SCALE, ECOLOGY AND COMPLEX SYSTEMS

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I.   Introduction

The relationship between political jurisdictions and ecologically-sensible geographic areas is a central concern of political ecologists; few are the cities, provinces, states or countries which map closely onto watersheds, airsheds, aquifers, ranges of migratory birds or top predators, or any other terrestrial space which makes (more-than-human) ecological sense.   As the need becomes more pressing to devise policies which help to reduce human impact on ecological systems, the inefficiencies and dysfunctionalities which result from this disjuncture between political spaces and ecological spaces are becoming more readily apparent. It is extremely difficult to devise and implement policies to protect Monarch butterflies, the ozone layer, North Atlantic groundfish stocks, or even the Oglalla aquifer, due in large part to the many political jurisdictions which must commit to policies and their enforcement. Ecological issues which are of central concern for some jurisdictions matter only peripherally or are swamped by other economic or foreign-policy considerations for other jurisdictions, leading to the familiar gridlock in environmental policy -- which of course exists not just at the international level, but also at regional and local scales (Press, 1994:84-107; Bhaskar and Glyn, 1995; Borgese, 1995:151-166; Schreurs and Economy, 1997; Adam, 1998:104-125; Altvater, 1998:34-39; O'Connor, 1994; Eckersley, 1998; Harvey, 1996:203-204; Rifkin, 1991:288-289).

Even in the unlikely event that political (and other) ecologists were to reach a consensus on how to create a global, nested series of political jurisdictions and boundaries which respected the earth's most important ecological features and systems, it would not be at

all easy to redraw political boundaries in this way, especially if democratic principles were to be employed (Low, 1997). Moreover, much of the literature on globalization stresses the declining importance of political jurisdictions and policy-making anyway, in the face of increasing global corporate power (Korten, 1995; Sachs, 1993). So what is the point of discussing the relationship between political scales and ecological scales?

In this paper, I will try to argue that the importance of political scale (both as a concept and in its grounded, appropriate ecological application) extends far beyond policy-making and supersedes corporate erosion. Political scale provides a primary means for humans to "make sense of" the world and come to terms with our place in it, as individuals and as a species.
Its value is educational, epistemological, ontological, and cultural; in fact, political scale can be seen as both a motivator and agenda for action.

Complex systems theory offers a number of insights about scale questions. After discussing some of these theoretical issues, I will return at the end of the paper to the role of political scale in a practical sense for activists.

II.   Political Scale and Bioregional Scale

Any discussion of "scales" needs to begin by defining terms. As David Harvey points out, scale questions in political ecology are both under-theorized and crucially important; different scales are simultaneously present at any particular site in nature; the temporal and spatial scales at which human beings operate as ecological agents are always changing; and political power structures are required to arbitrate and translate between the different scales required for different kinds of projects (Harvey, 1996:203).

From a political-economy perspective, scales may be defined in terms of political jurisdictions with constitutionally or internationally-agreed separation of powers, or trading blocs with integrated economic rules, or the "ecological footprints" of consuming regions on producing regions. All these areas are dynamic, changing over time as a result of political and economic activity.

From an ecological viewpoint, scales can be defined in terms of individuals, communities of individuals of the same species, food webs or chains, or ecosystem integrity. An ecosystem's integrity may be determined by its biodiversity, resilience in the face of environmental variations (whether "natural" or human-induced), or success in dissipating energy at specified temporal scales (Regier, 1992; Kay and Schneider, 1992; cited in Benvie, 1998).

Bioregionalists, in grapping with possible definitions of the term "bioregion", use such geographic criteria as watersheds, topography, and "biotic shift", or the percentage change in plant/animal species composition from one place to another (Dodge, 1990; Sale, 1985).

Porous, fluid, and changing boundaries in nature are difficult to reconcile with spatially-fixed political districts and jurisdictions. Often, as we know, it is the environment which loses out. "In view of the threats caused by spatial environmental spillovers to other areas .... a coordinated action is needed to prevent imbalances in sustainability policy at all levels and in all regions of an interconnected spatial system" (Camagni, Capello, and Nijkamp, 1998: 104). If we accept that integration of physical/geographic, ecological, economic, political and social systems is a meaningful goal, at least for policy purposes, are there some scales which make more sense than others?

The importance of scale in dynamic human-environment interactions is demonstrated by the following story:

> If a single miner attacks a mountain with a hammer and chisel, the dynamics of the mountain can be ignored because they are orders of magnitude different in scale. You can study dynamics of the mountain, such as erosion, and ignore the miner. You can study the activity of the miner and assume that the dynamics of the mountain are so slow that no feedback occurs. However, when the scale of the mining activity approaches the scale of the mountain, the systems become dynamically connected. The mining activity can no longer ignore the dynamics of the mountain, such as landslides and sloughing. The feedbacks become an integral part of the economic activity.... The simple fact is that the scale of resource utilization by society is now approaching the scale of dynamics of the ecosystem. It is no longer reasonable to assume that environmental feedbacks are not a dynamic component of the economic system (O'Neill, Kahn, and Russell, 1998:4).

Clearly it is not an easy task to weave ecological and political-economic criteria together in developing an integrated conception of scale. And yet, as the miner's story dramatizes, that is exactly what seems needed at this historical conjuncture. I would like to venture some preliminary and admittedly coarse-grained speculations about how such an integration might be developed.

For "pre-historic" times -- when human communities were closely dependent on "nature" as agriculturists and hunters, arguably the top predators in the food chain, and the geographic spread of particular human communities was limited by topography, climate, and interactions with other human communities; that is, before technologies of transportation, trade, culture and energy exploitation allowed human communities to drain

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resources and exert influence far beyond their living-space – it is easier to conceive of a correspondence between areas of human political-economic influence and "bioregions". Households, villages, towns and empires affected progressively larger geographic areas within fairly-definable discrete boundaries in what Harvey calls a "nested hierarchy" (1996:203), which was both influenced by its environment (in that wealth drawn from local "nature" permitted human population growth and concentrated settlements, and affected the kinds of power relations which evolved to mediate the production and control of this wealth) and also influenced its natural environment (by changing the local distributions of plants and animals, damming streams, using water supplies, etc.) A dynamic interplay among political power, economic livelihood and wealth-generation, and ecosystem integrity -- within geographic and temporal boundaries – is fathomable as a coherent template for discussing scale, at least historically.   (This viewpoint is now almost a cliché, thanks to the work of Oswald Spengler, Arnold J. Toynbee, Jane Jacobs, and many other commentators).

In fact, even today, as Murray Bookchin states, "the affinities between nature and society are more active than we care to admit. Very specific forms of nature, that is to say, very specific ecosystems, constitute the ground for very specific forms of society" (Bookchin, 1994:159). But as noted above, a crucial difficulty for the template arises when technological developments allow the "ecological footprint" of one polity to leapfrog over the globe in geographically-discontinuous and fleeting forays. At all scales below the global, the interplay among human political-economic scales and ecosystem scales has broken down; there is no more nested hierarchy.

What is to be done?

1)   One can argue that, since nearly all technologies are dependent on fossil fuels and

other resources which are being quickly depleted, humans will soon again be living within strict geographic and ecosystem constraints, so the old theory still applies (except for the weird temporary blip in which we are currently living). Within a few decades we'll be back to some form of nested hierarchies, albeit struggling to survive in blasted ecosystems.

2) Another option is to work for local economies and progressive community autarchy in order to increase the number of people who *do* try to live as part of their local bioregion. In effect, this means acting as if the technological developments which allow ecological leapfrogging did not exist, and/or superseding them through political action. This approach is fraught with difficulties (e.g. Where are the boundaries of each level in the nested hierarchy if you can't see them because they are only memories or yet-to-be-constructed? Is it a sure thing that local control means environmental protection? What about democracy, if most people choose cheap consumer goods and food over local self-sufficiency?) Nonetheless, the trade-reducing, local-economy approach is very attractive to many concerned and aware people (Dobson, 1990:117-123).

From this viewpoint, in general terms, it makes sense to emphasize economic activity and political decision-making at the local or regional level, since these likely correspond more closely to the bioregions in which human communities are situated. A reintegration of political-economic and ecological scales is easiest within the context of metropolitan or regional structures corresponding to bioregional and geographic spaces. Much of the critique of globalization fits neatly with this perspective: fight global corporate control by insisting on as much local/regional autonomy as possible.

The political principle of "subsidiarity", as outlined in many European Commission and trade contexts — which means to make decisions at as local a level as possible — points up the high stakes for representative democracies in keeping things local (or at least regional): "People want an accountable, truly local forum through which they can influence decisions which affect their immediate surroundings" (Bromley, 1994:138). As discussed below, local-level governance holds a powerful appeal in countering social alienation and public apathy and maintaining the relevance of political institutions (Whitwell, 1994:133).

3) Reworking theory is yet another option: if nested hierarchies are not a useful metaphor, we must come up with a new one which can handle the complexity of overlapping, discontinuous and detailed political-economic spheres of influence spotted over the globe, along with their particular ecological interactions and impacts. Time, which could practically be ignored in scale theories for pre-industrial civilizations because human-nature impacts took place mostly in terms of years or decades at least, must be incorporated as a central feature in post-modern scale theories: shifts in production and investment decisions now take place in a matter of seconds and days; storms and epidemics may ravage human populations in days or weeks; temporal stability cannot be assumed (Adam, 1998).

What are some examples of the kinds of actors and scale interactions this theory must encompass? Nike factories spread across the South, basketball players in inner cities and suburbs, television and the NCAAs, gender discrimination in Singapore and Mexico, advertising and Michael Jordan's public image, plastic factories and fabric mills, global income distribution inequities. What theory can link individual people, epistemic communities (e.g. athletes), corporate entities and their offshoots (e.g. contract factories), environmental impacts of production in one place

and disposal of used products in another place, as well as the cultural, transportation, trade, human rights and regulatory context in which all these interactions occur?   And overlap these connections geographically with myriad others?

The metaphor which comes to my mind when trying to grapple with such conundrums is vast numbers of overlapping but fairly loosely-woven spider's webs, with nodes of connection at specific points along particular information or communication channels. Some webs are circular, with most lines leading toward a point near the "center". But the centers of all the webs don't fall at the same place. Other webs are more like irregular and airy gauze, with lines going in many directions across the fabric.   The globe is swaddled in layer upon layer of these webs, each nearly-invisible but nonetheless traceable, under the right conditions.

This is not a vision of scale in a hierarchical sense. Is it relevant to "scale" at all? Only insofar as we can mentally de-link scale from a sense of physical place-with-boundaries, and conceive of regulatory and political jurisdictions as epistemic in the same sense that global corporations, environmental hazards, and cultural phenomena are unbounded.

When Saskia Sassen speaks of a "transformation in the geography of center and periphery" and says that "peripheralization processes are occurring inside areas that were once conceived of as 'core' areas – whether at the global, regional, or urban levels" (Sassen, 1994:120), I think she is talking about the same sort of de-linking of scale from place. Ingrid Burkett has recently traced the mental constructs which constrain perceptions and understanding of the distinctions between place-based communities and corporate or virtual communities. She says, "Corporate

'glocalisation'... involves more than an 'invasion' of space and place. There is also a subtler infiltration of mental constructs which occurs through such colonization, which in turn influences the ways in which people interact with both material spaces and subjective places. Thus, such colonization has a fundamental influence on the subjectivities which enable people to enact notions of 'community'...." (Burkett, 1998: 60).

The nice thing about this sort of theorizing is that all of the options listed above are not mutually exclusive! Thus, there is space for activists and non-activists, theoreticians and consumers, to find their own comfortable places and also to respect each other.

In the next section, I would like to extend this discussion by considering the cultural and educational/ontological aspects of scale issues.

III.   Complex Systems, Fractals, Disorder, and Scale

In many "natural" systems, patterns repeat at progressively larger and smaller scales. Wave action deposits ripples in sand which are echoed in the scalloping of coastlines; veins in leaves bifurcate into smaller and smaller capillaries, and these bifurcation patterns also appear in the placement of leaves themselves along branches, and branches along trunks of trees. Complex systems theory discusses these fractal patterns, or almost infinitely regressing series of similar structures which can be found at varying scales. Thus, choosing the scale at which to examine a system becomes a crucial question, at least in ecology (Benvie, 1999:59). Something which looks chaotic at one scale may, at another scale, be revealed as a version of a defining pattern in the system as a whole.

Human perceptions of political systems are arguably influenced by people's experiences of scale-related phenomena in our environment. Do we perceive a sort of fractal connection between our own individual comments in a community meeting, the role of the local representative at City Hall, an MP working in Ottawa, and Canada's voice in NAFTA or at the United Nations? To the extent that we do, the nested scale of a hierarchically-ordered political system structures our own sense of our individual and collective democratic roles and our ability to influence public events and, in fact, history.

Globalization-related pressures are changing the layout of the existing institutional hierarchy. City governments like Toronto's are amalgamated; institutional responsibilities for provision of services are rejigged (to hide, and muffle protest about, budget cuts -- but also, I would argue, as part of a fundamental attack on *how we understand* the political system and our role in it). The undermining of democratic institutions and removal of nation-states' traditional powers which come along with globalization have the effect of confusing people's perception of political scales and, to a greater or lesser degree, leading us to see existing political systems as chaos. Viewed at some scales, even the emergent structure of a mighty maple tree looks chaotic. So, is it a readjustment of political perspective (to, perhaps, the regional/bioregional scale) which holds the potential to reassert and reestablish the comfortable, nested hierarchy? Or can the hierarchical image be abandoned altogether in favour of another mental metaphor -- for example, overlapping webs of politico-economic structure within each of which people (as individuals or along with other individuals, groups and institutions which are also part of each particular web) can act, organize, and influence change?

There are attractive arguments in favour of each of these options. For example, David Slater states,

With the global deployment of neo-liberal ideas on fiscal decentralization and the cutting back of the central state's capacity to intervene economically and socially, far more attention and emphasis have been given to the local or municipal level of government than to the regional. It can be suggested that such an orientation, which leads to the weakening of the socio-economic power of the central state and the relative encouragement of a proliferation of local governments, tends to provide a more favourable environment for the operation of private capital.... In situations where the effectiveness of central state intervention in the peripheral economy is drastically curtailed, and this is combined with the relative absence of strong government at the regional level, large firms with mobile and dynamic investment strategies can operate with far fewer checks and controls than in earlier periods of development. Under these conditions accelerated insertion into the world market creates new forms of dependency, leaving financially-limited local governments in a weak bargaining position" (Slater, 1998: 24,28).

Slater also quotes Connolly and Held in arguing that "it is time to cultivate political loyalties, identifications and commitments that cut across state lines — the democratic spirit must be as mobile as the other major forces of the era" and that this requires "new imaginations that take us beyond the national frame which is necessary but not sufficient for a global project of radical democratic transformation" (Slater, 1998: 26-27).

James Rosenau, with his term "the bifurcation of world politics" (Litfin, 1993:95; Rosenau, 1993), highlights the emergence of a decentralized, multi-centric system which is as powerful as the traditional state-centred structure of international politics, and which is introducing new rules into the political game.

To speak of a world of unitary national actors with precisely defined interests

coming together to negotiate environmental regimes on the basis of their mutual

interests is simplistic to the point of distortion. Social movements and scientists

have emerged as core participants in all phases of the process, from placing issues

on the agenda to monitoring compliance with agreements. The knowledge-based

nature of environmental problems has opened up the playing field to a profusion of

unconventional players. New time frames and spatial horizons are being introduced

in international politics, even if they are not always adhered to. New norms and

principles are being suggested ina global arena, even if they are rarely

institutionalized. What is remarkable about the emergence of this multicentric world

of non-state actors is that it has occurred within the realm of ordinary international

practices – alongside the state-centric system. There are convincing reasons, then,

to believe that the two worlds may coexist and continue to interact in complex ways

(Litfin, 1993: 111).

The political functions of this parallel network include social organization, information

exchange, skills transfer, and cultural interchange (Lipschutz and Conca, 1993:336). It

can be seen as a "reconfiguration of class in modern state societies," a new form of

politics and citizenship which is *not* movement-like, since it is "specific, concrete, fluid,

and decentralized" (Isin, 1996:22, 31). Jonathan Boswell speaks of "extended proximity"

in describing the ties of "memory, loyalty and sharing" which link people across spatial,

cultural, and economic divides (Boswell, 1990:124-130).

Daniel Coleman notes that the Greens in Germany straddle the two worlds of traditional

politics and emergent, local alternatives.

The Greens are well aware that government is only one aspect of the structure of

national and global power. They see their path as one of transforming institutions

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and social relations throughout society. The German Greens describe themselves as having two legs: a "playing leg" in parliament, which raises issues, helps forge movement consensus, and legitimizes the movement; and a "standing leg" in grassroots movements, which builds the alternative structures of power. The greens raise issues and influence policy in the legislative sphere while simultaneously developing democratic initiatives in the community. Electoral success provides the Greens with a legitimacy that both empowers and politicizes local struggles. Green activity in state and national politics is geared toward supporting the development of ecological alternatives at the local level (Coleman, 1994:163-164).

In many parts of the South, where the traditional state has never had much sovereignty, authority or legitimacy, less formal but more-respected, democratic, and efficient political structures are often much better at mobilizing people to accomplish communal projects (Shahl, 1995:292-300; Egger and Majeres, 1995: 320-322). Direct linkages to outside sources of funds and ideas can facilitate these projects; the role of state governments may arguably be more problematic than helpful (Reilly, 1995: 331-344; von Wiezsacker, 1994: 172). (From this viewpoint, the WTO is finally making clear to the North the myth of state sovereignty!)

IV.   Conclusion: The Challenges of Scale

Before examining the implications for theory and action of the ideas derived from ecological and complex-systems theory discussed above, let us restate them:

1)   Defining a bioregion is not easy, but regional political units seem more likely to

correspond more closely to ecological boundaries than cities, states/provinces, or nations. For environmentally-sensible policy formation, planning, and decision-making, it makes sense to construct and empower regional jurisdictions.

2)   Human political systems echo the fractals found in nature. Spatially-organized, hierarchical political systems are familiar to many, and they structure democratic participation. Globalization is changing how these hierarchical structures function, and democracy may seem threatened by the ensuing sense of chaos.

3)   The far-flung but sometimes tenuous or ephemeral economic and political linkages characteristic of globalization reflect other patterns found in nature, such as webs and lattices. De-spatialized webs of political participation, organized along lines of communication and information, represent a new form of political structure. Whether this vision is hierarchical, democratic, desirable, or feasible, are open questions.

Two principles for measuring or deciding upon "appropriate scale" in political systems may be the following: Scale should help democratic participation, not hinder it; and scale should help policies meet ecological needs. These principles speak strongly in favour of local and regional political scales, within which people can witness the results of their own actions both politically and ecologically.

However, these principles do not exclude the sort of trans-geographic affinities which expand political scale to the global level. It may be that a consciousness of the democratic possibilities inherent in scale-shifting, in building webs of activism and political strength which span traditional spatial boundaries and gain their power exactly because of their geographic fluidity, is one of theory's most valuable contributions at this juncture.

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Local organizers and global communicators alike can take heart at the fundamental importance of both in constructing, and learning not to foul, Earth's one nest.

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