on an ecosystem - so too are there critical turning points in the dynamics of a population of living beings, or in single life. Viewed as a complex system, the organism itself is forged by a passage through successive bifuractions. Whereas philosophers or social scientists have often assumed that only differential forces or stimuli proper to the systemic level of the socio-cultural should be credited with shaping human lives, Deleuze has sought to show that, as embodied and thinking

beings, we too are open to the full range of fluctuations in our environment. In *Difference and Repetition*, he writes of a `turning and wounding gravitation capable of directly affecting the organism' and of `vibrations, rotations, whirlings, gravitations, dances or leaps which directly touch the mind' (1994: 219, 8). This capacity to be affected - in an immediate way - by the forces of the surrounding world is what gives bodies their ability for transformation, to become other than what they are (Deleuze, 1992: 224-229). And as we have seen, Deleuze's version of immanence is one that eschews any ultimate drawing of limits, our bodies, any bodies, are both imperilled and enabled by an alterity that is always ex-orbitant. In the Deleuzean universe, as James Williams reminds us, `the potentialities of any given actuality are the cosmos as a whole (1997: 236).

Ex-orbitant Responsibility

The ex-orbitant sense of globality I have been working towards is constituted by an otherness or excess that cannot be easily be discerned in a snapshot of the present and cannot be confined within the perimeters of our planet. But neither should we conceive of these forces and fluxes as an absolute exterior. Our bodies, Deleuze would have it, bear within their interiority the enfolding of the world around. ` Every organism', he writes `… is a sum of contractions, of retentions and expectations'. `We are made of contracted water, earth, light and air' (1994: 73). In this way the `human' always embodies something of the other-than human: traces of storms that have been weathered, stirrings of the earth that have been ridden out, poisons and infections that have been stomached. And the echo of events in the solar system and the wider cosmos. Some of these forces and process, as we now know, come back to us bearing our own imprint - which is the point theorists of a complex and disequilibrated globality have been driving home. But they also retain a power and a potentiality, I have been arguing, that is irreducibly alien, other, excessive. Whatever we have made or unmade of our world, in this sense, we remain partially under the sway of forces beyond our control, and even beyond our influence.

There is, of course, nothing new about gazing heavenwards and seeking out meaningful connections between terrestrial and celestial realms. What the study of dynamical systems may bring to this enduring enthralment, even as it substantiates intimations of an active exchange between earth and cosmos, is a new sense of the unpredictability and open-endedness of this interaction. But is this acknowledgement of the radical contingency of the universe a timely one? What is the point, it might be asked, of drawing attention to forces outside our control, at this moment when we are struggling so hard to come to terms with the events that we do have some sway over? Why, when a willingness to shoulder responsibility for triggering changes in the global environment still seems so tenuous and tentative, should we take up a concern with a different set of disturbances, with another kind of excessiveness that might well undermine these nascent sensibilities? If the world risk society thesis already finds itself flirting precariously with fatalism (see Beck, 1996: 39), invoking the chaotic and catastrophic agencies of the cosmos seems even more fraught.

This tension between renewed attention to other-than-human becomings, and moves to confront the human-induced perturbations of the biosphere, I want to argue, should not be evaded or repressed. Theorizations of global complexity, as we have seen, have already broached the issue of forces beyond human control, in the sense of forms of disorder that issue from human intervention in the material world. But stressing the

undelimitability of elements or entities unleashed by processes of technological modernization does not necessarily preclude convictions that the system might somehow come around to containing its abjects. As Van Loon has observed, in the case of theories of world risk: `(t)here is an implicit assumption that if we should deliberate properly, in an environment free from irrational interests and short-sighted power play, we may find a proper mode of reasoning about and with risks' (2002: 190).

Prominent amongst the emergent properties of increased connectivity that have been affirmed by social theorists, in this regard, are the transnational frameworks of data gathering, negotiation and regulation that are taking shape in response to the environmental predicament (see Urry, 2000: 169-70; Held et al, 1999: 408-12). Reasoning about and with risks, in this sense, unavoidably entails calculation and prediction: questions must be posed about what changes in earth processes are occurring, and may occur in the future. And equally inescapably the issue of justice is raised: questions of who is responsible and who might owe restitution to whom for transformations induced in the global environment. As Gayatri Spivak suggests, a sensitivity to the globality of the ecological crisis and the internationality of the issues of justice or responsibility it raises may well impel us to dream of an `undivided world' (1999: 382).

Theories of a complex and immanent globality, in this way, inevitably find themselves negotiating the tension between stressing the inevitability of the excesses of the global system and aspiring to their delimitation or reabsorption. Hypothetically, a world of our own making, however unruly, remains a world we might remake: a world in which there is no otherness or outside offers at least the possibility that its constitutive elements might find their way to into some novel and less threatening arrangement. Whether it is the prospect of slowing the leakage of `virulent abjects', of setting up new transnational conventions and institutions, or of the superseding of social difference into `panhumanity' (see Urry, 2003: 136), social theorists of global complexity seem to retain some hope in the reduction of disorder. And indeed, as Spivak's observation intimates, if we dream of a more just or secure world, then it is difficult not to affirm some ideal of greater symmetry, impartiality, or inclusiveness

But the point Spivak makes in relation to global environmental justice, and Derrida makes in regard to justice or responsibility in general, is its condition of `impossibility' (Spivak, 1999: 382, Derrida, 1995: 24). For all we may desire the symmetry of justice, its impartial arbitrations, well-computed restitutions and universal applicability, in the real world there will always be some intrusion that ripples the surface of reasoned judgement. What intrudes, in the language that both Derrida and Deleuze share with the field of complexity studies, is the `singularity': the critical point at which symmetry is broken and uniqueness asserts itself. What happens, or what might always take place, is `an *irruption* that punctures the horizon, *interrupting* any performative organisation, any convention, or any context that can be or could be dominated by a conventionality' (Derrida, 2001: 245). Justice - or all forms of organized responsibility - may be compelled not to exclude anything or anyone, but in doing so it always constitutes an outside. And it is that outside, leaking or bursting back in, that will sooner or later upset the dreams of a more even-handed and regulated existence (Derrida, 1992: 24, Grosz, 1998: 199-201).

While social theories of complex globality may be attentive to the logic of excess pertaining to human agency and its workings of the boundaries between polities or nation-states, I have been arguing, there is a premature foreclosure on the implications of `other-worldy' difference. The marginalization of earth-transforming forces that are other-than-human, the disavowal of fluctuations and instabilities that are not of our own making, in this sense, creates the conditions for further excessive outbreaks. The irruption that literally punctures the horizon of our planet - the impingement of a dynamic and unpredictable cosmos on earth processes - offers an extreme case of a remainder that cannot conceivably be contained, an asymmetry which is abyssal. And such excess is not simply an input that can be represented, accounted for, or anticipated, for this would constitute an inclusion. Recalling Briggs and Peat's formulation of `fluctuations … beyond any hope of measurement on earth', we need to keep in mind the element of incalculability inherent in extra-terrestrial forces, and hence their resistance to complete or ultimate disentanglement from terrestrial processes. The question of what belongs wholly to our planet, and what is incoming from beyond its perimeters, in this regard, will always retain a degree of undecidablity.

But the recalcitrance of the other-than-human, and the undecidability that attends it, is more than simply an extra-terrestrial phenomenon. There are other forces partly or largely earth-bound whose passage or non-passage through the appropriating circle of human influence will likely remain opaque to us, whose role in inducing transformations of the earth will continue to carry a remainder of incalculability. The problematizing of the self-identity of the globe by and through this `exorbitance' has implications for all decisions about environmental change, it is destined to haunt all questions of cause and effect applied to variable earth processes. To deal fairly with environmental change, inevitably, is to apportion responsibility. And to apportion responsibility is to attempt to retrace a path through successive singularities -back through critical points whose decisive influences may be fluctuations that are minute, random, and may not even issue from this planet. Measurement, calculation, reasoned judgement, in this context, present themselves as tasks which are utterly necessary, but at the same time, ultimately `impossible' (see Derrida, 1992: 16).

We should not shy away from the fact that this excess of an already excessive global complexity will prove deeply problematic for projects addressing environmental problems and other issues of transboundary endangerment. But as Derrida, Emmanuel Levinas and others have suggested, the excess that haunts every event of political, ethical, or legal decision-making also provides an opportunity. Recognising that singularities will forever exceed principles of calculation, accepting that there will always be asymmetries that draw us `beyond the straight line of justice', opens the way to a responsibility that is itself ex-orbitant (Levinas, 1969: 245, see also Derrida, 1992: 19). Following Levinas, Derrida speaks of the possibility of a justice, hospitality or generosity that is itself excessive: a response to the needs of others that is not underpinned by measure or calculation, and in this way affirms the singularity of the other, or the otherness that is always singular (1992: 25).

Under conditions where the immeasurability and limitlessness of our responsibility presents itself, as Levinas would have it, we glimpse `(t)he shimmer of infinity' in the face of the other (1969: 207). A feeling for the openness of individual and collective lives `in the last analysis' to the unpredictability of the cosmos, I have been

intimating, might bring a new impetus to this sense of obligation without reserve. In this regard, the study of complex dynamical systems reminds us that all but the simplest events are haunted by undecidability, which has implications for all organized responses to the eventfulness of our world. Pushed beyond their terrestrial application through successive levels to the scale of the universe in its entirety, theories of complexity and nonlinearity drive home the extent to which nature escapes the measure of the human. And in this way, a vision of the ex-orbitance of our planetary condition might be made to resonate with the excessiveness that is an escapable aspect of all ethical and political life. Though needless to say, any form of responsibility or justice without reserve would be no less `impossible' than its impartial, equilibrated, and equally desirable counterpart.

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[1] Clearly, life cannot provide its own preconditions. Planetary scientists refer to the `Goldilocks problem': Mars - being too far from the sun -is too cold for life, Venus - too close- is overly hot, while the earth is just right (Rampino and Caldeira, 1994). But the notion of `just right' belies important variations. Most notably, according to current astrophysical models, the sun's energy output has gradually increased by 30 percent over the last four billion years, which should have resulted in a much warmer earth than is now the case. Carbon dioxide is known to play a major part in trapping and holding incoming solar radiation (the `greenhouse effect'), and researchers have sought to identify mechanisms by which it is removed from the atmosphere and sequestered in order to explain the relative constancy of terrestrial temperatures. While geochemists have tended to emphasise apparently `abiotic' processes like rock weathering in carbon dioxide removal, the Gaia hypothesis has drawn attention to the possible role of life in the degassing of CO2, which includes pointing to the role played by the nutrient-gathering capacities of living organisms in promoting rock breakdown (Volk, 1998: 234-8; Rampino and Caldeira, 1994: 103-5).