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QUALITY COUNTS:
COMMON PROPERTY REGIMES FOR GROUNDWATER QUALITY MANAGEMENT

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Population, economic, technological and other changes combine to place ecosystems under stress from overuse. However, "overuse" may be manifest in more ways than simply an absolute reduction in the volume of the resource. "Overuse" may also characterize a Common pool resource situation in which, even if total quantity is unchanged, useable units available for harvest are reduced, or the basket of products becomes less diverse.

This paper argues; that resource quality its an under-appreciated factor in common property regime analysis, and that attention to this factor may improve the analysis and design of common property regimes. Conversely, I also suggest that CP regime analysis may offer insights on improving management of groundwater quality. First, I contend that groundwater can be appropriately viewed as a common pool resource, and that water quality protection would benefit by strengthening; common property regimes for its management. Second, I analyse the essential, subtractability of groundwater quality in the benefit stream, and discuss incentives for incurring the otherwise high transaction costs of collective action needed for groundwater protection. Finally, I suggest a framework for incorporating the quality dimension in the calculation of flow of resource units, which would more accurately represent the true benefits gained by collective action.

I. Common Pool Resources and Common Property Regimes

The terms “natural resources,” “common pool resources,” “common property,” and “common property regimes” are not interchangeable. Following Schlager and Ostrom (1992), in this paper “common pool resources” may include created resources (an irrigation system public security, weather, broadcast system) or natural resources (forests, fishing grounds, groundwater, etc.) which are accessible for joint use "Common property" refers to the various rights associated with a common pool resource, and the "common property regime" is the organization of rules, rights and the attendant responsibilities. These terms will be elaborated below in the discussion of their application to groundwater in water surplus regions.

A. Is Groundwater a Common Pool Resource? Groundwater has been considered as a common pool resource (CPR) insofar as it is a resource system to which many users have joint access, but analysis as a CPR has been confined mainly to the groundwater basins of arid areas, rights to which have been profoundly contentious (see Blomquist 1988; 1992). Elinor Ostrom defines a "common pool resource" as "a natural or man-made resource system that is sufficiently large as to make it costly (but not impossible) to exclude potential beneficiaries from obtaining benefits from its use" (Ostrom 1990:30). In other words, a resource is defined as a common pool resource not only in terms of its physical properties, but also in terms of its accessibility to human use.

Groundwater rights, like other water rights, have been defined primarily in terms of water quantity (Goldfarb 1984:xviii). In areas of abundant water, there has been less incentive than in arid regions to challenge and refine water law, especially as it applies to groundwater. Consequently there is still much in groundwater law which is archaic and inconsistent with current scientific knowledge and technological capacity. Both the capacity to extract and the ability to pollute groundwater have risen rapidly in recent decades.. The quality issue is of particular concern in light of the new awareness of the fate of synthetic chemical contaminants in groundwater.

Thenature of the ownership of groundwater rights likewise may seem somewhat murky in practice. Despite the legal status of groundwater as public property with usufruct rights assigned by the state,[2] the assignment of such rights in many states (and all eastern states) primarily to landowners lead to a perception of groundwater as de facto private property.[3] In water-rich eastern states," the de facto property rights associated with groundwater have not received the intense scrutiny they have faced in the more arid western states, and therefore have not had equivalent opportunity for challenge and accommodation to new information.

While the sheer abundance of a resource will generally make the transaction costs of rigorous management unaffordable, as has been true of

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[1] Goldfarb writes, j "Our legal system is replete with "legal fictions, ' such as the undiscoverability of groundwater movements, which are demonstrably false but are nevertheless preserved in the interests of administrative stability" (1984:xix).

[2] Access and withdrawal rights are defined by each) state according to one or a combination of several legal doctrines: absolute ownership (to owners•of overlying land), reasonable use (landowner's share is limited to reasonable use on overlying land) , correlative rights (reasonable use with proportional sharing of available supply) , and prior appropriation (first in time, regardless of land ownership) (Goldfarb 1984:24-26) .

[3] A recent study of public understanding of groundwater and contamination in one eastern city found that respondents did not soom to understand that "there is no such thing as private groundwater" (Hughes 1986:115, emphasis in original).

Groundwater in the eastern USA, other goals for the resource may achieve an importance great enough to reconsider the need for tighten* management. Such a need may have been precipitated with the recent awareness of the threat posed to groundwater :in the industrial east by the synthetic chemicals (Patrick, Ford and Quarles s1986).[4] Groundwater quality management became a major concern of policymakers during the 1930s. Given the diversity of interests in groundwater use, policies which were proposed involved action by diverse interest groups. Suggested federal and state strategies almost invariably emphasized the importance of voluntary local level action (see US.EPA 1984; Patrick et al. 1938:295-313). However, at the local level, municipalities were generally unprepared to take on the task of devising mechanisms for local, level protection of groundwater, even if they had experienced contamination of local drinking •water supplies (Turnquist 1993; Allee 1931).

There is a convergence here between reluctance; to organize collective action *to* manage a resource perceived as private property, and a perception of the risk posed by the contaminants which may lead users to prefer taking no action; the opposite of the course advocated by policymakers. As Bromley has noted, investigations of rational choice in situations of uncertainty have found that if the choice is framed in terms of a gain, risk seeking preference leads individuals to choose a small but certain gain over a larger but uncertain gain.

, Groundwater contamination differs significantly from surface water contamination in levels of toxicity as well as fate of the contaminants. Many synthetic organic chemicals are toxic in small concentrations and can be ingested unknowingly over long periods of time. Adverse health effects may accumulate long before they are recognized or associated with the water. The concentration and persistence of chemicals are generally much greater in groundwater than in surface water, and their source and path may be difficult to trace, particularly in areas of fracturedrock. See Patrick, Ford arid Quarles (1986). , *However,* rink aversion behavior is the opposite: if the choice is between a small but certain loss and a larger but probabilistic loss, individuals will take the chance that the large loss will not occur (Bromley 1992, citing research by Tversky and Kahneman 1907'), In terms of investing in measures to avert the risk of groundwater contamination, it would seem from this that communities would rather take their chances with possible groundwater contamination than choose the smaller but certain loss of investment to prevent contamination.

Bromley comes to the point that entitlement structures (property rights) influence the framing of the choice problem as well as the criteria for evaluation of the options for solving the problem (1392:10). He observes that

> if politicians perceive "an implicit entitlement structure in which individuals are; thought to have a right to something, we should not be surprised to observe actions that display scant interest in taking chances with that perceived right (1992:18).

My research in 90 communities of upstate New York which had experienced groundwater contamination supports thin observation at tin; community level. Comments during interviews revealed that a concern with property rights was one source of reluctance to adopt community level land use controls for groundwater connection (Turnquist 1993; see also Allee 1991).

It seems possible that this reluctance may be challenged by a reformulation of groundwater rights to include quality, and that acceptable quality may best be guaranteed by some increased level of collective management. Introducing the notion of groundwater quality as a collective property right may *he* facilitated by a reformulation of the benefit stream which demonstrates the essential subtractability of groundwater, if quality quality is also considered, even in water-rich areas.

II. Subtractability of Groundwater

The attribute of subtractability constitutes an important distinction between common goods and public goods. Subtraetability means that the consumption of a resource unit by one user makes it unavailable for other users. A nonsubtractable resource unit, for example, is a weather forecast;[5] one user of the information does not reduce the amount remaining for other users. Subtractability of resource units means that a resource may, quite simply, get used up. Ostrom makes a useful distinction between the "stock of a resource" and the "harvest, or flow, of resource units." Considering only the quantity dimension of groundwater, the resource flow would be defined as water extracted. However, it is clear that a use of groundwater which degrades it without reducing the volume is equivalent to the subtraction of resource units, as units of a necessary quality are no longer available to others. The flow of resource units has been affected, and may remain unavailable for years or decades, depending on the subsurface conditions governing groundwater movement.

The impact of quality degradation on other types of common pool resources also illustrates subtractability due to quality degradation as a resource unit quite distinct from a reduction in quantity. Both pollution and loss of diversity may degrade a common pool resource, reducing the benefit stream to users while leaving the total volume or quantity of the resource unchanged. For example, contamination of fishing grounds may render the entire catch worthless, or may selectively eliminate one or more desirable species, altering the balance of species in the ecosystem, perhaps to a less economically viable mix. A

[5] This example is taken from Ostrom (1990:32).

forest commons in which a certain product is overharvested, or in which fewer species are replanted to replace harvested resource units, may become less diverse. For a logging company, this may not be undesirable, but for a village commons, this could entail a serious; reduction of resource units. Although the subtractability of usable resource units due to degradation as described above focused on an unchanged volume of resource stock, it should be noted that for groundwater (and perhaps other resources) it is frequently the case that quality degradation may also result from a reduction in the volume of stock. Quantity/quality interactions may result when lowered water levels lead to extraction of water from levels with geological deposits of natural contaminants such as lead, sulphur, or fluoride, lowering the flow of resource units beyond that caused solely by the reduction in stock. Extraction of water above recharge levels also commonly leads to salt water intrusion in coastal areas, rendering groundwater unusable for agriculture as well,as domestic consumption.

While the flow of resource units in water have often been characterised in volumetric units or as in-stream and consumption/diversion uses, an alternative framework for incorporating water quality into the classification of water uses would provide a means for including quality in the calculation of the benefit stream. Reduction of usable units due to pollution of a seemingly plentiful resource may alter the cost/benefit ratio of undertaking collective action. Such a framework is discussed in the next section.

III. A Framework for Incorporating Quality in the Benefit Stream

A scheme for classifying water uses in terms which make them comparable has been suggested by William Goldfarb, who proposed distinctions based on the consumptive, nontransformative, or transformative uses of water (1984:xviii). A nontransformative use may•involve withdrawal of water which subsequently is returned to the source unchanged. Consumptive and transformative uses have the greatest impact on groundwater quality, either by reducing the supply to levels which affect the absolute quality of the remaining water, or by rendering the water unfit for some or most purposes through contamination, such as by agricultural use or by waste disposal. The scheme of consumptive, transformative, and nontransformative uses of water enables one to understand that each of these constitutes a distinct type of resource unit, requiring different rules for access and withdrawal.

Nontransformative uses pose the least need for control of access or withdrawal, as the water is essentially only borrowed and returned in the same condition. The flow of consumption units, at least in eastern states, seldom affects the resource stock adversely, and consequently require little management attention. The flow of transformative uses, on the other hand, presents the greatest threat to the other two types of resource units as well as to the resource stock itself.

The three types of uses are not necessarily mutually exclusive in a given event. Of the water extracted for consumption, some may be returned in a nontransformed state, perhaps after passing through a septic system, and some in a transformed condition, perhaps mixed with synthetic chemicals which were rinsed.

In eastern states of the USA, exclusion from consumption use rights is achieved in practice on the basis of landownership or residence. Overuse has seldom been a problem. However, excluding transformative uses (i . e . , preventing contamination) pose a major challenge to user-managers. A common property regime's resource may always be vulnerable to accidents or deliberate sabotage, but in general exclusion of transformative uses and of users with interest in transformative but not consumptive *uses are* pursued through institutional means such as community education, consensus on behavioral rules, various land use controls, and enforcement through fines, taxes, and other compensatory means.

Reconsidering the subtractability issue in terms of these categories, one can say that the usability of groundwater is reduced by the exercise of transformative use rights. An example from a community in upstate New York concerned a rural neighborhood in which the automotive repair shop operated by one homeowner discharged motor oil into the ground, contaminating the wells of seven additional houses. The owner of the auto repair shop essentially appropriated a right to transform the groundwater by the waste he discharged into it. His transformative use of the water subtracted from the total resource stock the flow of consumption uses, although if anyone else wanted to contaminate the water further their transformative use of the water for those
purposes ;was not affected by his actions. Its possible that nontransformative uses of the water, such as watering an unfertilized lawn or garden, may not have been reduced by his transformative use.

In sum, the impact of the flow of transformative resource units as the right to discharge pollutants into a groundwater source roust be considered separately for each of the three different types of uses. The flow of transformative resource units may not subtract from other transformative resource units remaining to be harvested by other users, unless (as in the

pollution permit systems employed by many states) rules define a limited number of these resource units to be available, or a transformative use degrade the resource in such a way as to make it unuseable for another transformative uses.
However, users who harvest these transformative resource units subtract from the total resource units , available for consumption and nontransformative uses (assuming these too require water of a given quality). The flow of consumption units reduces the stock in volumetric terms, while nontransformative uses have no impact.

Final Comments

If common property theorists begin to distinguish quality issues from strictly quantity issues, it will be important to clarify what is meant by "degradation" of a resource. Quality degradation can result from a number of factors such as resource depletion or resource contamination. Common property resource regimes which fail at the task of maintaining resource quality may ultimately destroy the useability of the resource, even if the resource quantity has not significantly changed.

Quality is by no means an overlooked factor in common property resource management, yet the lack of incorporating of quality issues into the calculations of the benefit stream may lead to undervaluingthe significance of these activities to the users' estimates of costs/benefit balance. Margaret McKean described mechanisms in several Japanese villages by which resource

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e Some transformative uses accumulate pollution such as to eventually render the resource unavailable for the same transformative use; a case of this is irrigation in which each time water is returned to the canal for use further downstream its quality has been additionally degraded by agricultural chemicals or soil deposits.

quality, of the commons was sustained at required levels,, such as restricting access at prescribed times or to harvesting with prescribed technologies (McKean 1992). Maintenance of a sufficient and high quality groundwater supply is a conscious objective of such practices in Rajasthan, India. as preventing salinization througha preference to recharge groundwater rather than retain captured water In surface storage (Rosin 1992) . Conversely, the desire to capture as much manure in a water supply as possible, when the supply will be used for irrigation (or the siltbed left behind will be planted) , is the rational1 for a tradition of removing one's shoes when walking across a recharge area abovean embankment, so as not to "walk off" with manure to an unproductive location.7 At the very least, the quality aspects of these techniques of traditional water management systems were invisible to outside water management specialists concerned to augment quantity.

Quality management of:common property resources may involve organizations and institutions beyond the boundaries of the immediate users/beneficiaries. In the case of groundwater, while moststateshave expressed quality goals as part of their water management strategy, it is well recognized that the state is unable to provide complete protection for water sources (National Research Council 1986) Patrick et al. 1386; USEPA 1984), particularly from "nonpoint sources" of pollution.8 Most nonpoint sources of groundwater contamination

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7My thanks toRavi Chopra, People's Science Institute, Dehra Dun, India for this example.

8Nonpoint sources Include just about everything which hasn't been issued a permit for routine discharges: agricultural runoff, leaking underground tanks, transportation accidents, leaking landfills or hazardous waste disposal sites, septic systems, midnight dumping, *and* dirty motor oil dumped down the woodchuck hole in the woods behind the house.

require collective action at the sub-state level for mitigation or elimination. Of particular note is the insstitutional tool of land use controls, a mechanism which in some states, including New York, is available for most purposes' only at the local level.

As we consider how to improve mechanisms for protecting the environment, the experiences of common property resource management seem to offer much scope for generating or analyzing proposals for institutional change. Additionally,

conceptual clarity in common property resource analysis may benefit by according greater recognition to the goals of resource quality preservation and the institutional rules devised to achieve these goals.

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