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Editorial

Rooted networks, relational webs and powers of connection: Rethinking human and political ecologies

1. Introduction

Complex connections between local and transnational realities, from markets, migration and social movements, to land use change, species invasions, viral plagues and climate change challenge geography's ability to explain and address the changing postcolonial and social-ecological landscapes that we simultaneously co-create and inhabit. Recently, a confluence of thinking about networks arising in both the social and physical sciences has shown the potential to cross the disciplinary divide and to shed light on questions of importance to nature–society geography generally and human and political ecology in particular. The purpose of this editorial is to outline a broad research agenda that would make the most of what network thinking has to offer and bring the best of nature–society geography and ecology to bear on networks in order to investigate changing social-ecological formations. To this end we propose a working coalition of scholars in human and political ecology, working through an "epistemology of allies" to apply network metaphors, models and theories to questions of power (in type, patterns, degree and terms of connectivity), integration of culture and nature, and relations of rootedness and mobility within and across territories. We are calling for a new situated science, a radical empiricism that seeks to understand complex assemblages by treating them as networks, observing and evaluating them from multiple standpoints (nodes) within a given structure. The methodology is one of 'seeing multiple', from situated perspectives within polycentric models (Rocheleau, 2004).

Networks and network theories are not new. We have long been participants in and co-creators of networks that weave together markets, materials, money and ideas, with people, places, plants and animals in myriad constellations of constantly emerging social-ecological formations; we have always been networked (Haraway, 1991). Network theories and models have likewise been with us for some time in the social sciences; regional science, transportation planning and spatial analysis have all understood some phenomena as networks. Trade, transportation, and communication networks were visible, physical entities which could be created or modified to deliver efficiencies to a developing or burgeoning economy. What is new is the recent network thinking – across fields – that refuses simple binary thinking and understands the world as always already networked, already embedded (Massey, 1994). Social networks, as invoked in social capital studies, actor network theory, social movement studies, science and technology studies, and cyber networks, have flourished in sociology, systems science, and to some extent geography. These tools, once refined, can help nature–society geographers to grapple with a complexity that refuses an easy definition into neat and tidy categories.

In addition to social network theories, complimentary network thinking – including theories of complexity, self organization from below, and neural networks – is flourishing in the ecological and computing sciences (Barabasi, 2002; Berkes et al., 2002; Gunderson and Holling, 2001; Holland, 1995; Kauffman, 2000; Strogatz, 2003) providing the potential for powerful theories and models that span the social and ecological sciences. These tools can facilitate thinking that encompasses dynamic systems and persistent structures, deterministic rules and random events (stuff happens because of x, and z; and some stuff just happens). In terms of power and hierarchies, these models can reconcile cybernetic control from above and self-organization from below.

In short, we must come to terms with networks. They have burst anew upon the academic and scientific scene, infusing our thinking with respect to technology, space and place, scale, social organization, social movements, globalization, history, dynamic ecologies and rethinking of the culture/nature dichotomy. As such this trend blazes a trail through the heartland of geographical questions regarding nature–society relations and catapults us into the new terrains of emergent ecologies and hybrid geographies (Braun and Castree, 1998; Robbins, 2004, 2005; Rocheleau et al., 2001; Whatmore, 2002; Zimmerer, 2000). Coming to terms with networks means more than just recovering or re-tooling the literal transportation and

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trade network models of connectivity and flows for duty in cyber-space (Castells, 2000). Many of the earlier generation of spatial models tended to assume 'flat' topologies and ignore the hierarchies of position and connectivity, while others over-emphasized and simplified the patterns of spatial hierarchy. We need to address the full range of new visions and values attached to networks as metaphors, models and formal instruments to expand and clarify our thinking. This takes us beyond the formal spatial tradition and into the intersection of nature/society studies with science and technology studies. The old walls are breached, and we geographers and political ecologists need to wade in, across disciplinary and sub-disciplinary lines, bridging qualitative/quantitative, physical/social and critical/positivist divisions to address questions that are central to human and political ecology as well as to social movements for justice, equality, solidarity and autonomy. The answers might even matter to people in a myriad of places and circumstances across the planet.

2. Complicating models to clarify thinking: four challenges

There is both promise and problem inherent in partial, parallel and scattered network theories and models in the 'natural' and 'social' sciences, as well as in recent attempts at integrated actor network models. Despite the compelling advantages of models that overcome the culture/nature dichotomy, there is a clear need to go beyond some of the simplified constructs that we have employed in various explanatory frameworks (social, ecological and combined). To meet the challenges of real world relevance we need to complicate our notions of networks, power, territory, connectivity and ecology. We need to (1) place power in networks, (2) connect networks to territories, (3) join social and natural networks and theories on equal terms, and (4) integrate static network structures and dynamic systems behavior. We address each of these four main points below.

2.1. Placing power in networks

The first challenge is to understand networks as relational web shots through with power. Political ecology, though noted for its attention to power in complex human ecologies (Peet and Watts, 2004; Escobar, 1999), needs to expand its notions of power to incorporate the biophysical, material dimensions of these relationships in systems and networks. Likewise, any broad science of complex human ecologies must recognize and address relations of power, not simply work within them, perpetuate them, excuse them or decry the "savage inequalities", we encounter (Kozol, 1992).

Power has been conceived as a fairly unilateral power over (control), sometimes as power against (resistance), and occasionally as power with (solidarity) (see Schmitt, 1995; Scott, 1985). We need to incorporate a whole range of more entangled and embedded relationships including power alongside, power from beneath and power in-spite-of. All of these may be manifestations of Foucauldian distributed power relations, though the model suggested here recognizes the unequal weight and force of various elements within both individual and system-wide interactions. In network models and theory there are five aspects of power that need further attention: type of connection (+ or −) terms of connection, strength of connection, structure of network, and position of actor within network.

First, we need to recognize that not all connections are positive and not all relationships are equal, notwithstanding theories of social capital (Putnam, 2000) that postulate all connections as an asset. Connections may be positive, negative or neutral in their effects on each of the connected parties in any relation. Second, we need to pay attention to the terms of connectivity amongst people, other species, and non-living elements, as well as their relation to specific locations. As Agustin (2005) has argued with respect to migrant women and sex workers, not all nomads (even if poor, alone and "foreign") are unhappy victims, and not all people living at home among family are happy and free. The terms of any one connection may be constrained, voluntary or imposed by a third actor. These terms of connection can mark the difference between, for example, slavery, commerce, coalition and partnership. Third, the strength of connection, which can be measured by units of space or time, by volume of exchange or by relative importance to the actors, is also critical to the task of identifying, describing and understanding networks. Fourth, the structure of a network has important implications for agency; four nodes with equal connections amongst all (each node has three connections) is a considerably different network, capable of different kinds and qualities of work in the world, than four nodes with uneven numbers of connections. Fifth, an individual's position within the network is not neutral or arbitrary, but has implications for how the individual views the network and how s/he/it may act within it (or against it).

Nuanced notions of power can be found in the skillful play, ambiguous meaning and pragmatic affiliations in patron–client relations as well as patriarchal families and political parties (Gibson-Graham, 2006). Power is also at work in the voluntary and passionate engagements of people in social movements, in the associations of people with place, and among living beings in ecosystems from ponds to forests to mega-cities. This expanded vision of complex, and sometimes creative, entanglements with power may in turn help us to imagine and create more just, viable and humane ecologies, and new ways to be at home within them.

2.2. Connecting networks to territories

The second challenge is to understand networks not in opposition to territory, but to recognize that networks exist in territory, help create territory and in turn are partially created out of territory. Likewise, territories can no longer be understood solely in the political tradition of fixed polygons describing the terrains of national sovereignty and

other administrative units (Goldman, 2003; Brosius et al., 2005; Roth, 2007; Vandergeest and Peluso, 2006). Territories are equally created by networks and intertwined with them; territories are no longer limited to their representation in Cartesian space. We need to ecologize the concept of territory and to deal with the contingent and relational nature of its shape, boundaries and its very existence (Roth, 2004; Rocheleau, 2005). The territory can be seen as the rooting zone of an entire network, sub-network or of individual nodes. In a network variant of an ecological footprint (Wackernagel and Reese, 1996) we can actually identify the locations and qualities of the source areas accessed by any one actor or whole groups of actors and entire networks. In effect the dispersed and articulated territory as such becomes a part of the network. Each source area and contributing 'resources' can also become elements of the network. That is, networks can be spatially explicit and specific, which allows us to recognize the sources of energy, nutrients, minerals, water, plants, animals, and human labor that "feed" networks. It is also possible to distinguish between the actors and elements that are of necessity permanently rooted in place, and those that are, or can be, mobile. We are always faced with a combination of people-in-place and people-in-networks, and we need to address the portability (or not) of people's ways of being-in-place and being-in-relation with humans and other beings. The territories of extraction can be seen as one kind of rooting, along with the territories of movement, transformation and residence. So there are distinct levels and types of rooting of actors and whole networks within territory, and these in turn are central to the creation and definition of territories.

If we think of network and root as verbs rather than nouns, it is easy to visualize some of the infinite variety of rooting strategies that connect webs of related elements to the surface(s) of the planet, as well as the technologies of internal connection within these complex entities. The patterns vary from fixity to mobility, from a focus on vertical to horizontal connectivity, and from individual to collective maintenance of connective structures and extractive processes. The habits of several plants (and plant and animal assemblages) provide clues to the varieties of rooting and webbing. For example, tap roots in some plants, such as pine trees, seem to anchor trees in place through a single deep root yet many pine species depend on an underground network of fungal mycorrhizae that pre-process nutrients otherwise unavailable for uptake through the roots. Spider plants set down roots outside the confines of fixed and overcrowded sites and when more water or nutrients are needed they drop small offshoots into new sites. Mangrove forests grow from seeds that float and take root in coastal zones, gathering soil as they grow, supported on stilted roots adapted to fluctuating tides and preparing the way for other species to form forests that join marine and terrestrial worlds. Likewise, we can imagine how nodes in networks, be they plants, businesses, people or animals, have similarly diverse rooting strategies, some with limited mobility but strong presence, others that circulate within and between territories easily, some that visibly create new land surfaces with their networks and so on. Networks do not float free from territory nor are they (or individual nodes within them) all equally fixed or equally mobile. Habit-forming connections and rooting strategies present in networks have yet to be empirically examined or taken into account when attempting to apply network thinking to questions of geographic importance.

2.3. Joining social and natural elements in polycentric networks

The call for a greater integration between social and ecological sciences is a common refrain for any scholar engaging in environmental issues, the understanding of which has been hampered by disciplinary divisions. Human Ecology, Political Ecology and Geography more generally are uniquely positioned to overcome this divide, as evidenced by the numerous scholarly works from these quarters drawing on both physical and human sciences (Escobar, 1999, 2001; Turner, 1996; Batterbury et al., 1997). Recently, network theories have been cited and used for their promise as a non-dualistic framework of enquiry. Latourian networks specifically combine humans (as individuals or as groups) with plants and animals as well as physical environmental features, artifacts and technologies (Latour, 2005; Hassard and Law, 1999; Law and Mol, 2002). However, the networks postulated by Latour tend to center on humans and expand an individual's or group's projection and power in the world. The network enlarges the reach and grasp of the actor. Meanwhile, the classification of "actors" and "actants" reinstates a separation between humans and other elements. Ecologies are characterized primarily as environments and resources in human centered networks.

We propose a polycentric model of networks that allows us to view any given assemblage from a variety of positions within the web of connection. Whether we begin with a point or with the network as a whole, it is possible to view the network from any given node, from the standpoint of each and every element, spanning all the categories of network elements from people, plants and animals, to rocks, furniture and machines. As scholars we then choose which standpoints to use and must state and defend the rationale for those choices. While some critical social theorists may oppose this on the grounds that it gives "standing" to non-human beings and even "things", it is not so far from the practices and concepts of commodity chain analysis, except that it enlarges the range of entities so viewed and the complexity of their interactions. Following the lead of other engaged critics of ANT, we propose that socio-ecological networks can be expanded from an ego-centered actor at the center to a "meshwork of multiple, intersecting networks" (Escobar, 2004) and beyond, to creative entanglements with agency on all sides, a relational web shot through with power (Rocheleau, 2003). These multiple

views from distinct points in a complex web of relation can also provide powerful examples of social and ecological viability, both existing and potential, to help envision possible futures.

2.4. Integrating static network structures and dynamic systems behavior

New material and symbolic ecologies constantly emerge from the unfolding encounters between social and biological communities, livelihoods, landscapes, technologies, and the myriad of artifacts made by people and other living beings. A network model of such dynamic socio-ecological formations may seem to imply a static, structural approach, yet new theories and models of neural networks from the biological and computational sciences incorporate the constant interplay of structure and practice. Neural networks in human brains, for example, are formed – and constantly re-made in new forms – by interactions between pre-existing structures, external events and stimuli, and subsequent responses, choices and actions. While a given structure of connections between neurons may predispose the brain to some responses, it does not determine a specific response in a given instance. Particular actions and practices (whether as responses or proactive choices) will selectively make or strengthen some connections while breaking or weakening others in the complex networks of the brain. These new structures, built through habit-forming practices of connection between neurons, will, in turn, predispose but not determine future decisions and actions. There is always the possibility and option for change, co-present with the weight and inertia of past practice and prior structure.

This very material expression of structure and agency provides a useful complex metaphor for the constant making and un-making of socio-ecological networks through continuous interactions. Cellular automata models – a class of computational model increasingly used by geographers – also provide compelling examples of self-organization from below emerging in systems with fixed, deterministic rules of interaction. If we combine these entwined models of hierarchy and self-organization with the notions of power, territory and polycentric structures introduced above, we can envision a wide range of socio-ecological scenarios and evaluate their equity and viability from multiple viewpoints.

3. Conclusion

We propose that we set out to develop new models and analyses of rooted networks, shot through with power and reconciled with territories. We specifically propose that we theorize circulation and rootedness in terms of powers of mobility and connectivity in horizontal and vertical dimensions, and that we join ecosystem, community and complexity paradigms in ecology with hybrid geographies, relational place and actor network theory to take political ecology and human-environment geography beyond the critique/technique divide. The world is networked, and always has been, but it is NOT flat, not socially and not ecologically. Neither is it a simple pyramid of predictable power with cybernetic control from above; we have always also had self-organization from below, but now it is legible to mainstream science as well as well as to several schools of social theory. The challenge is to mesh social, ecological and technological domains in theories and models of rooted networks, relational webs and self-organized assemblages, all laced with power, and linked to territories across scale.

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