Chapter Four

Whose Scarcity? The *Hydrosocial* Cycle and the Changing Waterscape of La Ligua River Basin, Chile

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Introduction

This chapter examines a conflict over water resources for irrigation in a rapidly developing agricultural valley in Chile's semi-arid *Norte Chico*. It explores escalating demand for new water resources, in particular groundwater, for export-oriented fruit plantations, and its implications in terms of water resources management and access to water rights between commercial and peasant farmers. Situated within the broadly-defined political ecology tradition, the chapter draws on emerging theorizations of human-nature relations to analyze how the nature of the conflict is shaped by social power, discourse and nature's agency, as well as how the conflict, and attempts to address it through the production of a physical hydrological assessment, configure uneven socio-ecological outcomes at the basin scale.

The chapter starts by outlining a political ecology approach to environmental change. The first section reviews recent theories of 'hybrid' or 'social' nature, that further attempts to conceptualize nature as simultaneously social and material, and proceeds to consider emerging critical perspectives on environmental science, that question both its supposed neutrality and its role in producing 'facts' to underpin policy. This section finishes by presenting recent applications of these perspectives to water, through the concept of the *hydrosocial* cycle, that simultaneously considers the physical hydrological cycle and the ways in which water is also controlled and shaped by social power relations and institutions, and which forms the analytical framework for the empirical case. The following section presents the case study of the material and discursive conflict over water resources in La Ligua river basin, focusing in particular on competing representations of water scarcity and visions of solutions to local water problems. The section then evaluates a hydrological assessment that was undertaken to respond to this situation, and the socioecological implications of the resulting water allocation. The penultimate section analyzes how social construction, discourse and scale are implicated in the conflict and its responses, and how they are reflected in the changing social relations and waterscape of the valley. The final section draws some conclusions about the dialectical relationship between the materiality of water and the social relations of control over it, and the very real implications for peasant farmers in La Ligua.

The Politicization of Nature and Environmental Change

Departing from the premise that socio-ecological change has *political* underpinnings, which occur at different spatial and temporal scales, this section draws on recent theorizations of nature-society relations as well as perspectives that critique environmental science and place greater attention on the agency of biophysical processes, to explore the relationship between social power and control over water.

Political ecology departs by recognizing that conventional technical approaches to natural resources (engineering, economics, law, resource management, science) are inadequate for explaining the complexity of environmental change. Such approaches are limited by their consideration of the environment as an assemblage of physical components that are subject to human manipulation. This forms the basis of 'human-environment impact' analyses, which focus on how human actions modify the natural environment. These conventional approaches are problematic in two key ways. First, they give little consideration to the complexity and interrelatedness of the social dimensions of environmental change, and instead tend to identify immediate spatial and temporal causes, with less attention to wider and/or multiple factors. Second, their primary explanations are often based on simple cause-effect relationships between human activity and environmental change, which are frequently regarded as self-evident, rather than the result of careful assessment (see also Forsyth, this volume). Failing to look beyond the 'observable' boundaries of environmental problems results in a depoliticized and dehistoricized analysis that fails to fully capture the complex nature of society-environment dynamics, and typically orients remedial measures towards these 'symptoms' rather than their 'causes' (Bryant and Bailey 1997; Castree and Braun 2001; O'Riordan 1999; Paulson 2003).

Political ecology enquiry has responded by seeking to understand the 'complex metabolism between nature and society' (Johnston et al., 2000: 590). In particular, it has more closely examined the roles of different social groups and institutions in society-nature relations, their vested interests and the power relations between them, and how these shape often uneven social and ecological outcomes, across wider spatial and temporal scales (Blaikie 1985; Bryant and Bailey 1997; Castree and Braun 2001; Paulson and Gezon 2005; Robbins 2004; Zimmerer and Bassett 2003). Power relations, which are by definition unequal, play a role in determining *how* nature is transformed: *who* exploits resources, under *which* regimes and with *what* outcomes for both social fabrics and physical landscapes (Bryant and Bailey 1997; Swyngedouw 1997b).

Given the often competing interests among different social actors *vis-à-vis* environmental management, power relations must be exercised to be effective. This is achieved by 'socially constructing' nature, whereby nature is perceived in distinct ways by different actors, within particular moments and contexts, and consequently represented according to these positionalities. The various constructions are then mobilized through associated discourses, through which social actors frame issues (definitions, problems, solutions) and promote them in ways that coincide with their particular interests and visions of how nature should be managed (Blaikie 1995, 2001; Braun and Wainwright 2001; Castree 2001b; Demeritt 2001). Political ecologists have thus sought to question conventional understandings and deconstruct situated constructions of nature, in order to uncover the power structures underlying them (Castree 2001a, 2001b).

Scale has been an important aspect of political ecology research, principally in relation to considering political economic influences on environmental change beyond the local level and the present time (Blaikie 1985). However, conventional notions of scale – 'local', 'national' and 'global' – have been criticized as preconceived divisions of space within which social processes occur, and have given rise to fresher notions of scale as more horizontal, complex, diverse, dynamic and socially produced (Mansfield 2005; Marston et al., 2005; Swyngedouw 1997a). In addition, ecological scales, such as the watershed, have largely been neglected, thus raising the dual challenges of working beyond conventional divisions of space and integrating social and ecological scales (Zimmerer and Bassett 2003).

The view of environmental issues as politicized, constructed and discursive is simultaneously challenged and complemented, by two theoretical developments: hybrid or social nature and critical approaches to environmental science.

Social nature

The *a priori* separation of 'nature' and 'society' into two distinct domains – the foundation of environmental studies, sciences and management – has been identified as both artificial and problematic (Castree 2001b; Escobar 1999; Haraway 1991; Harvey 1996; Latour 1993). As a result, attempts have been made to reconceptualize nature and society as a 'hybrid' (Swyngedouw 2004; Whatmore 2002), 'social nature' (Blaikie 2001; Castree 2001a, 2001b) or 'socio-nature' (Swyngedouw 1997b).[1] This resonates with Harvey's (1996) dialectical approach, which transcends the materiality of nature by instead considering it to be constituted, and reconstituted, by the *processes* that continually transform it:

> Dialectical thinking emphasizes the understanding of processes, flows, fluxes and relations over the analysis of elements, things, structures, and organized systems … [these] do not exist outside of or prior to the processes, flows and relations that create, sustain or undermine them (Harvey 1996: 49).

A dialectical understanding of nature emphasizes the two-directional dynamics of social and natural processes in socioecological change. This allows nature *itself* to be reconceptualised as inescapably politicized, rather than merely the object of political processes, thus overcoming the dualistic perspective of nature as external to social power. In this way, a hybrid perspective enables the political processes and power relations that underlie fused 'socioecological' change to be elucidated, as power and socioecological change can be understood as mutually and dialectically constitutive (Castree 2001b; Harvey 1996; Paulson et al., 2003). This rejects the view of nature as a purely material domain over which policies are made and social struggles occur, to an integrated 'social nature' in which the agency of non-human natures also shapes social power (Braun and Wainwright 2001; Castree 2001b; Whatmore 2002).

1 Neologisms used elsewhere include 'quasi-object' (Latour 1993), 'cyborg' (Haraway 1991; Swyngedouw 2004), and 'imbroglio' (Swyngedouw 2004; Whatmore 2002).

Rethinking environmental science

An acceptance that no presentation of ‘reality’ can be free from the positionality or discourse of the actor articulating it carries profound and far-reaching implications: it not only questions the very production of environmental knowledges and values, but also sheds scrutiny on the institutions that produce such ‘truths’ and ‘facts’. While such ideas have critiqued the supposedly objective role of the state in resource allocation, these had already been addressed by Foucault’s theory of governmentality, which holds that government technical approaches to environmental management tacitly coincide with the interests of powerful groups (politicians, technocrats, capitalists) (Foucault 2002). However, more recently, they have prompted scrutiny of the validity of science to provide knowledge about how nature works and how best to manage it (Castree 2001b; Demeritt 1998, 2001). This comprises two aspects: the validity of environmental science in producing facts, and the agency of biophysical processes in environmental change.

Moving beyond long-standing criticisms of positivism, work on the politics of environmental science has explored the constructions of nature that underlie science, and the values and interests of scientists (Forsyth 2003; Robbins 2004; Zimmerer and Bassett 2003). This has led to a reassessment of the superiority and neutrality of scientific knowledge in explaining ecological processes, and, in turn, has called into question the validity of science as a basis for environmental management (Braun and Wainwright 2001; Demeritt 1998; Forsyth 2003; Zimmerer and Bassett 2003). The use of science to produce ‘facts’ about nature, and as a basis for policymaking, is problematic. Many scientific assessments exclude social processes or make generalized assumptions about the human causes of environmental degradation, especially by failing to disaggregate the actions of different social groups. Environmental policies that accept such definitions and assessments can result in measures that not only fail to address the underlying causes, but also penalize groups who make minimal contributions to the problem. This calls for a more comprehensive analysis of scientific concepts and analysis into political ecology research, that seeks to uncover both the sociopolitical framings of problems and the epistemological limitations of ‘facts’ (Forsyth 2003; see also Forsyth, this volume).

Early political ecology work contained little explicit discussion of ecology, and tended to consider nature as both inert and the *object* of environmental struggles, which resulted in the predominance of largely political or political economy explanations for environmental change. Such analyses of environmental change or degradation are problematic because they may overlook both the complexities of ecological ‘reality’ and the agency of biophysical processes (Forsyth 2003; Walker 2005; Zimmerer and Bassett 2003). Notions of a more complex ‘ecological’ reality underlying environmental change are contentious. These stem from contemporary, but contested, debates within some ecological sciences that question notions of ecological equilibrium in favor of alternative nonlinear theories (such as chaos theory), which posit that environmental behavior is more complex, less uniform and more multi-scale than presented in conventional science (Forsyth 2003). The key debate centers on whether irregularities observed in natural processes are attributable to randomized behavior or the limitations of scientists’ ability to observe and measure them, especially beyond the local scale.

The hydrosocial cycle

Drawing on these related traditions, water has been reconceptualised from a purely material 'resource', that is tangible and observable, and which can be quantified, harnessed and manipulated, to a socio-natural one:

> Water is a "hybrid" thing that captures and embodies processes that are simultaneously material, discursive and symbolic (Swyngedouw 2004: 28).

Hybrid water can thus be understood as a dynamic flow that circulates within the *hydrosocial* cycle, as opposed to the physical hydrological cycle. As well as examining how water flows through the physical environment (atmosphere, surface, subsurface, biomass), the hydrosocial cycle also considers how water is manipulated by social actors and institutions (culture, laws, modes of management, hydraulic works, industries) (Bakker 2003; Swyngedouw 2004). Transcending the materiality of water allows the social power relations that are embodied within hydrosocial change to be revealed. These will be apparent from the different ways in which water is used by diverse social actors and its different modes of management, which are always embedded within space and time. The water-power nexus, in turn, will configure its socioecological outcomes, which will be reflected in both the physical waterscape and the social relations of access to, and exclusion from, water (Swyngedouw 1997b, 1999, 2004). Given that water is a strategic and essential resource for most economic activities, and that more powerful actors will strive to control it, water management should therefore not be merely understood as the partitioning and allocation of resources among different users, but as an inherently political struggle between social actors asserting control over nature in accordance with conflicting interests (Bakker 2003; Roberts and Emel 1992; Sheridan 1995; Swyngedouw 2004).

Water scarcity is an example of a concept that can be unraveled in this way. Its definition is typically framed as *physical* scarcity, expressed in terms of supply; for instance:

> Population growth throughout the developing world is increasing pressures on limited water supplies (Gleick et al., 2002: 2).

However, 'supply' is problematic because it fails to either fully investigate or disaggregate scarcity, in terms of *how* water resources become scarce. Although the physical supply of water is important, it cannot be separated from the social relations, which determine how, why and by whom water is used. Thus, when it can be explained by *social*, rather than (entirely) *physical*, factors, scarcity is 'produced', and can be better understood within the hydrosocial cycle (Bakker 2003; Roberts and Emel 1992; Swyngedouw 1997b, 2004). The next section examines the hydrosocial cycle in La Ligua river basin, by examining the ways in which water use and problems are framed by different social actors and how such discourses are mobilized to position favored water management solutions. It also examines the implementation of a physical hydrological assessment and its socioecological implications for water users in the valley.

Water Conflicts in La Ligua River Basin

La Ligua is a transversal Andean valley in the *Norte Chico*[2] in central-northern Chile (Map 4.1). The valley is short and narrow, approximately 20km wide and 100 km long, and characterized by steep sides. The River Ligua rises in the Andean foothills and discharges into the Pacific Ocean. Its source in the low Andes is important geographically, because the river only receives snowmelt in spring, while rivers originating in the high Andes are fed by snowmelt throughout the year. River Ligua therefore experiences a seasonal streamflow, peaking during the spring snowmelt but markedly reduced in the summer. La Ligua basin also contains a shallow and unconfined alluvial aquifer, implying that groundwater and surface water are closely interconnected. The valley is characterized by a semi-arid climate, with an average annual precipitation of 300mm, and a drought approximately every seven years (Gualterio and Curihuinca 2000; Niemeyer and Cereceda 1984).

The principal economic activity in the valley is agriculture, namely fruit cultivation on the valley floor and roaming livestock (cattle, goats) on the valley sides. The valley underwent agrarian reform between the 1960s and 1980s, in an attempt to redistribute large landholdings to landless peasants[3] (Garrido et al., 1988; Kay and Silva 1992; Thiesenhusen 1995). Under the first phase of agrarian reform (1967–1973), land was allocated to peasant collectives, whereby peasants received a small homestead plot and provided labor on the communal landholding. The second phase (until the mid 1980s) undertook ‘parceling’ projects whereby land ‘parcels’ (5–20 hectares, depending on land quality) were sold to individual landless peasants. Peasants within parceling projects were also able to buy large areas of rain-fed land on the valley sides.[4] La Ligua is now characterized by a mix of long-established farmers with large estates (100–300 hectares), peasant farmers with land parcels, and newer commercial farmers (with varying sized farms, including parcels purchased from peasants and converted agricultural land on the valley sides).

Under the neoliberal economic program implemented from 1975, commercial export agriculture became a priority for national development, and has led to the expansion and conversion of land to non-traditional export crops in the *Norte Chico* (Gwynne and Meneses 1994; Murray 1997). Since the early 1990s, La Ligua has undergone a shift from annual crops for the domestic market (beans, maize, potatoes, wheat) to permanent fruit plantations for export (avocados, citrus fruits, nuts). The area dedicated to these fruits doubled, from 3619 to 7503 hectares between 1997 and 2002, with avocados by far the dominant crop (INE 1997; ODEPA-CIREN 2002).

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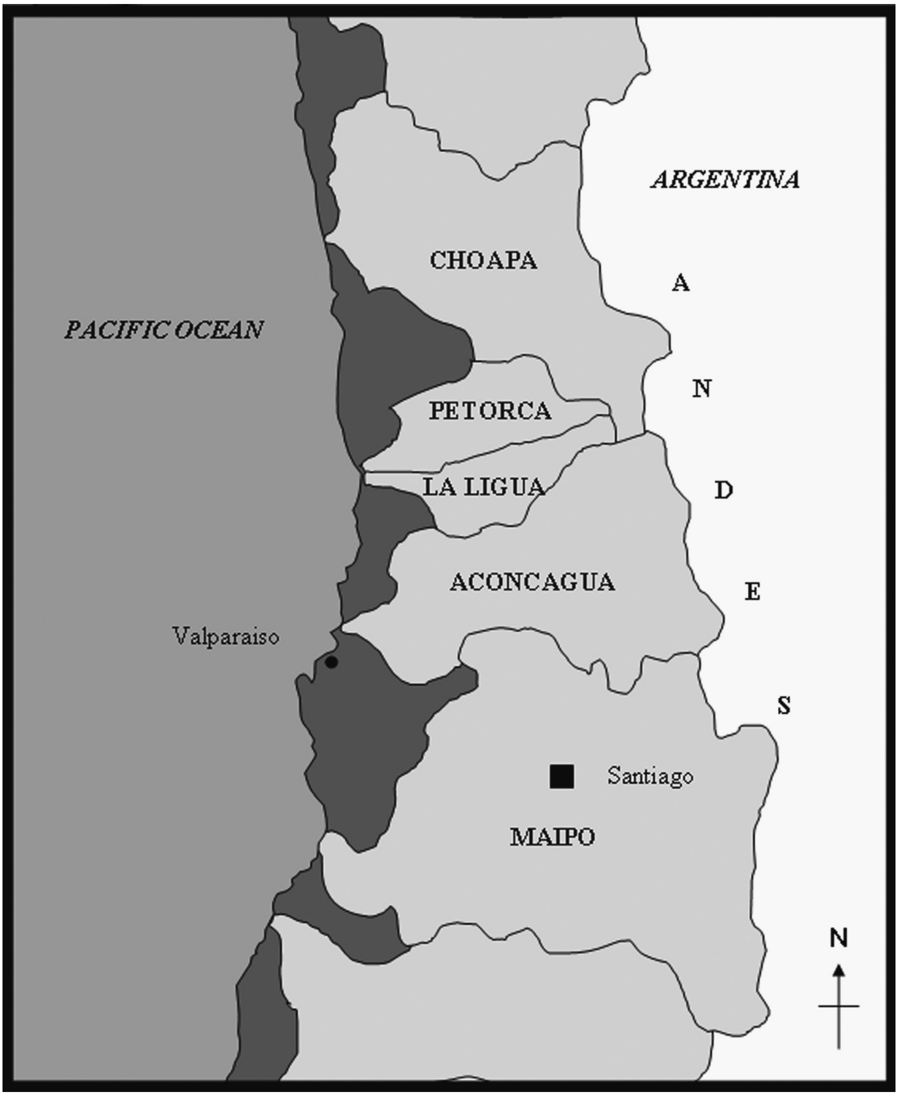
2 Situated between the arid Atacama desert in northern Chile (*Norte Grande*) and the mediterranean region of Central Chile.

3 Notwithstanding inaccuracy, for the purposes of this chapter the term ‘peasant’ is used to refer to beneficiaries of agrarian reform with small landholdings, while ‘large farmer’ is used to denote landholders of over 30 hectares who are engaged in commercial-scale production.

4 Carlos Carrera, Agricultural and Livestock Service, Santiago, interview, 28 July 2003.



Map 4.1 Location of La Ligua river basin in the Norte Chico, Chile (based on IGM 1984)

The expansion of fruit plantations was made possible by two factors: the development of new water and irrigation technology, and the availability of untilled rain-fed land on the valley sides. From the early 1990s, well-drilling, pumps and new irrigation technology, in particular sprinkler or drip systems using PVC pipes, became increasingly mass produced and inexpensive. The new irrigation systems have four important advantages compared with traditional flood irrigation: (i) they can transport water far from the source; (ii) they can irrigate uphill; (iii) they are water-efficient; and (iv) they are labor-saving. In parallel, much rain-fed land on the steep valley slopes remained untilled and used for roaming livestock, if at all. This land has two important advantages over that on the valley floor: (i) the temperature is slightly higher, which is optimal for avocados; and (ii) being rain-fed, it is very cheap.[5]

Due to the optimal climate for avocado production, high export demand and excellent returns until 2005, and the relatively easy and cheap management of avocado trees, large farmers increasingly converted land to avocado plantations. Many large farmers, as well as new large and small investors, bought up extensive areas of rain-fed slopes for new plantations (Figure 4.1). Peasant farmers have been slower to follow, but have increasingly converted some or all of their land to permanent orchards, some assisted by state credit and subsidies from the Institute for [Peasant] Agricultural Development (INDAP). While many maintained a mix of traditional crops and fruit trees, those that converted their entire parcels to avocados have been negatively affected by the drastic slump in avocado prices in 2006.[6]

The expansion of plantations resulted in increased demand for water for irrigation, and in particular groundwater. Unlike surface water, which had been fully allocated after agrarian reform, groundwater was available and apparently plentiful. As groundwater is cleaner and more reliable, it was the favored source for the new irrigation systems. Many irrigation wells now exist in the valley, and most farmers have at least one. The majority have been drilled to irrigate the slope plantations or as a backup source for dry periods. As groundwater is too deep on the slopes, most farmers have purchased land parcels – or even just a strip of one – on the valley floor, on which to drill their well(s), and transport water uphill (through PVC pipes). Water availability is the key constraint to agricultural development in La Ligua, and securing supplies is a constant preoccupation for many farmers.[7]

As Chile operates a system of private water rights under the 1981 Water Code,[8] applications to the National Water Directorate (DGA) for groundwater rights also increased. DGA records show that the majority were from large and commercial farmers. By 1996, so many groundwater rights had been requested that the DGA calculated a basic groundwater balance, and concluded that no more rights should be allocated (DGA 1996) pending a rigorous groundwater assessment, designed in 1998 and carried out in 2002 (DGA 1998, 2002). Applications for new rights were still accepted, but filed in a 'waiting list'.

5 Rain-fed land on the valley sides costs approximately US $1430 per hectare, compared with US $14,300–21,500 per hectare for land on the valley floor (2003 prices) (Ariel Zuleta, INDAP Petorca, interview, 11 February 2003).

6 Robinson Sanhueza, INDAP La Ligua, interview, 11 December 2006.

7 AI, large farmer, upper valley, interview, 13 June 2003; PLJ, large farmer, lower valley, interview, 11 September 2003; WJ, large farmer, central valley, interview, 6 June 2003.

8 Chile's 1981 Water Code converted existing water rights (the entitlement to use a certain flow of water under specified conditions) to *private property*. Private water rights are tradable, separate from land, protected by the state and regulated by civil law. The government water agency (DGA) has largely administrative, rather than regulatory, functions. For further details on the application of the Water Code, see Bauer (1997) and Budds (2004).

Figure 4.1 Expansion of avocado plantations in La Ligua

The suspension of water rights did not, however, impede the regularization of historic rights (used since 1976). Since the suspension, regularization became the principal mechanism for acquiring legal groundwater rights. However, it has been used mostly by large farmers, and has been widely abused. Many claims were either dubious or false in terms of the age of the well and the volume of water used 'historically'. Applications were submitted for wells on rain-fed land that had never traditionally been irrigated, some of which were supported by false testimonies from peasants.[9] Although water rights can be purchased from other users, there are too few on the market to be a viable option, and too expensive to be desirable.

Meanwhile, farmers continued to expand plantations and extract groundwater without the corresponding rights. Having no regulatory powers, the DGA was unable to intervene to control illegal extraction. The DGA downplays the scale of illegality in La Ligua,[10] but local evidence suggests that a large number of wells are illegal.[11] Groundwater illegality applies to all types of farmer. However, commercial farmers

9 Substantiated by two lawyers working in the valley (VP, La Ligua, 7 August 2003; SC, Santiago, 17 September 2003), and a review of 50 regularization cases (1995–2003) at La Ligua Civil Court.

10 Humberto Peña, DGA Santiago, interview, 4 August 2003.

11 This is the view of staff from local government agencies and non-governmental organizations, and corroborated by a survey undertaken by INDAP (INDAP 2003). Illegal use is openly admitted by large farmers, often citing the water rights suspension as the impediment to legalization: 'I'm in the same situation as everyone, with some wells registered and others not' (BI, large farmer, central valley, interview, 11 September 2003).

not only have resources to undertake the regularization process (legitimately or otherwise), but they also attach greater importance to legalizing water rights; partly for their value as private property (capital), partly to access state irrigation subsidies and partly to be able to legally defend their water against potential infractions. Given the barriers faced by peasant farmers to regularize their historic rights – illiteracy and/or unfamiliarity with administrative processes, lack of money to undertake the process – in 2003 INDAP initiated a program to undertake and subsidize the regularization of eligible peasants' wells, and to submit applications for newer wells to the DGA's waiting list.

Contested water scarcity

The agricultural development of the valley has become contentious among different farmers. Agricultural expansion and increasing groundwater use have significantly changed the waterscape, but opinions differ over their likely impacts. These disagreements are based on different perceptions of water scarcity, and are closely aligned with vested interests.

Established large farmers and some peasant farmers, whose farms are on the valley floor – the 'traditional' agricultural heartland – and in the lower valley, resent increasing and uncontrolled groundwater extraction to irrigate the valley slopes, a large proportion of which takes place in the upper valley. They argue that this will exacerbate water scarcity in the whole valley, which, in turn, will jeopardize existing agricultural investments. For example:

> The rain-fed land further up the valley is being irrigated with water that really belongs to the lower valley.[12]

They are particularly worried about the implications for groundwater availability in the next drought (one or more consecutive dry years), since many orchards and livestock were lost in the previous one (1996–1997).

In contrast, farmers who are cultivating the slopes *and* are located in the upper valley, including some peasant communities, generally see the problem as *produced* scarcity. Advocates of this view point out that the cultivated area irrigated with groundwater has expanded significantly since the suspension of water rights, with no apparent impacts. Some assert that the aquifer continually receives snowmelt, while others blame the DGA's failure to undertake an adequate groundwater assessment, and its 'ridiculous' decision to restrict water rights, which is detrimental to both agriculture and economic development. For example:

> Groundwater in Chile is abundant. … Water scarcity is impossible in Chile. … Problems with water scarcity are due to infrastructure, not natural scarcity. It is a problem of investment and organization, and a problem that should not exist.[13]

12 MJ, large farmer, upper valley, interview, 31 July 2003.
13 AI, large farmer, upper valley, interview, 13 June 2003.

> If all agriculture in Chile were using advanced irrigation technology, there would be no water scarcity.[14]

These competing perspectives comprise two dimensions. First, the scarcity discourse is strongly articulated by longer-standing farmers who fear that the large volumes of groundwater extracted by newer farmers could affect their water availability; while the abundance discourse can be linked to newer farmers' need to legalize their groundwater extractions. Second, there is a clear upstream-downstream dimension, whereby farmers in the *lower* valley fear reduced streamflows and declining water tables as a result of increased flows of groundwater used in the *upper* valley.

Discursive solutions

The construction of a reservoir in the upper valley is widely held as the solution to potential irrigation water shortages. A large farmers' consortium has lobbied the government for subsidized infrastructure, arguing that increasing water supply is necessary to fulfill the total irrigation demand for all users, including peasants. This argument is complemented by the observation that excess streamflows during the winter and spring are not presently being stored for irrigation. For instance:

> The problem at present is that water is just flowing into the sea, going to waste.[15]

While many peasant farmers also supported a reservoir, not all were convinced that they would benefit. Some even believed that their water would become 'trapped' in the reservoir, and that they would have to pay for it to be released.

Farmers are also divided over proposals to formalize the existing Vigilance Committee,[16] which would then have legal powers to monitor *surface* water allocation and extraction, and mediate conflicts. The debate has centered on whether to constitute one committee for the entire river, or one each for the upper and lower valleys. The divide is clearly territorial, whereby upstream farmers support two committees, whereas those downstream favor one.

The positions are closely tied to two interrelated factors: farmers' spatial location and their interests in terms of securing water availability. First, upstream farmers would benefit from a separate committee under which they would have no obligation to consider the impacts of their water use on the lower valley; while downstream farmers would benefit from the river being managed as one resource, in order to exert some control over use in the upper valley that could affect them. Second, the upper valley has a concentration of established large farmers with original estates and newer commercial farmers with slope plantations who need to secure water. The lower valley is dominated by a majority of small and peasant farmers, who fear that a potential division between the valley would mean that little or no water will flow downstream in dry periods. For example:

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14 MM, peasant leader, upper valley, interview, 20 June 2003.

15 AI, large farmer, upper valley, interview, 13 June 2003.

16 Water user organization that comprises those irrigation channel users' associations which take surface water from the same river or section of a river (Bauer, 1997).

Those upstream will grab all the water.[17]

The debate over the Vigilance Committee(s) elucidates the politics of water in the valley. The directional flow of water gives upstream users a 'natural' control over water resources against which downstream users are largely powerless. The institutionalization of this biophysical agency by upstream farmers is crucial for the success and continued viability of fruit plantations, and explains why they strive to manipulate the configuration of the valley's Vigilance Committee(s) in their own interests.

The hydrological assessment

The DGA commissioned a comprehensive hydrological assessment for La Ligua in 2002 (DGA 1998, 2002). The assessment calculated the water balance, and created a hydrogeological model to simulate future scenarios of water availability based on different levels of groundwater use (that is, granted water rights and pending applications up to 2003). The basin was divided into 13 sub-sections, and the assessment concluded that most were susceptible to aquifer depletion, due to natural hydrological patterns, but exacerbated by groundwater extraction (DGA 2002). While most sections would recuperate normal volumes following dry periods, three were predicted to undergo permanent depletion, which would also reduce surface water flows. The assessment recommended that some additional water rights could be allocated in most sections, but lower limits were advised for the more vulnerable ones. Based on the assessment, the DGA approved additional groundwater rights applications submitted by late 2003 (DGA 2004a), and declared an aquifer restriction in 2004 (DGA 2004b).[18]

The hydrological assessment contained several limitations, that compromised the accuracy of its results. First, it failed to adequately acknowledge the limitations of the model, primarily the degree to which it accurately reproduced the basin's water system. Second, it omitted a both a sensitivity analysis (which assesses the extent to which variations in the input data affect the simulated results), and margins of error for the results (the acceptable deviation from the specific value), so the accuracy of the simulations is unknown. Third, the quality of some input data was deficient. The model only used field streamflow measurements for the main river, while those for the ungauged tributaries were estimated. As these data are important inputs, any error will reverberate through the calculation of flows in the entire model. Data for agriculture and irrigation were also outdated, so crucial recent increases were not fully represented. Fourth, the model used groundwater rights as a proxy for water actually used. This is problematic because some farmers have more rights than they use, while others use water without the corresponding rights. The omission of the large amount of illegal groundwater use is particularly significant, because this is approximately *double* that of the rights considered.[19] Furthermore, the application

17 RA, peasant leader, central valley, interview, 19 June 2003.

18 A restriction means that no new groundwater rights can be allocated.

19 Illegal use (13,859 liters per second, compared with 7508 liters per second used legally) was estimated from the INDAP survey (INDAP 2003).

of a 'coefficient of effective use' to estimate the proportion of water actually used probably underestimates usage (DGA 2002).[20]

Nevertheless, the results of the assessment were adopted as the basis of policy, with no apparent consideration of the limitations (DGA 2004a). The results were presented as definite values, and a single figure of 1547 liters per second was adopted from one scenario to represent the amount of water available for allocation, despite the inaccuracies permeating the assessment. However, this figure alone was only sufficient to grant new water rights requested by October 1996. Other factors were then included to increase the flow of available water, although these were *not* included in the modeling exercise. These comprise: (i) water that is not used by crops and returns to the source ('return flow'), (over)estimated at 80 per cent; (ii) leakage from water supply; and (iii) an additional allocation of 'provisional' rights.[21] The new figure, 5542 liters per second, was sufficient to cover *almost all* of the water rights requested by November 2003, although the model had only included granted water rights and new applications until March 2001.

Although the situation in La Ligua was characterized by increasing groundwater exploitation and mounting social tension, the DGA commissioned a purely *physical* water resources assessment. The only data on water use were groundwater rights, which neither reflected irrigation practices (such as occasional well use in dry periods) nor the widespread illegality. Therefore, the assessment only considered physical flows of water and omitted qualitative factors such as patterns of use between different users. It also neglected local knowledge, from farmers, government institutions or non-governmental organizations, such as fluctuations in groundwater levels, location of springs or changes over time.

As required by Chilean law, the new groundwater rights were allocated by order of submission (DGA 2004a). However, this policy mechanism is *socially* problematic in three ways. First, the assessment failed to disaggregate the roles of different users in potential groundwater overexploitation. Second, it ignores differential access to the water rights application system based on socio-economic status. Third, it does not consider the social implications of the policy decision. Furthermore, it is also *ecologically* problematic. On the one hand, it pays no attention to the location of groundwater, so new rights can be granted in aquifer sections flagged as already vulnerable. Indeed, many applications were for the upper valley, which could affect downstream users. On the other hand, the factoring-in of return flows for new allocation reverses the order in which users receive water. If many new rights are allocated upstream of existing rights –which *is* likely– new users will receive water first, and existing users will rely on their return flow. Given the spatial concentrations of large farmers in the upper valley, and peasants in the lower valley, the *socioecological* implications of this policy have the potential to significantly impact downstream water users.

Legislative modifications to the Water Code in 2005 included a simpler mechanism for regularizing small wells (up to two liters per second) built by June 2004. The mechanism was initially valid for six months, but later extended to one

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20 For irrigation, the coefficient assumes that only 20 per cent of water is actually used.

21 Temporary rights that are allocated when permanent rights are exhausted, and are cancelled after five years if negative impacts on the aquifer are detected.

year. It has been welcome for peasant farmers, and has enabled many to gain legal water rights for wells that would otherwise have remained illegal. However, in many cases the process was impeded by peasants requiring assistance with the application, and by outdated land tenure documents.[22] The mechanism was also widely exploited by large farmers, some of whom submitted over 100 wells.[23]

Contested Scarcity and Hydrosocial Change

In La Ligua, water resources, scarcity and illegality are all unevenly distributed between large and peasant farmers. While large farmers have the awareness and resources to access water rights and lobby government bodies for solutions, peasants have fewer (legal) water rights and the exhaustion of new groundwater rights jeopardizes their irrigation security. Already suffering from low avocado prices, potential losses during the next drought, and their livelihood implications, may be severe. Wider temporal-spatial processes relating to land and water have influenced these social relations of access to water, and the physical waterscape. Historically, agrarian reform and export agricultural policies have largely exacerbated existing inequalities and made little improvement to rural poverty (Kay and Silva 1992). In La Ligua, reformed land has been regained by large farmers and converted to fruit plantations, while, large volumes of water are pumped from the valley floor to the slopes, with little attention to the water security of existing users.

The interconnectedness and directional flow of water facilitates this hydrosocial change. Unlike land, water allocations cannot be alienated, and can be difficult to protect. Instead, upstream users gain a ‘natural’ advantage, by being able to access water before it flows downstream. This is reflected in attempts by upstream farmers to form a separate Vigilance Committee that would exploit this biophysical agency and absolve them of responsibility for downstream users. The debate over the formation of the Vigilance Committee(s) transgressed into a power struggle between farmers who organized themselves on a predominantly *spatial*, rather than a *class*, basis to support the option that best coincided with their interests; demonstrating the ability of water’s agency to shape the social relations around it.

The geography of water in the valley also shapes powerful discourses used to exert social control over water. While physical hydrological conditions can produce water scarcity, the discourses of ‘scarcity’ and ‘abundance’ are used to mobilize different farmers’ interests. Thus, upstream farmers argue that the aquifer restriction reflects arbitrary and unnecessary government bureaucracy, and lobby for the reversal of the restriction; while downstream farmers criticize the over-allocation of groundwater rights and petition the state to sanction illegal extraction. Farmers favoring a reservoir relate water scarcity to seasonal fluctuations in river flow or ‘wastage’ of water into the ocean. These arguments blur physical and produced scarcity by framing the problem in terms of hydrogeological conditions and water’s materiality, which justifies a supply-led solution, while ignoring patterns of water use, namely increased irrigation of the valley slopes. Moreover, framing

22 Carmen Cancino, INDAP, personal communication, 18 April 2005.

23 Leonardo Olivares, Provincial Government of Petorca, 12 December 2006.

the problem in this way detracts attention from their *own* role in causing it. In this way, they discursively construct particular 'narratives' (Cronon 1992) or 'storylines' (Hajer 1995) to frame the water situation in a way that tacitly supports their own particular motives and desired ends. These framings are then mobilized to position these particular explanations as dominant, which will garner political support and acceptance that, in turn, will deliver benefits to those social actors who promoted their own situated readings of the problem (see also Boykoff, this volume).

Such discourses of 'scarcity' and 'crisis' are generalized to all farmers in the valley, especially peasants, in order to garner support for favored solutions. The need for a reservoir is promoted on the basis that it will foster development of the valley, with benefits to *all* farmers. Peasants have been co-opted into supporting a reservoir, but few have questioned *why* that solution is being promoted so forcefully. Indeed, it could be argued that it is precisely the large farmers undertaking agricultural expansion who are potentially exacerbating water scarcity and jeopardizing water security, in particular for peasants; yet it is also they who are supporting supply-driven solutions to this situation, but in the name of all farmers – and especially peasants – even though they themselves are likely to be the principal beneficiaries. Such discourses are only possible due to the interconnected, flowing and inalienable nature of water, which obscures the social relations of its control.

The integration of the scales at which both social and ecological processes occur gives an insight into the complexity of the situation in the valley. In particular, there is a mismatch between the scales at which processes are observed, situations are caused and remedial measures are applied. The hydrological assessment oversimplified hydrosocial processes by focusing exclusively on aquifer depletion as a result of increased groundwater extraction, and neglecting the potential effects of the relocation of groundwater use within the basin, especially in the upper valley. By only considering the hydrological cycle, the assessment restricted its analysis to the basin scale and thus narrowly examined local processes, namely groundwater extractions. As a result, it omitted underlying socio-political processes that shaped hydrosocial change, such as the Water Code and export agricultural policies, yet which operate beyond the space-time boundaries of the basin. Similarly, the policy response was homogenous in terms of its uniform application to both water users and the river basin, with potentially uneven socioecological outcomes. It was precisely the dualistic view that separates people from water, as well as the conceptualization of water as purely material, that permitted policies that produced differential access to water.

The choice of a *physical* hydrological assessment shaped how the water situation and its solutions were framed in the ensuing policy formulation. Focusing exclusively on the materiality of water had several implications. Considering water in desocialized terms obfuscated the fact that peasant farmers have not been largely responsible for any potential aquifer depletion, yet stand to lose most from the restriction. It also enabled the situation to be framed as an *environmental* issue rather than a *social* or *political* one. This itself legitimated a physical approach, positioned as a technical and accurate assessment that would reliably inform water resources decisions. The DGA presented the scientific assessment as the only legitimate knowledge about water resources, but manipulated the results by ignoring its limitations, incorporating other calculations in order to satisfy the majority of the demand (as it was under pressure to do, mainly from large farmers), and using the narrative of ‘depletion’ to impose a groundwater restriction. This also allowed the DGA to focus on the hydrological dimension (the aquifer restriction), while leaving the social dimension (the allocation of new groundwater rights) to be determined by administrative processes under the Water Code, thus deftly sidestepping the thorniest element of the situation. The decision was top-down and non-negotiable, framed as administrative and neutral, yet powerful in that it carried significant socioecological implications.

The Dialectics of Power and the Waterscape

Through the case study of La Ligua river basin, this chapter analyzed the material, sociopolitical and discursive elements of a real water conflict, based on the reconceptualisation of water from a ‘resource’ to a ‘socio-nature’. In turn, this highlighted several important and nuanced dimensions. The chapter explored how water is deeply politicized by the different actors in La Ligua, as different types of farmer struggled to secure irrigation water to meet their needs, and vied to influence modes of water management in line with their particular vested interests. However, rather than considering water as merely a static object over which power is exerted, the dialectical relationship between social power and hydrosocial change also illustrated how the materiality of nature – its biophysical properties and agency – configured the social relations of control over it. In particular, due to water’s dynamic and directional flow, upstream users enjoyed a ‘natural’ priority over access and farmers organized on a spatial, rather than a class, basis, with each group socially constructing groundwater as scarce or abundant, according to their location in the valley and agricultural interests.

The chapter also explored the implementation of a hydrological assessment, the results of which formed the basis of water policy for the basin. Although framed as scientific, by failing to consider its technical limitations, and by focusing on purely physical and quantitative processes and data, the accuracy of the results of the model simulations were questionable. Moreover, the assessment’s exclusive treatment of water as a material resource circulating within the physical environment failed to represent, and, indeed, served to subjugate, the *political* conflict over water. Similarly, based on technical environmental science, the assessment was positioned as *independent*, the water situation as *environmental*, and the subsequent policy processes as *administrative*. These discourses of neutrality – that are particularly powerful because they seek to deny their own situated nature – became important vehicles for enabling socioecological inequalities in their practical implementation, through the implementation of the desocialized water resources assessment and the resulting depoliticized allocation of water rights.

The resulting decisions had the potential to reduce the water security of the poorest group of farmers in the valley, who were least responsible for the overexploitation of groundwater to which the assessment responded. This outcome was not only exacerbated by failing to disaggregate water (ab)use among different farmers, but also by treating the basin as a homogenous scale, despite the upstream-downstream dynamic. In particular, the eventual allocation of new groundwater rights produced potentially uneven socioecological outcomes, by both failing to consider access to rights, and by reorganizing the spatial use of water in the basin. Given that the lower valley is populated by a large number of peasant communities, the 'social' and 'ecological' dimensions of the outcomes are likely to reinforce each other. This implies that peasant farmers will become the worst off, not just because they are poor, but also because they are downstream.

The approach to assessing water resources in La Ligua clearly prioritized the hydrological cycle, by privileging the estimation of physical water flows using scientific and quantitative methods, as a means of both producing knowledge and determining water rights allocation. In this way, it entirely dismissed the *hydrosocial* context within which water also flowed. As such, it ignored the conflict over water that was the very reason for undertaking the assessment; it neither paid attention to qualitative factors (such as patterns of use between different users) nor the institutional framework within which use, access and control of water was embedded (the Water Code); and it neglected local knowledge, from farmers, government institutions or non-governmental organizations. In contrast, a *hydrosocial* assessment would have given equal importance to sociopolitical factors as meteorological and streamflow data, and would also have considered local knowledge and participation in the research process, thus overturning the dominant view that only formal scientific knowledge is valid. This would not only have produced a more comprehensive, legitimate and democratic water resources assessment, but would also have reduced the potential for top-down decisions to be made. It would, however, have significantly challenged existing dominant traditions and power structures.

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References

Bakker, K. (2003), *An Uncooperative Commodity: Privatizing Water in England and Wales* (Oxford: Oxford University Press).

Bauer, C. (1997), 'Bringing Water Markets Down to Earth: The Political Economy of Water Rights in Chile, 1976–1995', *World Development*, 25:5, 639–56.

Blaikie, P. (1985), *The Political Economy of Soil Erosion in Developing Countries* (London: Longman).

—— (1995), 'Changing Environments or Changing Views? A Political Ecology for Developing Countries', *Geography*, 80:3, 203–14.

—— (2001), 'Social Nature and Environmental Policy in the South: Views from Verandah and Veld', in Castree and Braun (eds).

Braun, B. and Wainwright, J. (2001), 'Nature, Poststructuralism, and Politics', in Castree and Braun (eds).

Bryant, R. (1992), 'Political Ecology: An Emerging Research Agenda in Third World Studies', *Political Geography* 11:1, 12–36.

Bryant, R. and Bailey, S. (1997), *Third World Political Ecology* (London: Routledge).

Budds, J. (2004), 'Power, Nature and Neoliberalism: The Political Ecology of Water in Chile', *Singapore Journal of Tropical Geography*, 25:3, 322–342.

Castree, N. (2001a), 'Marxism, Capitalism, and the Production of Nature', in Castree and Braun (eds.).

—— (2001b), 'Socializing Nature: Theory, Practice, and Politics', in Castree and Braun (eds).

Castree, N. and Braun, B. (eds) (2001), *Social Nature: Theory, Practice, and Politics* (Oxford: Blackwell).

Cronon, W. (1992), 'A Place for Stories: Nature, History, and Narrative', *Journal of American History* 78:4, 1347–1376.

Demeritt, D. (1998), 'Science, Social Constructivism and Nature', in Braun, B. and Castree, N. (eds) *Remaking Reality: Nature at the Millennium* (London: Routledge).

—— (2001), 'Being Constructive about Nature', in Castree and Braun (eds).

DGA (1996), 'Determinación de la disponibilidad de recursos hídricos para constituir nuevos derechos de aprovechamiento de aguas subterráneas en el sector del acuífero del valle de La Ligua, Provincia de Petorca, V Región' [Assessment of the availability of water resources to grant new groundwater rights in the aquifer of La Ligua basin, Petorca Province, Fifth Region], Technical Brief No. 13 (Santiago: Dirección General de Aguas [National Water Directorate]).

—— (1998), 'Análisis y evaluación de los recursos hídricos de las cuencas de los ríos Petorca y Ligua' [Analysis and evaluation of water resources in Petorca and La Ligua river basins], Technical Report (Santiago: Dirección General de Aguas [National Water Directorate]).

—— (2002), 'Evaluación de los recursos hídricos, Cuenca del Río Ligua, V Región' [Evaluation of water resources, La Ligua River Basin, Fifth Region], Technical Report No. 80 (Santiago: Dirección General de Aguas [National Water Directorate]).

—— (2004a), 'Actualización de la evaluación de los recursos hídricos subterráneos acuífero cuenca del río La Ligua, Vª Región' [Update and evaluation of groundwater resources in the aquifer of La Ligua river basin, Fifth Region], Technical Report no. 166 (Santiago: Dirección General de Aguas [National Water Directorate]).

—— (2004b), 'Área de Restricción para un sector del acuífero del valle del río La Ligua' [Restriction area for a section of the aquifer of La Ligua river basin], Technical Report No. 54 (Santiago: Dirección General de Aguas [National Water Directorate]).

Escobar, A. (1999), 'After Nature: Steps to an Antiessentialist Political Ecology', *Current Anthropology* 40:1, 1–30.

Forsyth, T. (2003), *Critical Political Ecology: The Politics of Environmental Science* (London: Routledge).

Foucault, M. (2002), 'Governmentality', in J. Faubion (ed.) *Power / Michel Foucault* (London: Penguin).

Garrido, J., Guerrero, C. and Valdés, M. (1988), *Historia de la Reforma Agraria en Chile* [History of Agrarian Reform in Chile] (Santiago: Editorial Universitaria).

Gleick, P., Wolff, G., Chalecki, E. and Reyes, R. (2002), *The New Economy of Water: the Risks and Benefits of Globalization and Privatization of Fresh Water* (Oakland, California: Pacific Institute).

Gualterio, H. and Curihuinca, J. (2000), *Zonificación Agroclimática: V Región* [Agro-climatic Zoning: Fifth Region] (Santiago: Dirección Meteorológica Nacional [National Meteorological Directorate]).

Gwynne, R. and Meneses, C. (eds) (1994), 'Climate Change and Sustainable Development in the Norte Chico, Chile: Land, Water and the Commercialisation of Agriculture', Occasional Publication/Research Report (Oxford: University of Birmingham and University of Oxford).

Hajer, M. (1995), *The Politics of Environmental Discourse: Ecological Modernization and the Policy Process* (Oxford: Clarendon Press).

Haraway, D. (1991), *Simians, Cyborgs and Women: the Reinvention of Nature* (London: Routledge).

Harvey, D. (1996), *Justice, Nature and the Geography of Difference* (Oxford: Blackwell).

IGM (1984), *Mapa Hidrográfico de Chile* [Map of Hydrological Basins of Chile] (Santiago: Instituto Geográfico Militar [Military Geographic Institute]).

INDAP (2003), *Catastro de obras de captación de aguas subterráneas de propiedad de pequeños productores agrícolas cuyos derechos de aprovechamiento no se encuentren inscritos y/o regularizados en la cuenca hidrográfica del Río La Ligua* [Survey of infrastructure for extracting groundwater resources and the legal status of the water rights among small agricultural producers in La Ligua River Basin] (database) (Santiago: Instituto de Desarrollo Agropecuario [Institute for Peasant Agricultural Development]).

INE (1997), *VI Censo Nacional Agropecuario* [Sixth National Agricultural Census] (Santiago: Instituto Nacional de Estadísticas [National Statistics Institute]).

Johnston, R., Gregory, D., Pratt, G., Watts, M. and Smith, D. (eds) (2000), *The Dictionary of Human Geography*, 4th edition (Oxford: Blackwell).

Kay, C. and Silva, P. (1992), *Development and Social Change in the Chilean Countryside: From the Pre-Land Reform Period to the Democratic Transition* (Amsterdam: CEDLA).

Latour, B. (1993), *We Have Never Been Modern* (London: Longman).

Mansfield, B. (2005), 'Beyond Rescaling: Reintegrating the 'National' as a Dimension of Scalar Relations', *Progress in Human Geography* 29:4, 458–473.

Marston, S., Jones, J.P. and Woodward, K. (2005), 'Human Geography without Scale', *Transactions of the Institute of British Geographers* 30:4, 416–432.

Murray, W. (1997), 'Competitive Global Fruit Export Markets: Marketing Intermediaries and Impacts on Small-scale Growers in Chile', *Bulletin of Latin American Research* 16:1, 43–55.

Niemeyer, H. and P. Cereceda (1984), *Geografía de Chile: Hidrología* [The Geography of Chile: Hydrology], Volume VIII (Santiago: Instituto Geográfico Militar [Military Geographic Institute]).

O'Riordan, T. (1999), 'Ecocentrism and Technocentrism', in Smith, M. (ed.) *Thinking Through the Environment: A Reader* (London: Routledge).

ODEPA/CIREN (2002), *Catastro Frutícola – V Región* [Fruit Production Survey – Fifth Region] (Santiago: Oficina de Estudios y Políticas Agrárias [Agrarian Research and Policy Office] and Centro de Información de Recursos Naturales [Natural Resources Information Center]).

Paulson, S. (2003), 'Gendered Practices and Landscapes in the Andes: The Shape of Asymmetrical Exchanges', *Human Organization* 62:3, 242–254.

Paulson, S. and Gezon, L. (eds) (2005), *Political Ecology Across Spaces, Scales, and Social Groups* (Piscataway: Rutgers University Press).

Paulson, S., Gezon, L. and Watts, M. (2003), 'Locating the Political in Political Ecology: An Introduction', *Human Organization* 62:3, 205–217.

Robbins, P. (2004), *Political Ecology: A Critical Introduction* (Oxford: Blackwell).

Roberts, R. and J. Emel (1992), 'Uneven Development and the Tragedy of the Commons: Competing Images for Nature-society Analysis', *Economic Geography* 68:3, 249–71.

Sheridan, T. (1995), 'Arizona: The Political Ecology of a Desert State', *Journal of Political Ecology* 2, 41–57.

Swyngedouw, E. (1997a), 'Neither Global nor Local: "Globalization" and the Politics of Scale', in Cox, K. (ed.) *Spaces of Globalization: Reasserting the Power of the Local* (New York: Guildford).

Swyngedouw, E. (1997b), 'Power, Nature and the City: The Conquest of Water and the Political Ecology of Urbanization in Guayaquil, Ecuador: 1880–1990', *Environment and Planning A* 29:2, 311–332.

—— (1999), 'Modernity and Hybridity: Nature, Regeneracionismo, and the Production of the Spanish Waterscape, 1890–1930', *Annals of the Association of American Geographers* 89:3, 443–465.

—— (2004), *Social Power and the Urbanization of Water: Flows of Power* (Oxford: Oxford University Press).

Thiesenhusen, W. (1995), *Broken Promises: Agrarian Reform and the Latin American Campesino* (Boulder: Westview).

Walker, P. (2005), 'Political Ecology: Where is the Ecology', *Progress in Human Geography* 29:1, 73–82.

Whatmore, S. (2002), *Hybrid Geographies: Natures, Cultures and Spaces* (London: Sage).

Zimmerer, K. and Bassett, T. (eds) (2003), *Political Ecology: An Integrative Approach to Geography and Environment-Development Studies* (New York: Guilford).