SOCIAL ECOHYDROLOGY: AN INTEGRATION OF THE SOCIAL AND NATURAL SCIENCES

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Abstract

This paper considers some of the intellectual challenges that arise in efforts to integrate social issues into water management, with particular reference to UNESCO's Ecohydrology programme. It suggests that there is need to extend natural science models to mesh with well-established theoretical frameworks of human-environmental interactions developed within environmental anthropology / ecological anthropology. It considers these theoretical models, and the potential for bringing them into productive articulation, and proposes some practical ways forward.

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Introduction

This paper was written in response to a request from UNESCO's Scientific Advisory Committee (SAC) which oversees its International Ecohydrology Programme. The major aim of a recent meeting of the SAC in Paris was to consider the increasingly urgent need to encompass social and cultural issues in the Ecohydrology Programme and thus to enable more integrated forms of water management. The programme has recently undertaken some significant moves in this direction, most particularly with the formation of a Social Science Task Force.

The challenge of integration is not a new problem: most Government agencies and other water management bodies around the world have realised that it is not tenable to ignore social and cultural issues in resource management. Yet it remains that efforts to develop genuinely integrated water management programmes have been, at best, only partially successful in arriving at an equal balance of data and analysis from the social and natural sciences, or in integrating these into holistic theoretical frames, policies and practices. In the vast majority of cases social and cultural issues have been marginalised, and/or dealt with in superficial and thus not particularly useful ways. There are various reasons for this imbalance and some significant practical and political barriers to collaboration, which I have discussed elsewhere (Strang 2006, in review). Rather than reiterate these issues, this paper focuses on the theoretical models and their potential to 'speak to each other' productively. However, it is useful simply to note three key intellectual barriers:

- One: many non social scientists aren't really sure what is meant by 'social and cultural issues' and these are usually taken simply to mean economic factors.

- Two: social issues are complex, and not readily quantified or measurable. They do not fit easily into the kinds of reductive quantitative models more familiar to natural scientists and economists.

- Three, most of these debates are conducted according to assumptions arising from a dominant dualistic vision of culture and nature, as if Nature, or 'the environment' was something separate from the people who do things to it. Ecohydrological models, though integrative in considering relationships between ecosystems and hydrological systems, have yet to adopt the same approach to encompass social and cultural issues.

Ecohydrology and its theoretical principles

There have been early efforts to bring social and hydrological issues together (eg. Chorley 1969), but increasing specialisation in the sciences has tended to work against interdisciplinary or transdisciplinary development. Until recently, UNESCO's Ecohydrology programme – as one would surmise from its nomenclature – has focused heavily on ecological and hydrological issues. Thus an advanced study course at the Centre for Ecohydrological Studies in Lodz included topics such as river flows; water quality; pollution; irrigation; flood defenses; climate change scenarios; conservation strategies; hydrological patterns of river ecosystems and suchlike (Zalewski and Wagner 2000). This focus on bio-physical areas of interest is reflected in the principles of Ecohydrology as framed by the International Ecohydrology Programme and laid out in a summary of the activities of the European Centre for Ecohydrology (ERCE):

> Ecohydrology is a transdisciplinary and applied science. It uses the understandings of relationships between hydrological and biological processes at the catchment scale to achieve water quality improvement, biodiversity enhancement and sustainable development. (Zalewski, undated: 1)

The original intention of 'Ecohydrology' was to bring together ecosystemic and hydrological processes in a coherent way. Its core premise is one of 'dual regulation' which Zalewski describes as 'regulation of biota by altering hydrology, and regulation of hydrology by shaping biota' (Ibid.:2). Thus the three interactive factors are 'biota, regulation and hydrology', with the view that there will be 'harmonization of ecohydrological measures with necessary hydrotechnical solutions' and 'integration of various regulations acts in a synergistic way to stabilize and improve the quality of water resources' (Ibid.:2). This is a dual process which sees sustainability as being achieved by dealing with threats to ecosystemic health, and by enhancing the robustness of ecosystems through managerial techniques. Thus it promotes the following:

- Elimination of threats: reduction of point and non-point pollution; elimination of catastrophic floods and droughts; use of biota as impact indicators.

- Amplification of opportunities: use of ecosystem properties as a management tool. (Zalewski, undated: 2)

The underlying principle, therefore, is the idea that the ecosystem and its hydrological characteristics present a set of processes which can be actively employed to assist more sustainable forms of water use and management. This shares common conceptual ground with ideas current in catchment management discourses, about the 'environmental services' provided by catchments, for example, the water-cleaning offered by riparian vegetation, or the ability of the aquatic system to 'produce' biota. These, it is proposed, can be utilised to combat or at least ameliorate negative impacts, for example by coping with the polluted run-off from industrialised farming.

It is notable that in the Ecohydrology model (and those employed internationally by various Integrated Catchment Management programmes) most of the 'threats' to be tackled are the outcomes of human activities: pollution; overuse of water resources; land degradation; floodplain development etc. These can reasonably be presented as a set of 'negative pressures' on the normal (and hydrostatically balancing) processes of an aquatic ecosystem, while managerial attempts to support ecosystemic processes and assist them in achieving this balance may therefore be seen as a set of 'positive pressures'. I present them in these terms because it is useful to recall, at all times, that we are talking about dynamic processes: both ecosystemic and human. When we consider the ecohydrology model in this fashion, it is really not such a large step to consider how ecosystemic factors articulate with the social and cultural activities that produce both 'negative and positive pressures' on ecohydrological systems.

Ecological Anthropology and its theoretical principles

Unlike the majority of the social sciences, anthropology has – from the earliest days of the discipline – always been directly concerned with the relationship between human beings and their environments. This is due to its particular analytic approach, which is located at a 'grassroots' ethnographic level, and involves in-depth research, the collection of empirical data, and close engagement with cultural groups and their everyday activities and forms of production. In this sense, it is intrinsically inclusive of ecological issues, which are central to the immediate material world with which people interact.

An interest in specifically 'ecological' issues grew in the 1950s, with the cultural ecology led by Julian Steward (1955), and burgeoned in the 1960s and 70s (alongside the environmental movement) with the development of ecological anthropology (Rappaport, 68, Forde 1970, Harris 1965). This was further advanced in the 1970s and 80s by anthropologists such as Steven Lansing, whose work on the religious and ritual management of irrigation systems in Bali, and more recent work on rivers, has particular relevance for those interested in ecohydrology (Lansing 1991, Singer and Lansing 1989, Lansing *et al* 1998). In recent years, we have also seen the emergence of comprehensive theoretical models about cultural adaptation (eg. Morphy 1998 [1993]); human-environmental interactions (Ingold 2000); and the construction of cultural landscapes (Bender 1993, Hirsch and O'Hanlon 1995, Strang 1997).

In the background to these developments there has been a long term debate in anthropology between theories which give primacy to environmental determinism, and possibilist or constructivist theories which give human activity the major role in directing human-environmental interactions. The 'bottom line' though, is that human and ecological systems are mutually constitutive. As Sponsel put it:

> The central proposition of cultural ecology is that the ecosystem places an active role in the daily lives of a human population and interacts to some degree with every component of the cultural system (infrastructure, structure, superstructure). A corollary of this is that culture may be viewed as a system that adapts the population to its ecosystem, i.e. it promotes the survival, maintenance, and reproduction of the population. (Sponsel, 1986:73)

The major point of this paper is that it is possible to point to underlying commonalities in the principles of ecohydrology and the broad theoretical assumptions central to cultural ecology or ecological anthropology. Like ecoyhydrology, ecological anthropology focuses on interactions between systems: in this case ecological and cultural systems. The idea of 'dual regulation' can be employed here too: in essence, a concept of human-environmental relations entails a vision of ecological and cultural systems actively engaging with and interpenetrating each other. With the debates about determinisim-possibilism in mind, we can consider this as a meeting of systemic sets of pressures which can be 'positive' or 'negative' in their effects upon each other – ie. in being sustainable or unsustainable in both ecological and social terms, or as Castro puts it, in balancing environmental protection, economic development and social equity (2004).

It is important to underline, however, that these are not separate 'human' and 'ecological' systems, but interactive, interpenetrative, interdependent aspects of a whole complex of systems which are 'co-constructive' (see Hughes 1988). Anthropologists and related disciplines have gone to considerable lengths to critique a dualistic vision that separates 'nature' and 'culture' (eg. Descola and Palsson 1996). Though undoubtedly dominant in Western thinking (though not in other cultural contexts), this foundational model has been a major barrier to greater integration between the social and natural sciences, and the development of more genuinely integrative ICM. I therefore want to stress that although it is heuristically practical to label human and ecological systems as such, we need to bear in mind – at all times – that this compartmentalisation tends to obscure their actual interdependence.

As an environmental anthropologist, I rely on a theoretical model that sees 'ecological management' as part of the way that human groups actively create cultural landscapes – or waterscapes – molding their environments in accord with specifically cultural beliefs and practices. In other words, 'the environment' that they create is a product of a whole range of social and cultural beliefs, practices and values. This environment – which is as much cultural as it is natural – also acts upon them. So this is a recursive relationship – a two way street. With an understanding of this recursivity, the need to treat both 'sides' of this relationship with equality is obvious.

THE HUMAN-ENVIRONMENTAL RELATIONSHIP

Human social and cultural beliefs and practices	<<==>>	Material environment Ecosystems Hydrological systems

Making use of our heuristic labels, we can usefully consider what we might call social or cultural 'systems'. Each social and cultural (or sub-cultural) context is composed of a range of key organisational systems, for example:

SOCIAL AND CULTURAL SYSTEMS

- Religious and secular beliefs and values.
- Social and spatial organisation.
- Economic organisation and forms of production.
- Political organisation, governance.
- Legal and moral systems.

The task of an anthropologist is generally to compare and contrast these systems in different cultural or sub-cultural contexts. For instance, I have a particular interest in the meanings that people encode in water, which may be said to relate to each of these 'systemic' areas:

MEANINGS ENCODED IN WATER

- Religious and secular meanings: water as a (re)generative substance of life and health for humans, animals and plants, and whole ecosystems.
- Social meanings: water as a collectively shared social 'substance', integral to identity and vulnerable to pollution.
- Economic meanings: water as a symbol of wealth and productivity.
- Political meanings: water as a source of power.
- Moral meanings: water as a human right, a common good.

These meanings have significant effects on the ways that people use and manage water. For example, in research carried out in Dorset, I found that the meanings that people encode in water had direct effects on (among other things) the relationships between water users and suppliers; on people's willingness to conserve and protect water, and on conflicts over the ownership and management of resources. (Strang 2004).

Social and cultural systems, and the meanings they contain, result in specifically cultural practices in relation to water.

SOCIAL AND CULTURAL BELIEFS AND PRACTICES IN RELATION TO WATER

- Religious and secular beliefs and practices (eg. rituals, water for baptism, mortuary ceremonies, spiritual cleansing, water as health/life giver).

- Social and spatial practices (eg. water for cleaning, recreation, aesthetic use, demonstrating status).
- Economic practices (eg. farming, irrigation, water supply).
- Political organisation, governance (ownership and control of water).
- Legal and moral issues (material rights to water, access and control).

Thus all aspects of human social and cultural life flow into how we use and manage water in practice, with concomitant effects of ecosystems and hydrological systems. The task of an environmental anthropologist is to consider these factors systemically. Those familiar with anthropology will know that this entails involves long-term, in-depth fieldwork, with a view to building a comprehensive ethnographic picture of all the dynamics of particular cultural contexts. At the moment, for example, I am working on a project in Australia, funded by the Australian Research Council (in collaboration with another anthropologist, Sandy Toussaint, at the University of Western Australia). This is entitled: *Under Water: a comparative ethnographic analysis of water use and resource management in Queensland and Western Australia.* It is a three-year research project intended to examine the social and cultural issues involved in the way that different groups in Australia interact with water resources. Based in four river catchment areas, in remote, rural and urban areas, it compares the perspectives of a diverse range of groups on water resource issues,[1] and considers how these relate to the environmental/ecological problems relating to water in Australia, and the conflicts that arise over water resource management. As well as contributing to theoretical developments, the project is intended to inform policy development and feed into wider ongoing debates about water resource management.

All of the groups inhabiting and making use of Australia's river catchments have their own ways of interacting with and managing water resources, and their own perspectives on how this should be done. This diversity has led to some considerable difficulties in achieving a shared understanding of resource issues or agreement between groups on management. Meanwhile the environmental problems and the anxieties that these engender for individuals, communities, organisations and sectors of government are increasing in intensity.

Just as environmental scientists have found it useful to approach river catchment areas as definable 'ecosystems', social scientists are also learning the value of locating ethnographic analyses within a systemic environmental context. As with previous work in Australia and the UK (1997, 2004), this project takes a catchment-based approach in considering the diverse groups of water users in Australian river catchment areas. Research is being conducted in the Mitchell River area in Far North Queensland and the Fitzroy River area in the Kimberley region of northern Western Australia; the Brisbane River area in South Queensland and the Swan River in Western Australia.

[1] These include Aboriginal communities, graziers, farmers, miners, tourists, and domestic water users, and the local, regional and state (governmental and non-governmental) organisations involved in catchment management.

The use of the river catchment as a comparative focus is particularly helpful in bringing together socio-cultural analyses with more 'natural science' research on environmental factors. The four case studies on which this project centres will therefore place the ethnographic analyses in a context provided by quite definable ecosystems and hydrological systems. We are hoping, therefore, that it will provide a useful exemplar of how social and cultural systems can be brought together with ecohydrological systems, by recognising, from the very beginning, that human-environmental relationships are based on an interaction between social and environmental systems.

There is insufficient space to explore these here, but I also want to acknowledge that other social sciences, as well as anthropology, have attempted to bring social and natural science approaches together and integrate social issues more clearly into analyses of environmental issues. Sub-disciplinary areas, such as Science and Technology Studies (STS) and research on Large Technical Systems (LTS) have generated influential approaches (eg. Hughes 1983, 1988). Urban political ecology, emerging from Marxist geography, has generated new ideas (eg. Gandy 2002, Kaika 2005, Swyngedouw 2004, Heyden, Kaika and Swyngedouw 2006), and there has also been a range of contributions from cultural geography and sociology (eg. Crang 1998, Fiske and Shweder 1986, Gasper 2001, Yearley 2005).

Bridging the Divide

It might seem obvious, given the preceding discussion, to consider the utility of systems theory in bringing analyses of social and ecological systems together (eg Summerton 1994). There is a variety of such approaches: some efforts have been made to treat all data as multiple variables within artificial systems (Crane 2000, Schweitzer 2002, 2003), and to introduce them into agent-based modelling programmes (Paget 2000). A related systems approach (though less directed towards charting technological change) is Actor-Network Theory (ANT), which draws on semiotics as a systemic base and, as its name implies, considers the social networks that promote particular technological developments (Latour 1999, 2004, Callon and Law 1995, Dryzek 1997, Murdoch 1997, 2001).

While these endeavors have been useful in providing discursive models of systems, critics have pointed to severe limitations in their ability to encompass the range of actors involved and the complexities of the cultural contexts which direct their behaviour (Moss 2000, Hommels 2005). Major problems arise with efforts to compress social data by quantifying or simplifying complex issues in order to present a limited number of 'variables'. Treated in this way, social data tend to lose the richness of information, the multiplicity of influences upon them, and most importantly the transparency which is necessary to elucidating human behaviour. From an anthropological perspective, the detachment of social data from their explanatory context tends to render them largely meaningless, As I have pointed out elsewhere:

> In effect, this leaves human behaviour largely as a 'black box', rather than articulating the social dynamics of human-environmental interaction. (Strang 2006: under review)

The purpose of ethnography (though it is necessarily reductive to some degree) is to provide an explanatory context sufficiently detailed to locate and elucidate the issues foregrounded in the research. I would therefore argue that the major value of reductive systems approaches is as a form of 'shorthand' for facilitating communication between social and natural scientists.

What is really needed, for analytic purposes, are highly effective and comprehensive systems of data management which enable the comparison and analysis of empirical social and ecological data. These need to deal with the reality that such data take various forms, some of which are quantitative, but many of which are not. The central challenge is how to manage such a system in a coherent and consistent way.

If we come back to the 'dual regulation' offered by ecohydrology, for example, we can imagine a system in which social and ecological data are considered as interactive 'layers'. I believe that there is considerable potential in using spatially organised GPS based models, which organised data in this kind of way, thus being amenable to include data about socio-spatial organisation, resource distribution, ecological data, archaeological evidence, ritual sites and so forth. For example, if we examine Steven Lansing's study of Balinese water temples, we can see a potentially transparent 'layer' for religious sites and ritual managers; another for dams and hydrological flows; another for social and spatial organisation; and another for crops and resources. Placing these over one another imaginatively, we can then consider how these data sets affect each other.

A key point is that all of these levels of data don't have to be reconciled via systems theory or agent based modeling. The major need is that the relationships between them are made visible so that they can inform each other analytically. The maintenance of such transparency is actually much easier when researchers don't attempt to compress or quantify data that do not lend themselves to such reduction. Thus the potential for articulating relationships between social practices and ecological outcomes is greatly improved by theoretical models and data management systems which live comfortably with complexity.

I would therefore like to propose a model of social eco-hydrology that conforms to the following principles:

PRINCIPLES OF SOCIAL ECOHYDROLOGY

- It encompasses social, ecological and hydrological data.
- It recognises that social and natural science data represent two 'halves' of a whole human-environmental interaction, and treats them with equal weight.
- It allows for the inclusion of both qualitative and quantitative data.
- It organises data systematically.
- It is navigable, enabling analytic movement around the 'landscape' of data, and comparison between datasets.

Inevitably, a more complex and holistic social ecohydrological model is likely to produce more complex and holistic outputs. Policy makers and non-academic users (and possibly those more familiar with specialised and reductive scientific approaches) may consider this to be an obstacle. However, I would argue that a model which permits engagement with the real complexities that attend human-environmental interactions is more transparent and thus more likely to be comprehensible. Crucially, it is more likely to offer strongly founded analysis and better quality policy advice, and to enable the development of more successful water management practices.

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