ORGANIZATIONAL ENGINES OF WATER PRODUCTIVITY, SOCIAL JUSTICE, AND ENVIRONMENTAL SUSTAINABILITY IN THE POUDRE RIVER BASIN OF NORTHEASTERN COLORADO

David M. Freeman[1] John Wilkins-Wells[1]

ABSTRACT

Non-profit cooperative associations of irrigators--known as Mutual Companies–divert, transport, and manage irrigation water across the arid landscapes of the Western United States. These local organizations empower people to provide themselves with agricultural water under control. This paper describes general attributes of mutual companies and reports that 18 mutual companies operating canals and reservoirs in the Poudre River Valley of Northern Colorado have evolved organized patterns of water use, exchange, and re-use that contribute importantly to water resource productivity, distributional justice, and environmental sustainability. Daily water re-use ratios average 1.9:1 over a 24 year period (1970-1994) and sometimes rise as high as 3.3:1 in a calendar year. This level of water re-use is made possible by the 18 mutual companies and the arrangements that they have made among themselves and other water users over the last century. By studying the attributes and capabilities of mutual companies, we can distill lessons regarding how human beings can better organize themselves to manage water.

OBJECTIVE

It is the objective to examine a set of organizations diverting and managing irrigation water in the Poudre River Valley of Northern Colorado. They are non-profit cooperatives known as Mutual Companies. Mutuals are incorporated or unincorporated associations of irrigators who have organized themselves for the collective task of diverting, transporting, and managing irrigation water in their canal command areas. This form of local organization is strategic to any policy attempts to improve water resources management in the arid Western United States because they are central to:

1. enhancement of water productivity that is critical to agriculture, municipalities, and industry;

---

[1]Respectively, Professor and Assistant Professor, Department of Sociology, Colorado State University, Fort Collins, CO 80523

2. improvement of distributional justice among multiple and conflicting water users;

3. advancement of environmental sustainability via improvement of wildlife habitats.

By studying the attributes and capabilities of mutual companies, we can distill lessons regarding how human beings can better organize their water resources. There is much at stake in the investigation of a form of organization that empowers people to transcend individualistic self-seeking behaviors in marketplaces and that provides socio-political space for communities of resource appropriators to 1) democratically conduct discourse about resource policy; and 2) to adapt themselves and general national policies to local site-specific conditions.

MUTUAL IRRIGATION COMPANIES

Mutual Companies, non-profit cooperative associations of irrigators, have been constituted to divert, regulate, store, and distribute water to members primarily for irrigation of agricultural crops (Maass and Anderson, 1978; Dunbar, 1983: 29-35). With urbanization and industrialization of their canal command areas, they also increasingly integrate into their operations municipal, industrial, and environmental agendas (Wilkins-Wells, 1999). Mutual Companies constitute by far the greatest proportion of irrigation organizations in the Western United States and they serve about 45% of the irrigated acreage (Table 1). Obviously, Mutual irrigation associations are a most strategic form of local organization on the Western water scene.

As European settlers established irrigated agriculture in the arid regions of the Western United States in the late 19th and early 20th centuries, they everywhere faced the problem that construction of river diversion works, ditch systems, and reservoirs required large outlays of economic capital–sums far exceeding their capabilities individually or in small groups. The general response was for farmers to mobilize themselves into mutual ditch associations for the purpose of combining resources to undertake the work collectively as a community of irrigators.

As an organizational form, mutual irrigation associations share some common attributes:

1. Farmers and their associations do not own water; water is publically "owned" by all of the people of the respective states. Mutual ditch associations have secured a right under state appropriation doctrine to divert water for beneficial use and they mobilize the revenue from their membership of water

Table 1. Types of Organizations As Percentage of Western State Total, 1969

Irrigation Organization	Percentage of All Organizations	Percentage of All Acreage Irrigated By Organizational Type
Mutual Water User Cooperatives	86.3	45.1
All Districts (Irrigation & Other)	9.1	47.1
Bureau of Reclamation Constructed and Operated	.7	1.8
Bureau of Indian Affairs	.7	2.9
State and Local Governments	.5	.2
Commercial Companies	2.7	2.9
	100.0	100.0

Source: U.S. Bureau of the Census, Census of Agriculture, 1969. Vol. IV. Irrigation. U.S. Government Printing Office, 1973 p. xxv. This represents the most recent data available given that such organizational data have not been reported in subsequent census efforts. There is, however, good reason to believe that these data closely reflect present realities.

users to pay annual costs of managing the resource while it flows through their canal command areas. In addition, revenue is raised to pay non-routine costs of initial capitalization of canal and other works, and periodic rehabilitation.

2. An organizational centerpiece is a system of water shares. Farmer-members transferred any individually held water rights to their mutual ditch company and, in return, received shares of stock representing their fraction of investment in the collective enterprise. These shares of the association's collective water and physical assets could then be bought, sold, or leased among shareholders within the canal network. The concept of water share (Freeman, 1989: 27-29) is two-sided: 1) on one hand it confers a benefit–organized delivery of a fraction of the Mutual's water under appropriate control to meet crop or other demands; and 2) it imposes an assessment obligation upon each shareholder to pay a proportionate "fair share" of organizational management cost. Example: costs of water management are summed for an operating year and if irrigator X received 5/100's of the beneficial water flow, X would be assessed 5/100's of the organization's cost of managing and delivering that flow.

3. The organizations are non-profit. Revenues are mobilized to the extent necessary to cover costs and no more than necessary to provide for emergency contingencies. It is in the interest of members to assess themselves as little per

share as possible to keep costs as low as possible for the water resource. Incorporated Mutual Companies, registered with the Secretary of State, must submit annual reports to establish that their operations are conducted within the legal parameters established by the enabling legislation for such non-profit enterprises.

4. Shareholders democratically establish policy and elect Boards of Directors (typically 5-7 leaders from the irrigation community) to implement policy adopted by shareholders at annual meetings and to oversee daily management. Boards, in turn, employ the necessary staff for operations and maintenance. Association policy, including establishing annual share assessments, is established by voting shares of organizational stock. Unlike stock in private corporations that delivers a periodic dividend check, stock in mutual companies delivers no monetary benefit but does provide a benefit in the form of water deliveries under community control.

Mutual Companies in Colorado's Poudre River Valley

The Cache La Poudre river drains a modest area (about 1,900 square miles) and appears as little more than a short wisp of line on the typical highway map used by travelers contemplating North Central Colorado. The river, in its physical and biotic aspects has been described (Evans and Evans, 1991) and a scholarly summary of the operation of irrigation organizations in the Poudre river valley is also available (Anderson, 1978). The main stem flows about 80 miles from its source in Rocky Mountain National Park (Poudre Lake placed just below the Continental Divide at nearly 11,000 feet of elevation) to its mouth east of Greeley, Colorado at about 4,600 ft. where it becomes a major tributary to the South Platte.

Europeans came to the Poudre valley first as trappers linking Native Americans to the global fur trade, then as gold seekers (especially the 1859'ers), and then following the Civil War as settlers lured by the Homestead Act. Scarcity of water supply on the East Slope of the Rocky Mountain front has constituted a major constraint for all peoples. Native Americans adapted their summer and winter hunting and foraging patterns to the realities of small surface streams etching highly variable and frequently dry pathways across a vast landscape. Miners had to divert small "heads" of water across considerable distances via sluices to work ore fields located above stream bottoms. Agriculturalists, either as disappointed miners or as fresh homesteaders, sought opportunities to provide themselves subsistence and cash by diverting water out of the Poudre river bottom to irrigate crops in a region where annual rainfall averaged 14 inches.

Demand for agricultural and municipal water soon exceeded supply. Most irrigation canals were constructed between 1860 and 1881 by which time the river was substantially over-appropriated. Water flows in the Poudre valley in a reasonably predictable pattern–highest snowmelt flows pass through in mid-June (well before peak crop demand) and quickly diminish by early July (Figure 1). To serve an 1881 right under the operative distribution rule of "first in time, first in right," all prior ditch headgate rights would have to be filled and that would require a river running at 3642 cubic feet per second.

A glance at Figure 1, the river hydrograph, reveals that a) there is much variation of river flows from season to season; and b) such a substantial flow does not exist, on average, at any time in the irrigation season without even considering the fact that the river can be counted upon to rapidly diminish after peak flood flows. Soon, therefore, mutual companies–especially those with more junior river rights-

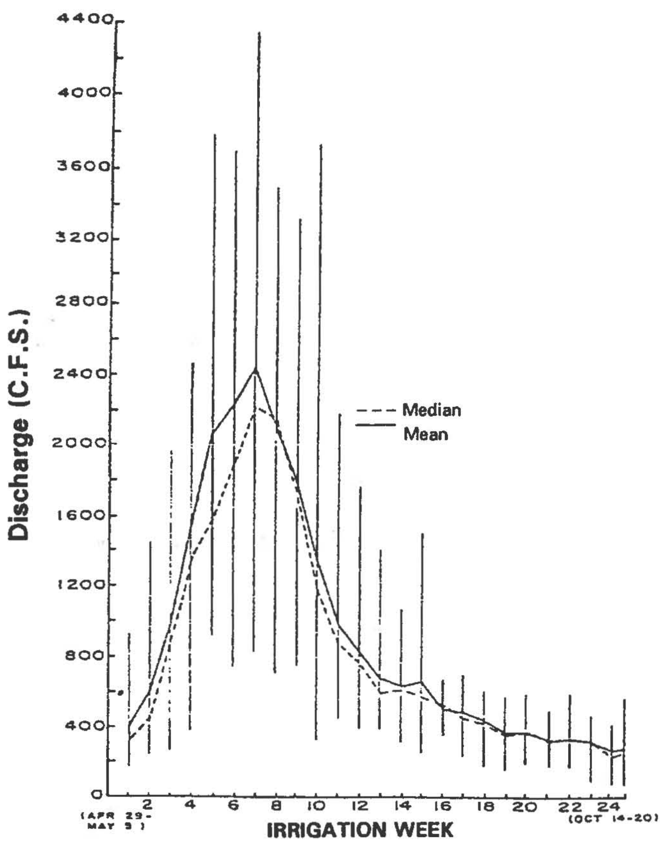

Figure 1. Poudre River Hydrograph

-set about to supplement river flows with reservoir storage as opportunity permitted. Water was thereby diverted off-season--and during those brief periods during the cropping season when flows exceeded demand--into reservoirs for use when required, especially mid-to-late summer to sustain crops.

The essential reality of the Poudre river basin, as has been the case throughout much of the arid west, is that there has never been a time of water surfeit. Water has always been the limiting factor constraining the quest for production, distributional justice, and habitat for other living things.

In the over-all Poudre and downstream South Platte system, over 100 irrigation organizations serve more than 500,000 acres of irrigated land (Anderson, 1978: 284). Almost all these organizations are mutual companies–a few are Irrigation or Conservancy Districts. The irrigation canals of the Poudre valley are owned and operated by 18 Mutual Companies, all of which were established in the late 19th century and, possibly after having gone through one or more reorganizations, continue to operate in the 1990's. Some possess both reservoirs and canals, some possess only service canals, and some operate only as reservoir associations.

Mutual Companies Created A Spaceship Recycling Economy

Three decades ago Kenneth Boulding (1968) developed a pair of metaphors distinguishing a "cowboy" economy from that of a "spaceship." People in "cowboy" economies exploited resources without regard for sustainability, paid little heed to negative spillovers of their activities, and generally assumed little or no interdependence among users or with the natural world. Resources were looted to the limit and then abandoned leaving a trail of degraded environments and broken communities. On the other hand, a spaceship economy was taken to mean an organizational system whereby people managed their resources for sustainability, where attention was paid to intimate interdependencies among people and their natural environments, where negative externalities were internalized by decision-makers who produced them, where there was priority for recycling scarce resources for long term life support.

In the context of the unrestrained frenzy of globalized economic growth in the late 20th century, we may be prone to think of spaceship economies, and the social capital that it takes to produce them, as being in the distant future--if possible at all. However, a close look at the 18 mutual canal companies of the Poudre river valley, and an examination of how scarce water is organized on that landscape, provides insight into the workings of a spaceship water economy that has been functioning for decades. Here water has been organized in ways that have enhanced water productivity, distributional social justice, and has done so in a manner that makes room for incorporation of new environmental agendas centering on upgrading open spaces and riparian wildlife habitat.

Organizing Water at the Canal Level

After water has passed through the canal headgate at the river, the Poudre valley mutual companies distribute water employing variations on a common principle--i.e. water is delivered in amounts proportional to shares owned in the organization (Anderson, 1978). A key aspect of water delivery is that water is volumetrically measured to fulfill each user's quota per share owned on the common ditch. Shareholders receive their proportional share without respect to their location in the ditch command. This has three consequences:

1. Water productivity is much enhanced because water is as much available in the tail reaches of a given ditch as in the areas toward the head. Water productivity is fundamentally a function of water control; water must arrive at the time, and in the amount, required by crop consumptive needs. Unlike many systems elsewhere (Freeman, *et. al.*, 1989) not served by the Mutual Company form of social organization, there is no necessary decline in agricultural production in the middle and tail reaches of the canal due to mal-distribution of water. Water may be delivered on demand (if there is sufficient reservoir storage available) or upon some form of rotation but water will be available in a timely manner at all points along the canal to fill crop consumption and soil leaching requirements.

2. Distributional justice among users is made possible by the fact the losses in earthen ditches are shared by the entire canal community. Water losses in an earthen ditch are a function of channel length and condition. Those irrigators nearer the tail will, in general, be disadvantaged in receiving their water if one simply takes water from the canal during a given time period–e.g. the amount that would run during one hour or one day. Obviously, in the absence of an organization to prevent it, less water will flow in tail reaches per time period than at the head because of leaks, seepage, and evaporation–not to mention the depredations of users taking more than "fair share" amounts above one's field gate. However, if the organization distributes water by volume per share, and if volumes are measured so that losses anywhere on the common channel reduce volumes to all irrigators, then all farmers absorb the water loss and all have an incentive to reduce losses wherever they occur–the "shrink" has thereby been " socialized." For example, if irrigator X is served by a leaky length of ditch, and if a specified volume of water must be delivered to "X's field outlet, it will take a much longer time to deliver that specified volume to X than would be required if the ditch were improved. Farmers at all points in the canal command can see that water lost in delivery to X–to fulfill X's quota measured in acre feet per share--is water lost to themselves. All are advantaged by improving ditch performance without respect to their location. This fact strengthens canal communities of common interest and promotes distributional justice as well as water productivity.

3. Given that each share not only delivers benefit but also carries an assessment to pay a fraction of organizational management cost, ownership of excessive shares relative to crop demand imposes the burden of paying assessments on the unneeded shares. Therefore, there is an incentive for each irrigator to be innovative in reducing demand for water and thereby minimize the number of shares owned to keep assessments as low as possible. This fact, in turn, has two positive consequences: a) there is disincentive to purchase more shares than needed simply to dominate organizational voting; and b) there is constant quest to improve water use–and thereby reduce–total seasonal cost of irrigation water.

Organizing Among Canals – Exchange

The fundamental principle for river flow allocation among canal and reservoir headgates is "first in time, first in right." This notion is rooted in a fundamental ethical concern–i.e., those who came before and who have invested in the community irrigation works should be protected from the depredations of those who came after. In the late 19th century, prior to development of an adequate river regime, there was incessant threat that latecomers could open a headgate upstream, divert water away from longer established headgates, and thereby bring ruin to those who had already invested much to build their communities. The doctrine of "prior appropriation," properly organized and implemented, removed that threat and served the ethical concern that those who have invested in good faith should be protected.

Prior appropriation doctrine succeeded in creating zones of investment security within which stable life-plans could be socially constructed, but it left junior appropriators without sufficient water in most years. Water users in all supply situations tended to face significant scarcity, but junior appropriators, especially, had incentive to increase their supplies given that the river flows would generally not rise to a level necessary to serve their "calls" given that those senior to them had to be served first.

The solution was, for many water users, to construct reservoirs, and to store off-season (winter) flows on a separate winter season "first-in-time, first-in-right" priority system. However, this could only work if a storage reservoir could be located at a place on the landscape that would serve well the investing organization. All too often storage opportunities did not occur at places capable of serving, by gravity flow, the investing community. The solution was water exchange.

The basic idea of a water exchange is simple; it consists of a trade of water between two or more users from one point of diversion to another. Exchanges must be completed in such a manner as to prevent injury to the vested water rights of others. Depicting a typical situation, Figure 2 assists in explaining how exchanges work and why they are fundamental to creation of a spaceship water economy in the Poudre river valley. Organization A has a topographical opportunity to store water in a surface reservoir which can be filled by gravity by its supply canal (Figure 2). However, the reservoir is too low for Organization A

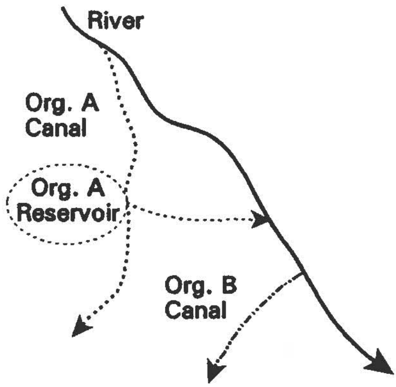

Figure 2. Water Exchange

to release that reservoir water back into its own canal. Rather than build pumps to physically lift A's storage water into A's supply ditch for its own shareholders–an expensive option given initial capitalization and recurring costs–Organization A releases water back to the river when requested by Organization B which has a downstream headgate capable to taking the water by gravity flow. B works with the river commissioner (who is responsible for administration of the prior appropriation doctrine) to allow Organization A to take B's water knowing that, at a mutually agreed time, Organization A will pay its water debt to B in equivalent volume. Both parties are better off. Organization A has expanded its supply of water available to its shareholders by developing a reservoir of water that it cannot use except as trading stock, by legitimately taking B's water at A's headgate, and by paying back the debt with water that it has stored. B, in turn, has gained flexibility and control that comes with having a water bank account in A's storage that releases B from the constraint imposed by fluctuating and declining summer river flows. Water has moved uphill from B to A and back to B by virtue of an exchange agreement implemented at minimum of transaction cost and at no cost in time, economic capital, or hydrocarbon energy. Social capital, in the form of mutual companies, has substituted for money and physical energy.

There are hundreds of such water exchanges conducted in the Poudre river valley of which eleven are major in the sense that they occur regularly and involve substantial amounts of water relative to the total annual flow of the river. Exchanges increase productivity when they improve timing of water deliveries relative to crop, municipal, and industrial demands. They increase distributional justice when they provide additional water to those with junior river rights. They enhance ecological sustainability when a Mutual Company permits water it normally would divert from the river bottom to flow past its headgate and through critical riparian habitat knowing that it will stored by another entity lower in the river and be exchanged for another company's water when needed. Exchanges are a major tool for constructing the spaceship water economy.

Organizing the Common Property Resource Among Canals – Water Re-Use

The mutual companies of the Poudre valley have created an approximation of the spaceship water economy not only by exchanging water across the landscape with positive consequences but also by developing capacities for multiple re-uses of this scarce commodity. Water users are not only highly interdependent within canal commands, and also among canals via systematic water exchanges, they are also interdependent because they generate return flows to other users (human and wildlife) down gradient from higher to lower canal, from canals to wells, from wells back to canals and to the river.

To assist in clarifying the point, Figure 3 provides a simplified schematic diagram of four major canals in the valley and their location relative to each other. Not represented on Figure 3, are 950 agricultural irrigation wells distributed from the command of the upper canal (North Poudre) to below the lowest ditch. The wells pump from an aquifer which is, itself, sustained by canal seepage and deep percolation. The over-all direction of water flow is from the northwest downslope to the southeast. Of that water which is diverted higher in the system, a goodly portion is not consumptively used by the first appropriator, and it then moves to become part of another source of supply where it is again diverted by canal or pump.

As water is delivered to any given party, a fraction is consumptively used (e.g., evapotranspiration through plants to the atmosphere, evaporation from a reservoir, wetland, or cooling tower) and a fraction leaves the user's system as runoff or discharge that creates a return flow to other down gradient users. Return flows are created by:

1. seepage from canals and reservoirs. The Poudre basin ditch and reservoir system efficiency is about 55%, meaning that water available at the average field is 55% of the water diverted at the average headgate and transported in the average canal.

2. deep percolation of water below the root zone of irrigated fields which

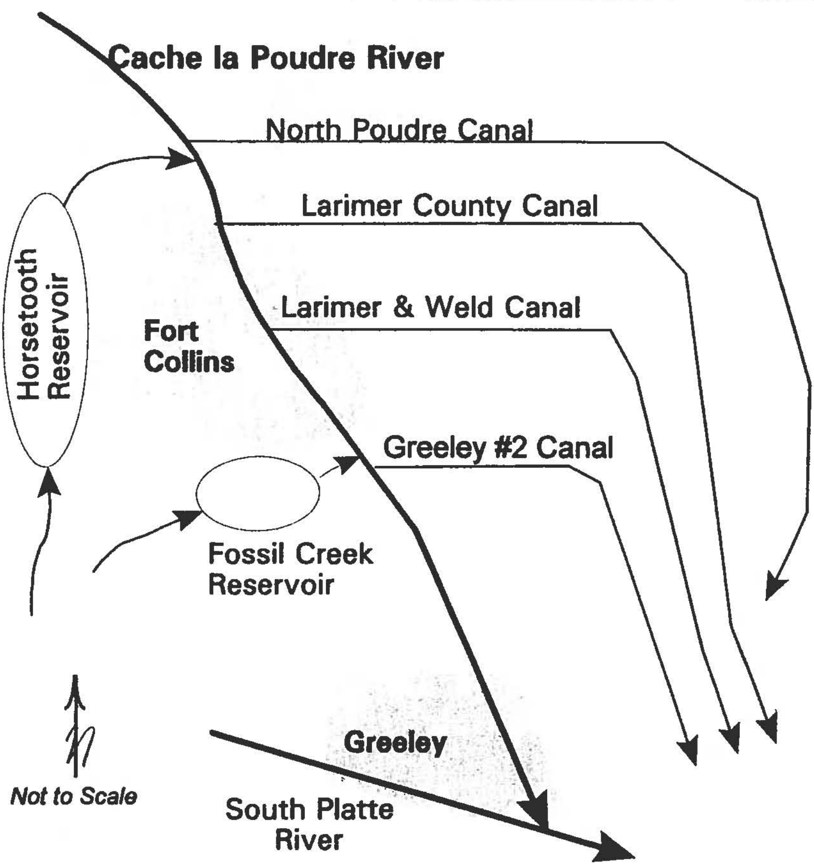

Figure 3. Schematic of Four Principal Poudre River Mutual Company Canals

then makes its way back downslope to other canals and the river.

3. surface run-off from irrigated fields.

4. municipal-industrial discharges back to rivers.

In such a system one user's "wasted" (i.e. non-consumptively used) return flow water is another user's supply. Inefficiencies in farm application of water can create high over-all system efficiencies as seen in the Poudre valley re-use ratios reported on Table 2. The waste of one appropriator is an asset to others and to other living things. A literature has developed around the notion that Western

Table 2. Poudre River Water Re-Use Ratios 1970-1994

Month	Monthly Ratios	Daily Ratios	Maximum Daily Ratios
November	1.99	2.35	4.20
December	1.76	1.94	3.72
January	1.65	1.71	2.69
February	1.60	1.68	2.40
March	1.49	1.69	3.26
April	1.78	2.17	3.95
May	1.22	2.43	3.00
June	1.20	1.55	1.92
July	1.33	1.39	2.09
August	1.51	1.60	2.62
September	1.92	2.52	5.00
October	1.69	2.14	4.65
Average Re-use Ratio	1.6	1.9	3.3

Re-use ratio: total measured water diverted below Poudre Canyon Mouth River Gauge/ total measured water in river at Canyon Mouth River Gauge plus Horsetooth supplement

water has been, and is, wasted in large volumes (Postel, 1992: Reisner, 1986; Gleick, 1998: 19-24) and that the demonstrated inefficiencies are to be lamented and prevented. There needs to be a more thoughtful debate on this point. The analysis here accepts the fact of inefficiencies in water delivery and application as measured at a given point in the system but then asks: where is the so-called "wasted water" going and with what effect on human beings and other living things? Insofar as it is going to other users–human and wildlife habitat–to serve beneficial uses that address problems of productivity, distributional justice, and environmental sustainability, there may be redemption in inefficiencies as measured at any particular segment of the over-all river-canal-reservoir network in the valley. Table 2 reports Poudre river water re-use ratios for the 24 year period 1970-1994. The ratio expresses the total quantity of water diverted by all users in the valley (numerator) as compared to the actual water available in the river (denominator). The ratio values report that substantially more water is diverted than there is water available in the river during a given month, day or year. For example, given a daily average reuse ratio of 1.9, if 150,000 acre feet of water was available at the top of the basin in a given year, actual user diversions of water molecules amounted to 285,000 acre feet. Such a ratio is possible only in a spaceship water society that, in turn, is made possible by the Mutual Company form of social organization operating on a landscape congenial to the project. Several notes are in order:

1. Re-use is highest during fall and winter months when there little or no agricultural crop demand. Agriculture is, by far, the biggest user of water and its consumptive uses are heavy in summer months during which time reuse ratios markedly decline.

2. On the highest reuse days, water in the basin is recycled as much as 4 or 5 times in a stretch of river less than 45 miles long.

3. Cities and industry, if they are good stewards of their water, do not typically impose consumptive uses as high as does agriculture. Therefore, as urbanization and industrialization encroach on agricultural uses, water is often released to new uses. The challenge will be to put such water releases to uses that enhance ecological sustainability, to preserve strategic agricultural land and the open spaces that come with it, to enhance distributional justice for farmers relative to the urbanite, and to avoid unthinking watering of suburban and rural sprawl.

IMPLICATIONS AND CONCLUSION

Mutual associations of water users empower people with the capacity to undertake collective action on agendas of common community concern. Mutuals make possible the collective effort necessary to run irrigation canal networks, they can collectively "share the shrink" among all members without respect to location in the canal command so as to create a common interest of all in the irrigation enterprise, they can conduct water exchanges and exploit water re-use opportunities that make for enhanced water productive, distributional justice, and environmental sustainability.

This paper has briefly summarized essential attributes of the Mutual Companies found in the Poudre River Valley of Northern Colorado. Mutual cooperative water associations have empowered water users to provide themselves with a critically important common property resource–water under control. This form of social organization has mobilized human capacity to create something approximating a "spaceship" socio-economic system of water exchange and re-use. Non-profit Mutual Companies substitute social organization for money and hydrocarbon energy, and they take advantage of opportunities to re-cycle scarce water resources among multiple and competing uses--agricultural, municipal, industrial, and wildlife habitat.

The common property resource described here cannot be produced by individual self-seeking rationality of marketplace exchange. There would be no ear of corn, bale of alfalfa, or bag of pinto beans for marketplace exchange if there was no higher level of organizational rationality operating the common property water resource that makes private enterprise possible and rewarding. People operate with an individualistic calculus in the world of private marketplace exchange. Those same people must also operate as social organizational agents and entrepreneurs who can transcend the limits of individual rationality and provide themselves with a common property resource that draws them into the civic life of a larger community. The water users of the Poudre valley have found ways to actively pursue both dimensions of life; it behooves us to contemplate how others can follow their lead with regard to organizing water for better productivity, distributional justice among senior and junior appropriators, and insuring water availability for environmental agendas.

Sociological analysis must make room on its working agenda to examine carefully the nature of the organizations that encompass, constrain, and guide individual rationality in markets. In doing so, sociologists may well find ways to better approach issues facing us in the domain of water resources. The study of Mutual Companies–and other forms of local water organization in the arid West–can be expected to lead to more adequate specification of the attributes of organizations successful in producing and sustaining organized collective action in water resources management.

Many, if not most, natural resource problems found on the landscapes of the planet are common property resource problems that require people to mobilize for collective action in a context of high interdependence and a need to control free-riding–e.g., water resources, social forestry, livestock grazing, fishing and fisheries management. For example, effective local organization to protect a forest in Nepal from the ravages of individual sub-optimizing rationality in exploitation of fuel wood would produce a range of valuable services–protecting soils, controlling erosion, reducing downstream siltation and flooding, recycling wastes, providing habitat for plant and animal species. Sustenance of such a forest is the best and cheapest way to insure the continued supply of essential services for sustainable local, national, and international development. The form of social organization managing irrigation ditches in the Poudre valley may–when invested with appropriate local cultural content–be capable of mobilizing local peoples in South Asia and elsewhere to allocate fuel wood and other resources according to viable distributional share system designed to insure sustained yields, to connect delivery of the forest benefits with fulfillment of organizational obligation to the forest, to prevent individual free-riding, and to establish terms and conditions under which globalized economic capital is permitted to penetrate into local resource areas. By examining the attributes organizations in Northern Colorado that have historically empowered people to do things collectively that could never be accomplished individually in marketplaces, we may glimpse a path to a more sustainably productive and distributionally just future.

Acknowledgments

We wish to express our thanks to Mr. Jon Altenhofen, Professional Engineer, Northern Colorado Water Conservancy District, who calculated the data appearing in Table 2, Poudre River Water Re-Use Ratios, 1970-1994. We further appreciate the able graphical and editorial assistance of Ms. Annie Epperson.

REFERENCES

Anderson, R. 1978. "Irrigation Systems in Northeastern Colorado." Chapter 7 in *...and the Desert Shall Rejoice: Conflict, Growth, and Justice in Arid Environments.* Cambridge: MIT Press.

Boulding, K. 1968. *Beyond Economics.* Ann Arbor: University of Michigan Press.

Dunbar, R. 1983. *Forging New Rights in Western Waters.* Lincoln: University of Nebraska Press.

Evans, H., and M. Evans. 1991. *Cache La Poudre: The Natural History of a Rocky Mountain River.* Niwot: University Press of Colorado.

Freeman, D. 1989. *Local Organizations for Social Development: Concepts and Cases in Local Irrigation Organization.* Boulder: Westview.

Gleick, P. 1998. *The World's Water: The Biennial Report on Freshwater Resources.* Washington, D.C.: Island Press.

Maass, A., and R. Anderson. 1978. *...and the Desert Shall Rejoice: Conflict, Growth, and Justice in Arid Environments.* Cambridge: MIT Press.

Postel, S. 1992. *Last Oasis: Facing Water Scarcity.* New York: W.W. Norton.

Reisner. M. 1986. *Cadillac Desert: The American West and Its Disappearing Water.* Viking.

Wilkins-Wells, J. 1999. Irrigation Enterprise Management Practice-Study. Technical Report submitted to U.S. Bureau of Reclamation. 3 volumes. Project N.E.I.D. 4.4. Ft. Collins Colorado State University. January.