Part Three Water for agriculture

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Communal irrigation

A comparative perspective

Introduction

There are upwards of 1 million irrigation systems in our world, supplying water to grow at least 40% of the food we produce annually on this planet.¹ These irrigation systems vary in climate, degree of development of the nation in which they are found, in complexity of how they extract water from nature, in size, in age, in their social organization, in their cost, and in how sustainable they are. We know much about the role of water in the green plant (Chrispeels and Sadava 1977; Grigg 1996). We know a good deal about how to manage the flow of water (hydrology) and to build dams and canals (hydraulic engineering). We know relatively little about how people organize, or are organized, to manage the process of moving water between some natural place (river, stream, aquifer) and the root zone of the plant. My article will concentrate on the organization of people.

To inquire about communal irrigation implies that irrigation can be modified by other adjectives. Some of the noun phrases that can be found are agency irrigation, public irrigation, and bureaucratic irrigation. There is a general perception that the dichotomy of communal versus bureaucratic is strongly correlated with if not composed of users versus engineers, small versus large, inexpensive versus expensive, effective versus ineffective, efficient versus inefficient, and good versus bad. As will be made clear below, many of these oppositions as descriptions are indeterminate, and some are inaccurate. The models most of us use to think about irrigation, and particularly the dichotomy between bureaucratically and communally managed, are far too simple. The reality is more complex, and more interesting.

In this article I will first describe the major concepts needed for the comparative study of irrigation, paying particular attention to those needed for

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communal irrigation. Second, I will summarize the results of empirical studies. Third I will articulate a number of questions about communal irrigation which have not been addressed satisfactorily in the literature.

Concepts

Comparison

All comparative inquiry depends upon clear concepts to achieve valid and reliable results. The amount of scholarly work needed to achieve clarity and comparability of concepts is often unappreciated. A comparative effort asks the same questions of two or more instances (say irrigation systems), and expects that the answers will be mutually intelligible. If, for example, we wish to ask about the relationship of the size of a system to the way that it is organized (a question which everybody thinks they know the answer to), then we must have clear concepts of irrigation system, size, and the way that it is organized. The comparative effort has to make valid observations of the several instances and conceptual equivalence is necessary (see Hunt 2007 for an account of how this is done). Fuzzy or ambiguous concepts reduce the comparability of the several observations, and thus raise the uncertainty in the results to a very high level, rendering them nearly if not totally useless. The concepts to be used in comparison must be clear, and ideally will be operationalized.

Conceptual clarity is not mere semantics. It is a prerequisite to comparable sets of observations, which is a prerequisite to the establishment of correlations, which are the core of empirical knowledge (see Hunt 1979, 2007).

This section of the paper will deal with the clarification and specification of the concepts needed for the comparative study of communal irrigation.

Irrigation

Irrigation will be described as moving sweet or fresh water from some point (or points) in nature to the root/zone of the intended crop, when the water would not so move under natural conditions. There are two problems with water in agriculture, not enough, and too much. Each condition is a constraint on crop growth. Irrigation systems typically are designed to deal with insufficient water, although dealing with too much water is often built into the same systems.

Every part of our habitable world is subject to floods. Humans can organize physical systems to deal with floods and often do so. Wittfogel's massive work (1957) on *Oriental despotism* is widely taken to be about irrigation works and their effects. But Wittfogel's hydraulic hypothesis includes protective (flood) works as well as productive works (irrigation), as Mitchell (1973) has so clearly argued. I have defined my task as a discussion of communal irrigation, which excludes flood protection works, and therefore the Wittfogel

hypotheses will be relegated to another discussion (on other Wittfogel discussion, see also Christie, Wolters, this volume).

The water may be found in streams and rivers, or in lakes, or in an aquifer under the surface of the soil. The water is extracted from these sources by a variety of means.

The most common is to erect some kind of a barrier in a stream. Usually called dams, there are two separate functions. One is to raise the head, or level of the water surface, and those barriers that only do this are often called barrages. The other function is to store water for later distribution by creating a reservoir behind the dam, and these are often called storage dams. Water storage dams are very old. The Purrón Dam in Mexico dates from 1000 BCE, and had a capacity of 3 million cubic meters (Spencer 1979). In Sri Lanka the Anuradhapura tanks are at least 2,000 years old.² Note that these barriers often serve other purposes as well, including flood protection and power. Both the power and the flood protection functions are pre-industrial, although they apparently do not pre-date classical Rome.

Underground water has been utilized for a very long time. Access requires that overburden be removed down to, and usually below, the water table. This is usually a vertical shaft of fairly narrow diameter. The water often seeps into the shaft at a slow rate, although occasionally one hits water under pressure (an artesian well). Utilizing the water for irrigation requires that it be lifted out of the shaft to the surface, a non-trivial problem for water is liquid (and therefore must be contained) and it is heavy (1 metric ton/cubic meter). Preindustrial lift irrigation is small in scale due to the energy demands for raising the water. Some devices are the *shaduf*, the Archimedean screw, pedal pumps, and the use of animals to pull up the container, or power a pump (the *saquia* in Egypt).

There are also nearly horizontal shafts, *quanats*, found in Iran and Central Asia (with two examples in the new world, the Tehuacan valley gallerias and in Peru). These may be tens of kilometres in length, and are excavated and maintained by crews of specialists. The tunnels usually are started close to where the water will be used, and are excavated into the hills until a water table is reached. In this case the water flows by gravity, so it is the use of underground water without lifting.

Once extracted the water has to be led to the vicinity of the crops. By far the most common way to accomplish this is to use open channels on the surface of the land. Most often these are ditches dug in dirt. Small sections may be constructed differently to deal with problems of the terrain. A siphon (a closed tube) or an aqueduct (made of wood or stone or brick) may be used to cross a valley.

² Murphey 1957. In the West we often use the terms dams and reservoirs to refer to water storage on the surface. In South Asia tank is the term used. The South Asian tank is a reservoir held behind a dam.

In the industrial era we have invented two other means of leading the water to the crops, sprinklers and drips. Both require industrial power sources. In sprinkler systems there is a pump which sends water under pressure through a closed system of pipes, and the water is delivered through the air by means of sprinkler heads. The centre pivot sprinklers can be enormous, with the sprinkler heads mounted on carriages which are powered around in a circle, or back and forth in a rectangle, by the water pressure in the system. Drip systems on the other hand bury pipes with holes in the root zone. Water is then pumped through the pipes, and the water in the irrigation system never appears above the surface of the soil. In the remainder of this paper I will be referring only to irrigation systems which deliver water to the plant by means of open channels on the surface.

When the water arrives in the vicinity of the crop another set of considerations becomes paramount. Ideally one delivers the right amount of water at the right time to each plant. Conditions in and near the field have to be appropriate for achieving this aim. Most irrigation systems deliver water to and in the field by means of open surface channels. If one part of the surface of the field is too high water delivery will be deficient and the plants will suffer from water shortage. If another part of the surface of the field is too low water delivery to that section will be excessive, and the plants there will suffer from water logging. In consequence the preparation of the field's surface is a critical operation. It must be nearly flat, and sloped very carefully. And it must be so prepared every growing season. If the water is delivered in open surface ditches the levels of those ditches must also be very carefully adjusted so that water will flow, and not too rapidly. Slope is very important.

Constructing the extraction device, the delivery device, and the field are not trivial tasks. They are expensive in labour and require technical competence. Furthermore, once constructed properly they are subject to entropic pressures on many different time and force scales. When we build such systems we are forcing water to take a longer route to the lowest point. Water is heavy and liquid, and will eventually take the shortest route. Sometimes this pressure is slow and gentle, as during the normal drier part of the year. But most parts of the world are subject to flooding, and major floods unleash forces that can destroy, or at least severely damage, the anthropogenic landscape. Dams break apart, canals fill with silt, and the water escapes the system and returns to its natural channels, perhaps created anew by the flood waters. This means that sustaining an irrigation system requires constant battle against entropy, and frequent major repairs to broken devices.

Clearly technical competence is required, and it is in fact found in a very wide variety of places, times, and contexts. We know almost nothing of folk knowledge of hydrology and engineering, but we can certainly see the results, so we know it must be there. But the technical capacity is only part of the

story. Once built, keeping these systems operating is in part a social problem. People must organize to provide the technical skill, and the resources, to keep these systems going. My focus in the rest of this paper will be on the social organization which manages these irrigation systems.

Irrigation system

We are all aware of irrigated agriculture spread across the landscape, sometimes covering many thousands of square kilometres. The question then arises as to whether, and how, the irrigated landscape might be partitioned at a scale larger than the irrigated field. The entire irrigated landscape may well be a single ecological and perhaps economic entity. But in terms of hydrological and social organization it may be partitioned into irrigation systems. There are socially integrated irrigation systems of 500,000 hectares and more, so it is clearly possible to do so on a vast scale. But many irrigated landscapes are partitioned into much smaller social entities (on the order of thousands, or hundreds, of hectares.)

The question of how to identify individual irrigation systems must be solved if comparative observation and analysis is to proceed. In 1988 I presented a tentative definition of irrigation system: 'a canal irrigation system is composed of 1. a facility (gate, offtake) which takes water from a natural channel and moves it away from its natural downhill course and 2. the subsequent control works (canals, gates, fields) that guide the water flowing on the surface to the agricultural plants until that water either soaks into the earth or flows on the surface out of the control works' (Hunt 1988:339-40). Two problems I then singled out were multiple sources of water for a single system, and the question of whether these systems are physically distinct at all levels.

Jacinta Palerm Viqueira (2001) and her co-workers have looked at this issue on the ground in Mexico, and have found many irrigation facilities with more than one source of water, and some where the physical facilities seem to be intermingled. However, in the remainder of that article the term irrigation system is used without a new definition.

An alternative to the physical network concept which I presented in 1988 might be to consider the social network. Starting with where the water is abstracted from a natural source, one might identify the social entity that is responsible for that abstraction down to the social entity (often a person) that is eligible to receive the water and apply it to plants. The network of these social entities in many cases constitutes a social system, and might be an attractive candidate for the concept of irrigation system.

Comparative work demands some sort of solution to the problem of an irrigation system concept. What most of us have resorted to is accepting the naming of a network as evidence of the existence of a system. If a network is named in local practice it is assumed to be a system. It is not an ideal solution,

but there is no evidence as yet that there are severe difficulties with the comparative studies as a consequence.

Size of system

Size or scale of irrigation systems has been with us as a potentially significant variable since at least the work of Wittfogel. The concept has been extremely fuzzy. It might refer to the amount of water managed, to the number of people who use the system, to the complexity of the management tasks, or to the territorial extent of the use of the water. Most systems that measure their own size use number of hectares irrigated, although how they determine that number is never publicly discussed. In my comparative work I defined size as the number of hectares irrigated from the physical system, recognizing that the numbers we are given are more than somewhat approximate (Hunt 1988:343-5).

Roles and tasks

An irrigation system has work to do, and those who are delegated to do it, and it is useful to partition these into roles, and tasks. Tasks refers to the kinds of work to be done for the system. It includes construction, allocation, distribution, maintenance, accounting, conflict resolution, and often ritual (see Uphoff 1986; Hunt 1988; Jha 1998). All but ritual are universally found. The line between maintenance and re-construction can be hard to draw.

Role includes users or farmers, officers, and workers. The terminology in our comparative efforts has not been precise. We tend to be hazy about users and farmers, for example. The situation on the ground can be very complex, with owners, operators, tenants, share-croppers, and squatters. Who the user or farmer is under these circumstances has not been adequately clarified. In the vast majority of irrigation systems so far investigated there is some office which is recognized as having authority over managing the water (I referred to this office as the CEO in 1988). Whether that officer is also a user of the water varies in important ways. There is always work to be done, and those doing the work can be called workers. Whether they are also officers, and/or farmers, varies with the scale and kind of organization of the system.

Charter of authority

Karl Wittfogel set a political problem for our understanding of irrigation, and the question has been with us ever since. A major form has been the relationship between size and political structure, with many suspecting (or asserting) that large size demands a centralized management structure. In this context centralized is often contrasted with communal.

Most discussions of centralization are less than clear about the concept. Kelly (1983) waded into the swamp and distinguished between the organization of power within a system, and how the system is linked to other (usually

higher) realms of power, such as the state. In 1988 Hunt attempted to clarify matters further. 'The charter of authority is the variable used for measuring administrative authority structure. [...] Charter is the source of authority of the chief executive officer, who is responsible for carrying out allocation decisions at the head facility. The scale of this variable is nominal. Its values as isolated so far are 1. national government, 2. irrigation community, and 3. private.' (Hunt 1988:343.)

The variable charter of authority has not been challenged so far. The values of the variable, however, have been, and need further differentiation. There are some supranational charters of authority, often found in colonial situations. Within the nation it is useful to distinguish between the national and the provincial³ levels. In India for example the provincial level charters many irrigation systems, not the state. My original value of Irrigation Community was challenged by Wang (1997) in his dissertation. He perceived that in California we had two distinct forms of organization for irrigation systems, the mutual company and the irrigation district, thereby splitting my value of irrigation community into two distinct concepts.

Communal irrigation

Communal has at least two meanings, both referring to forms of social organization. Communal has been used to refer to local territorial units of government (such as a village, or Leiden, or Cambridge). It has also been used to refer to an organization of people who are all users of the water (as in Irrigation Community). It now seems to me that we have several different ways of organizing irrigation systems that have been referred to as communal.

In my original meaning of irrigation community I included a corporate group of users of the irrigation water, who chartered their CEO. These groups exist in large numbers, and as I suggest organized as common property resource managers (see Hunt 1986; Ostrom 1990).

³ Terminology is important here. We usually reserve the term state for the political entity that effectively claims sovereignty. A reasonable operational definition at this point in time is membership in the United Nations. All states, so defined, are structured with levels of organization. What we label these levels is an important decision. In the USA, India and Mexico, for example, the level below the state is labeled State (New York, Andhra Pradesh, Oaxaca). In France they are called *département*. Province seems a useful general term for this level of government. At the bottom all states are divided into what are often called townships, and in the Spanish speaking world are usually called *municipios*. They have a territory, a capital, a set of offices, and some government responsibilities. They may or may not have the right to generate revenue, to decide on education policy, etc. Between the province and the municipality there is usually at least one other level, called variously county, district, region. In France the Province seems to be very important, and in China the County seems to be very important. Further, the boundaries of the sub-state levels seem to be very stable. In parts of Mexico they are hydraulic in nature, but in the US they are not. We have here a set of interesting problems in comparative political structure, and it does not seem to have received much attention. It is highly relevant for our comparative analysis of irrigation organization.

There is another kind of local organization of irrigation wherein the municipality contains (entirely, or largely) the physical irrigation system, and it is the political structure of the municipality that provides the charter of authority, and perhaps even the officers, of the irrigation system. Resources for some or all of the irrigation system tasks may come from the municipality. Note that in this case only some of the residents (citizens) of the municipality are irrigators, and some non-residents may well be irrigators as well. The irrigators may or may not dominate irrigation affairs, or municipal affairs (see also Wolters, this volume).

There is a third kind of local organization of irrigation wherein a special-purpose governmental entity is created. We have found these in California, USA. The province provides the template for these, and they are spatially rather than hydraulically defined. A block of territory is marked out, which may or may not be isomorphic with the boundaries of counties or municipalities, but are always totally within the boundary of the province. The province authorizes an election to determine whether an irrigation district should be formed. Those resident within the territory vote in an election. If the irrigation district is approved, then a special-purpose government entity is created with a bureaucracy to run the irrigation system. This entity has taxing power, and the power of eminent domain. The number of farmers (or, alternatively, of owners of irrigated land) may be a tiny fraction of the voting population of the territory.

We have, then, three different forms of communal organization of irrigation (as of this moment!). In the subsequent discussion of what we know about communal irrigation it will be useful to distinguish between these three forms.

They need to be named unambiguously. I suggest that Irrigation Community has a core meaning, which is that the holders of water rights, and only the holders of water rights, are organized to manage their own affairs. I suggest Municipal for the second type. I suggest single-purpose District for the third type.⁴

Rights and duties

All role systems involve sets of interlocked rights and duties. These apply to the roles (and the offices) in an irrigation system. The rights and duties may be spelled out, in part, in formal documents, including laws and regulations. An important feature of irrigation systems is juralty. By juralty I refer to the condition whereby rules of conduct can legitimately be formulated and enforced. There are two distinct loci of juralty, internal to the system, and

⁴ There are two other ways of organizing local irrigation. In one, there is a private entity (a person, or a firm) which owns the water rights, and organizes the irrigation system. Most of the users of the water are employees of the private entity. Some sugar mills in Mexico were, and perhaps still are, organized in this fashion. There are only two accounts of this phenomenon in the literature that I am aware of (Barkin and King 1970; Ronfeldt 1973). The other way is to not have any authority structure at all. Less than ten cases have come to light (Hunt 1988:345).

external to it. By internal juralty I mean that the system (however defined) has legitimate authority, in the eyes of group members, to make and enforce rules. Note that criminal gangs have internal juralty. By external juralty I mean that in the eyes of an exterior entity (such as the state), the group has a right to exist, and to make and enforce certain rules. There may not be perfect conformity of internal and external juralty. When there are disjunctions we have the condition called legal pluralism (see Bruns and Meinzen-Dick 2000; see also Von Benda Beckmann, this volume).

With respect to irrigation, and particularly communal irrigation, we need to investigate whether the communal system has internal juralty, and external juralty, and whether or not they conform to each other. The impact on rights and duties, and their enforceability, is substantial.

Water rights

There is virtually no discussion of irrigation without some reference to water rights. What exactly is being referred to by water rights is very rarely clear. In English speaking countries the word right has recently been used in a wide variety of contexts – natural rights, human rights, property rights, the rights of species other than *Homo sapiens*. It is standard procedure to analyze social systems in terms of rights and duties.

Water rights, when they appear in most discussions, seem to belong to this generalized category of vague and unspecified rights. Some would seem to think that if someone needs irrigation water they have, or should have, a right to it. In cases of legal pluralism there may be violent disagreement between local and national social and jural entities over what the rights to water are, and who has them under what circumstances (see Bruns and Meinzen-Dick 2000; Mathieu et al. 2001 and Ruf 2001 for striking cases).

We do not have a body of extended case studies of water rights and how they operate. However, some outlines are clear, due particularly to the work of the Von Benda-Beckmanns. Presumably water rights refers to some legitimate and potentially enforceable claim to a benefit stream, in this case to supplies of irrigation water. If this is accepted, then at least the internal juralty of the water managing organization must exist (otherwise the claim is neither legitimate nor enforceable). Several questions can then be asked. How does an entity⁵ acquire such a claim? What must the entity do to maintain the claim? And under what circumstances can the claim be alienated from the entity? The clearest and most nuanced analysis, although for Nepal, not a particular system, that has come to my attention is Von Benda-Beckmann et al. (2000).

⁵ By entity here I mean a jural entity (see Appell 1983; 1984). In the irrigation context this entity will in most cases be a person. But it could also be a municipality, a corporate group, a lineage, a household, a shrine, even the irrigation community itself. Many entities can be the possessors of claims to water. We must not assume that the individual person is the only relevant social entity.

Sometimes the right is inalienably associated with some other phenomena, as when water rights are permanently attached to land. This is the most frequent form (insofar as our small number of ethnographies and reports is representative of the universe of irrigation systems). But there are some systems where water rights are separated from land rights, and transacted independently (see Maass and Anderson 1978). The accounts of communal systems are more likely to contain statements about water rights than are accounts of national systems.⁶

Property

All irrigation systems involve property relationships. Only recently have we begun to appropriate concepts of property analysis to the irrigation arena. Bruns and Meinzen-Dick (2000) and Pradhan and the Von Benda-Beckmanns (2000) have recently published books which begin to analyse some of the property aspects of water rights.

A conceptual basis for an analysis of property is found in Hunt (1998). Property is there seen as a relationship between two kinds of social entities – owners, and non-owners – where there are rights and duties attached to both entities with respect to the object owned.⁷ Most analyses of property focus on the object alone. Analysis has been shifted from the object to the social relationships with respect to that object. There are a number of categories of rights, including possession, use, exclusion, alienation, and destruction. Almost every property relationship involves more than one right with its linked duty, and in consequence we speak of bundles of rights. Such bundles can be disaggregated, and particular rights distributed to different social entities.

Irrigation systems are potentially owners of water, land, dams, canals and gates, roads, buildings, equipment, rituals, and cash. Individual irrigators are also potential owners of water, land, infrastructure, buildings, animals, equipment and cash. This ownership automatically invokes rights (and duties), and implies jurality someplace in the social system.

We have the conceptual apparatus for doing an analysis of property. That conceptual apparatus is being applied by Von Benda-Beckmann and Von Benda-Beckmann (2000) in Nepal.

⁶ See Wade 1986 and Mollinga 1998 for examples from South India. The water right situation in large nationally chartered irrigation systems is largely a mystery. It is not even clear if there is any local conception of a water right.

⁷ Object is not a good term. Non-material phenomena can be the subject of property relationships. Some examples include dances, songs, rituals, and stories, which are now called intellectual property. In this analysis I am trying to shift attention away from the object to the rights and duties in the relationships of owners and non-owners. A single term for whatever it is that is the subject of these relationships is necessary, but object, with its implication of tangibility, is not the right term. Any suggestions for a better term would be most welcome.

Sustainability

It seems as though every other book published in US these days has sustainable in the title. With such general enthusiasm it will come as no surprise that the meanings of the term have proliferated and precision has declined. In most cases sustainable has an environmental or ecological meaning. It refers to organizing a production system so that renewable resources are harvested at such a rate that that rate can be continued indefinitely (assuming that environmental parameters do not change).

In reference to irrigation systems, sustainable use means using water no faster than it is replenished. This is particularly important with ground-water extraction systems. Sustainable irrigated agriculture would mean that the soil, soil nutrients, and water would all be used at rates which can be sustained indefinitely.

There are other ways to look at the question of sustainability in the context of irrigation systems. We can ask whether irrigation systems are economically and politically sustainable.

An irrigation system that did not produce a sufficient economic benefit stream (roughly profit plus subsidies) would not be sustainable in the long run. The first place to look is at the economic performance of the agriculture. If the economic costs of agriculture are more than the returns, then some sort of subsidy is being provided. That subsidy can be coming from savings, or from urban relatives, or from the state. If the agriculture sustains these losses for a considerable time period the subsidy may well dry up. This in turn implies that the irrigation system itself will not be viable economically.

If the irrigation system is dependent upon the financial health of the users (as in communal systems), then the sustainability of the irrigation system will respond to the financial condition of the users. Alternatively, some systems are dependent upon the financial health of the state, and when the state withdraws payments for the operation and maintenance of the irrigation system, then the irrigation system is not economically sustainable (see Hayami and Kikuchi 2000 for a case study in the Philippines).

A sustainable irrigation system is embedded in a political environment, and is also itself a political environment. Political sustainability might refer to the ability of an entity to perform tasks (including delivering water, maintenance, and resolving conflict). Officers exist, pay attention to their duties, and are able to recruit others to do the work. Meetings are held, decisions are made, and succession to office occurs. If the communal system is rent with violence due to factionalism, it is not politically sustainable. Chaos and/or incompetence at the national level also compromises political sustainability. If payments are not made, contracts not written, too much is skimmed in corrupt practices, then the work will not get done and the system will spiral down in effectiveness.

Privatization

The term 'privatization' is as ubiquitous as the term 'sustainable' and has even less substantive content. There is a very old discussion in western civilization over the appropriate, or just, distribution of market relationships. It goes back at least to Aristotle, who was highly suspicious of the market, and the market principle.

At the state level we have been encouraged to use a simple dichotomy on this matter – either the state does it (command economy) or the market does it. (Note that communal is left out of the discussion.) For most of the twentieth century there was a marked tendency to shift from market to the state. Since 1980 or so (Thatcher and Reagan terms in office) there has been a shift towards what has been called the market, and private enterprise. This whole conversation is so imbued with ideology that it is hard to discuss it sceptically and empirically.

In the arena of irrigation there are two contexts where the matter has arisen. One is the withdrawal of the state. Virtually all public and charitable enterprises (governments, museums, churches, universities) have seen demands for expenditures rise above the supply of money. One consequence has been a call for these entities to reduce their expenditures. Health care, safety nets, roads, railroads, and especially irrigation systems have seen a decrease in national funding. The effect upon the activities of these systems has been deferred maintenance at best, and abandonment of activity in many cases. Part of the argument has been that the state is inefficient in use of resources, and it would be better to privatize these functions by shifting responsibility from the state to some non-state organization such as a private firm.

The other context is the claim, particularly in developed countries, that the users of irrigation water are not paying the market value of the water they use. The demand for water is increasing more rapidly than the supply resulting in increasing frequency of scarcity. In this context the other users of water are putting pressure on the irrigation systems to release water for other, more economically productive, uses. The argument used is a market valuation one (see also Braadbaart, this volume).

Privatization then means at least two things, the reduction of state activity with respect to water, and the application of market principles to the allocation of water in society. They are not identical meanings. The first case is a question of who is going to pay for something, in the irrigation case the O and M costs of systems. The impression has been that the state pays some or all of the costs, and those costs should be paid for by the users, not the taxpayers of the state. The second case is a question of how much is paid for the water. The general impression has been that the farmers are paying too little, and if they paid the real market rate the farmers would use less, and the urban and industrial users would have less scarcity.

*Findings so far**Incidence of communal irrigation*

Communal irrigation, as defined above, is very widely found in the world, and nobody knows how many systems there are, how many hectares they irrigate, and how many people work on them. The two major gaps in the world literature are for the ex-Soviet Union, and the People's Republic of China. In the 1970s Mexico had identified and named most of the communal irrigation systems, and there were more than 14,000 of them, varying in size from a few dozen hectares to several thousand hectares. Virtually all of the irrigation systems in the USA are communal, of one form or another, but there is no central register of them. I am unaware of any central register for France, Spain or India, three heavily irrigated countrysides.

I have guessed that there may be as many as 1,000,000 communal irrigation systems in the world now. We have accounts of perhaps 200 of these, and the majority come from a few countries. India for example has many communal systems, with only a tiny handful of reports on them (Easter and Palanisami 1986). We have a number of reports from Peru and Mexico, some from Ecuador (see Ruf 1997, 2001) and virtually nothing from Colombia, Bolivia, Chile and Argentina, all of whom have a large number of such systems. It is likewise with Turkey, Iraq, Iran and Algeria.

Nepal and Sri Lanka are now well represented, due largely to the efforts of the International Water Management Institute (IWMI) (formerly the International Irrigation Management Institute – IIMI). Thailand, Indonesia and the Philippines also have very large numbers of communal irrigation systems, yet we have only a small number of reports on them (see Lewis 1991). Myanmar and Vietnam, two large countries with many irrigation systems, are virtually a blank so far as our field studies are concerned (but see Fontenelle 2001).

We are reasonably certain that there are very large numbers of such systems in the world. I am reasonably certain that very few countries have identified them, counted them, or measured them for any variables of interest. They are not a part of national or planetary social accounting. I am reasonably certain that their economic importance is far greater than their statistical presence indicates.

Multiple levels of control

At this point in time all agricultural land is in territory claimed by some state and therefore all communal irrigation systems are found in states. The relationship of these communal systems to the state is never irrelevant. I have argued that a recent set of case studies shows that the state is always present and relevant, but that the functional load of the state is highly variable (Hunt 2001). The role of the state may be as slight as providing a legal charter for the

system (thereby providing external juralty), or it may stretch as far as investment of funds, providing technical advice, or paying for the management of the headgate. Even in the very large state-run systems there is considerable influence of the farmers.

Most cases of conflict involving legal pluralism are instances of the state extending its involvement in communal irrigation, often to the detriment of the communal system (Bruns and Meinzen-Dick 1998; Mathieu et. al. 2001; Ruf 2001). The state decides to 'improve' the local situation, with new physical works, or new sets of rules, and either advertently or inadvertently creates conflict with established local custom or rule.

When the situation is stable the two entities, the state, and communal irrigation systems, have a working relationship whereby the division of labour is clear (although not always uncontested). Trying to expand or change a sphere of influence usually produces tension, but it may not result in a change in the sphere of influence. When the sphere of influence does actually change then legal pluralism is on the table for all to see.

Size and structure of authority

There is a widespread belief that state-managed systems are large, and communal systems are small. I have demonstrated that, empirically, there is no truth to this truism (Hunt 1988). Some state systems are small (the smallest so far is 700 hectares), and many communal systems are very large (the largest so far is 448,000 hectares.) All of the systems so far found below 700 hectares in size are communal in authority structure, and all above 448,000 hectares are run by the state. In between 700 hectares and 448,000 hectares, however, there is no explanation for why the system is run by state or by communal management.

Thus it is not true that communal systems are small in size. Many are, but many are not. And it is not true that state systems are large. Many are, but some are not. The popular generalization linking size and form of authority has no basis in fact.

This is a fact of considerable import. With the withdrawal of the state from irrigation we are not faced with the destruction of irrigation. Rather, we know that farmers can manage irrigation systems of very large size, so our thinking should be moving towards how to shift the large state systems to communal control, thus extending their lives. The Water User Associations have been suggested as a solution to this problem, whereby small areas of a state-managed irrigation system would be turned over to the farmers. I have made some suggestions about this matter (Hunt 1989). But I suggest a more radical move, which is to substitute farmer control for state control over the system, which my comparative work shows to be more than a possibility. At issue of course is the political culture of the individual states.

Multiple forms of communal management

So far communal management has been treated as a single form. It now appears to me to be the case that there are at least three forms of communal organization – Common Property, Municipal, and District. I have in the past claimed that communal irrigation systems were common property forms of organization, and I now think that that is not true.

Many communal irrigation systems are Irrigation Communities. They are common property managers, whose members are all those who have water rights, and only those who have water rights. In the vast majority of cases the users are defined by owning land which has rights to the water, but other forms are possible. In the vast majority of cases these systems are run as democracies, with each user, or each water share, having a right to vote, and each user (or water share) having correlative duties (paying dues, providing a worker for maintenance, participating in the rituals). All the users, and only the users, are members, and many rights and duties are attached to membership.

The organization has internal juralty, including the right and duty to restrain the activities of the members. On rivers with two or more such systems there is external juralty as well, for these systems have to deal with each other with respect to the benefit stream from the river. The property held in common may well include water, water rights, some irrigated land, reservoirs, dams and canals, roads, equipment, buildings, cash, temples, and perhaps even the rights to a certain amount of labour of the members. Irrigated land is for the most part owned individually by members (and members may include corporate groups or government territories.) These systems are almost always staffed by irrigators.

The Municipal form is organized by a municipality, a low-level territorial jurisdiction of the state. The irrigators may vary from a large number of town residents (as in Highland Peru – see Guillet 1992) to a small percentage of the town residents (as in San Juan, Mexico in the early 1960s – see Hunt and Hunt 1974). In this form there is clearly local control over the irrigation, but that control is in the hands of the municipal administration. How strongly that administration is influenced, or controlled, by the local elite, by large land-owners, or by irrigators, is an empirical question worth pursuing. The irrigation system itself may well be viewed locally as being municipal property. The staffing is provided by the municipal government.

The District form of organization is less well understood. It was suggested by some systems in California. There, the political culture of the province permits (indeed encourages) the creation of special-purpose government entities, in this case dedicated to operating an irrigation system. It is the voters of the territory, not the irrigators, who are the members, for it is they who vote for or against the creation of the district, and then vote for or against the taxes and fees that support the district. The district has powers of taxing and eminent domain,

and has internal and external juralty. In California, at least, these can be very large (the Imperial Valley Irrigation District has 222,000 hectares of irrigated land, Westlands is supposedly much larger). They are run neither by the state, nor by the province, but are a local organization, albeit territorial rather than irrigator in membership. The staff often forms a full-time permanent bureaucracy, reminiscent of the large agency systems in other parts of the world.

Because this distinction has only recently been formulated it is uncertain how it will apply to the cases of communal irrigation we have. Valencia, Unidades de Riego in Mexico, many of the systems in Colorado and California, and the *subak* of Bali are all Irrigation Community examples. How many communal cases are actually municipal rather than common property is uncertain. The distribution of districts is an unknown.

It is certain that the common property form can be of very large size (King's River near Fresno California is 448,000 hectares). Unless the municipal territory is very large, which most are not, it would seem that the municipal form would be confined in size. The district form can be very large.

Sustainability

Some common property forms of communal irrigation have been in existence for millennia (Valencia, 12-Go in Japan, Balinese *subak*) and are therefore sustainable. These are also cases of common property management. I suspect that irrigated agriculture must be economically viable as well. The *acequias* in New Mexico (small-scale irrigation systems in Hispanic regions of northern New Mexico – see Northern New Mexico 2000) have been threatened with loss of water because the small-scale agriculture they supported has become uneconomic. Something similar has been reported for an agency-managed system in the Philippines, where the price of rice has fallen while the price of inputs has not, putting the agriculturalist in an economic dilemma and the irrigation system at risk (Hayami and Kikuchi 2000).

One has to presume that an irrigation system existing for 1,000 years or more is environmentally sustainable. Whether it will continue to be so with industrial technology is perhaps a different question. But as long as it is economically sustainable, the common property form of management is without any doubt politically sustainable. As long as irrigated agriculture is economically viable, there should be a strong interest on the part of the farmers to keep the irrigation system going. This is probably enhanced by the single-purpose nature of the organization. Whatever factional disputes arise in the region they apparently can be partitioned off from the irrigation system.

The municipally governed systems may not be as sustainable in organizational terms. Municipal organizations have many purposes and tasks, and are prime targets for factionalism. A dispute over who holds the mayor's office, based on some external consideration (such as national road policy, for exam-

ple) may well be a factor in the municipal arena, and thereby distract attention from irrigation, or even involve irrigation matters in extraneous disputes. It is plausible, in other words, that the municipal form of organization is more vulnerable, and therefore not as easily sustained. We know too little about the district form to see how sustainable they might be. It may well depend upon the ratio of those involved with irrigated agriculture to those who are not. A high ratio of irrigation folk might mean a higher degree of sustainability.

Occidental despotism

Karl Wittfogel's *Oriental despotism* (1957) is an analysis of water management and power which is widely known and often referred to. It was not an irrigation hypothesis (as was clearly spelled out by Mitchell in 1973). It was an hypothesis concerning protective as well as productive hydraulic works and their relationship to scale and political centralization. It was also located in the orient.

Thierry Ruf (of IRD in Montpellier, France) has proposed the concept of 'occidental despotism' (Ruf 2001). The UK, France and the USA, all occidental, organized irrigation systems overseas during the Industrial era. At home they have many communally organized water management systems. Overseas they organized vast centrally controlled bureaucratic systems. The same may be said of Japan with respect to Taiwan, and in this regard one may suppose that an Industrial Japan may be part of the occident. Thus the major examples of centrally managed irrigation systems today are direct descendants of an occidental diffusion (Egypt, Iraq, India, Office du Niger, Philippine agency systems).

Unanswered questions

In this, the third part of this article, I will accentuate some questions to which we do not currently have effective answers. The spirit is one of encouraging future field work.

Cost of operation and maintenance

There is no doubt that sustaining an irrigation system is costly. Construction is expensive, and so is fighting entropy. It requires organizational attention, quickly mobilized emergency work, and the drudgery of regular maintenance. Somebody has to keep track of rights, and the performance of duties. The costs always include paying attention, and humans performing work. It also involves materiel, and often money. Where rituals are involved there is another drain on resources. We have almost no information on the scale of resources needed for all this work. In my comparative work on agricultural productivity, comparing swidden with sawah rice systems in Southeast Asia (Hunt 2000), I looked with great care at whether or not work on the irrigation

system was included for the *sawah* cases. Only one field report paid attention to it specifically, and then did not include all the work.

There are mountainous areas with extensive terraces used for irrigation agriculture. The Andes, Himalayas, and the Philippines are the most often photographed, but they undoubtedly exist elsewhere. I have found no satisfactory detailed account of the amount of work needed to construct or maintain these terraces (Conklin's account (1980) needs amplification).

Surely the sustainability of communal systems is a function of their cost, at least in part. For many centuries some communal systems have been able to provide that cost, and continuously. The cost must have some relationship to their resources and their incomes. Surely it would be good to be better informed on this matter than we are.

Acephalous systems

I reported in 1988 that there were a tiny handful of irrigation systems without any authority system whatever, including some in the Philippines. I remarked at the time that these are a mystery given what we imagine we know of the necessary conditions for running an irrigation system. Our models focus on coordination and conflict, and therefore the need for an authority system to manage both of them. Achieving coordination and conflict resolution without an authority structure is unimaginable. And yet, according to Robert Netting (1974), such systems actually exist, and in the Swiss Alps have been in existence for hundreds of years.⁸

These acephalous systems are a profound challenge to our assumptions about how things work, and should be the subject of a dedicated field project. The gain for social science could be very large.

Effectiveness of irrigation systems

Many of us who study irrigation are prone to say that the agency or national systems do not work, whereas the communal ones do, and are effective. This is an assertion rather than an empirical finding, and it is very easy to make. It is almost impossible to convert it into an empirical result. A prime reason for this is the lack of an operationalized concept for dimension of effectiveness of an irrigation system. The challenge is great, especially now given the withdrawal of the state and the move to change the conditions under which irrigation systems operate (market, privatization).

Part of the difficulty is in separating out the effectiveness of the irrigation system from that of the irrigated agriculture that it supports. In any judgement of effectiveness the goals or targets against which one is measuring performance must be stated clearly. Only then can one see how close to the target the performance is. This needs to be spelled out, and it has so far not been successful.

⁸ Personal communication.

Drainage systems

My assigned task was to consider communal irrigation. If irrigation is a kind of additive act (adding water when it was not present before), there is also the subtractive act of drainage (removing water when it is present). Many irrigation systems are also equipped to drain excess water, and this function of irrigation is almost never addressed in the social science literature. However, there are large systems of water management which are devoted principally to drainage. There are substantial numbers of them along the Mississippi River (Stewart 1993), in the UK, and certainly in the Netherlands. I have looked at a few UK Drainage Boards, and can report that they are single-purpose common property managers under the local control of the users. The same seems to be true of the Drainage Districts along the Mississippi River. Presumably many of these drainage systems are under communal control. We should support detailed historical and field studies of at least a handful of these systems.

Conclusions

My task has been to consider communal irrigation in a comparative perspective. My stance is that of a social scientist. In order to carry out systematic comparative study I have argued that concepts need to be clear, unambiguously named, and operationalized. The first section of this paper discusses some concepts.

The second section presents the results of comparative efforts. Communal irrigation is found in nearly every country, and there may be as many as 1,000,000 of these systems in existence. Now all communal systems are embedded in a state, and the role of the state varies considerably. Communal and state spheres of influence are dynamic and at times contested. Comparative research has demonstrated that there is little relationship between size and structure of authority. There are very large communal systems, and small state ones. Three forms of communal management have been isolated – Irrigation Communities (composed of all and only the irrigators); Municipios (where the local administration does the management); and Districts. Communal systems are environmentally sustainable, but only when they are economically viable as well. Finally, ‘occidental despotism’ is the curious phenomenon whereby colonizing nations, with communal management at home, impose state management of water on their colonies.

The third raises some problems and makes some suggestions for field investigations that might be productive to undertake.

We do have a large number of concepts that are under pretty good control, and we have learned a fair amount about communal irrigation, thanks to the efforts of a large number of investigators. Fortunately we still have much to learn.

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