ANTHROPOLOGICAL PAPERS OF
THE UNIVERSITY OF ARIZONA
NUMBER 25

IRRIGATION'S IMPACT ON SOCIETY

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THE UNIVERSITY OF ARIZONA PRESS
TUCSON, ARIZONA 1974

CHAPTER 6

THE SYSTEM NOBODY KNOWS
Village Irrigation in the Swiss Alps

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Although the European Alps are not generally thought of as arid, in many areas dryness severely limits local agriculture and herding under natural conditions. This phenomenon is particularly apparent in Valais Canton of southern Switzerland (Fig. 6.1), where extensive mountain ranges to the south and north block moisture-bearing winds from the Mediterranean and the Atlantic. The upper valley of the Rhone from its glacier source to Lake Geneva is left in a rain shadow with only 50 to 80 centimeters (roughly 20 to 30 inches) of annual precipitation (Bär 1971:43). It is also relatively less cloudy than other regions of Switzerland, so that, for instance, the cantonal capital Sion has a yearly average of 400 more hours of sunlight than Zürich (Gutersohn 1961:13). Local valley winds blowing on fair days in summer may further increase transpiration.

The effects of continental climate are intensified on southward facing slopes (*Sonnenseite*) where exposure to the sun is highest. This condition is exemplified in Törbel, a German-speaking village in Vispertal.[1] Rainfall figures are unrecorded, but they may be slightly less than neighboring Grächen, with 56 centimeters, and Staldenried, whose 53 centimeters is the lowest average in Switzerland (Gutersohn 1961:53). Most of Törbel's territory is located on a southerly incline, receiving its major unobstructed insolation down the valley of the Mattervisp from the direction of Zermatt. A continuous, rather steep slope rises from the river at 770 meters, through the main village site at 1500 meters and the timber line at 2200 meters, to the peak Augstbordhorn at 2972 meters. The favorable exposure and the variety of accessible microenvironments based on altitude provide niches for all the major forms of subsistence – vineyards, grain fields, gardens, hay meadows, forests for fuel and building materials, and alpine pastures for summer grazing (Netting 1972). In the past, the community was largely self-sufficient in its staple dairy products, bread, and wine, its timber and stone for houses, and its wool for clothing.

The high location of the village, though it made transportation difficult, gave protection from the floods, malaria, and occasional marauding armies menacing the Rhone valley floor. Törbel is also well sited in regard to avalanche and rock slide danger. Such advantages, along with the presence of springs for drinking water and deep-soiled terraces for the planting of rye, characterize the mountain areas which were settled in pre-Christian times by Celtic populations (Staub 1944).

The crucial adaptive technique in this physical environment is irrigation. Without it, the rocky slopes above 1000 meters would carry only xerophytic (*Felsensteppe*) vegetation or the semi-arid larch forests from which Törbel takes its Gallic name (Zimmerman 1968:19-20). With intensive watering, the lower meadows can produce two lush hay crops plus a few weeks of grazing every year. Irrigation generally results in a four-to-five-fold increase in productivity over dry-farming.

Mountain irrigation is not rare in Europe, and indeed, Burns (1963) cites it as one of ten traits distinguishing a circum-Alpine culture area. Sections in the Alps have been irrigated for at least a millennium. Mariétan, in his richly illustrated essay (1948), presents historical documentation for irrigation in Valais from the eleventh and twelfth centuries. At present, canals of ten to twenty kilometers are common. A count in 1907 indicated that over 200 major channels, with a combined length of perhaps 2000 kilometers, were in operation (Stebler 1922:70-71).

In the simplest form of irrigation, water is merely diverted by a dam from a perennial stream and led through a stone-lined channel (*Wasserleitung*). Shallow feeder ditches (*Rus*), dug out of the soil, follow the contour of the meadow. Water is directed through

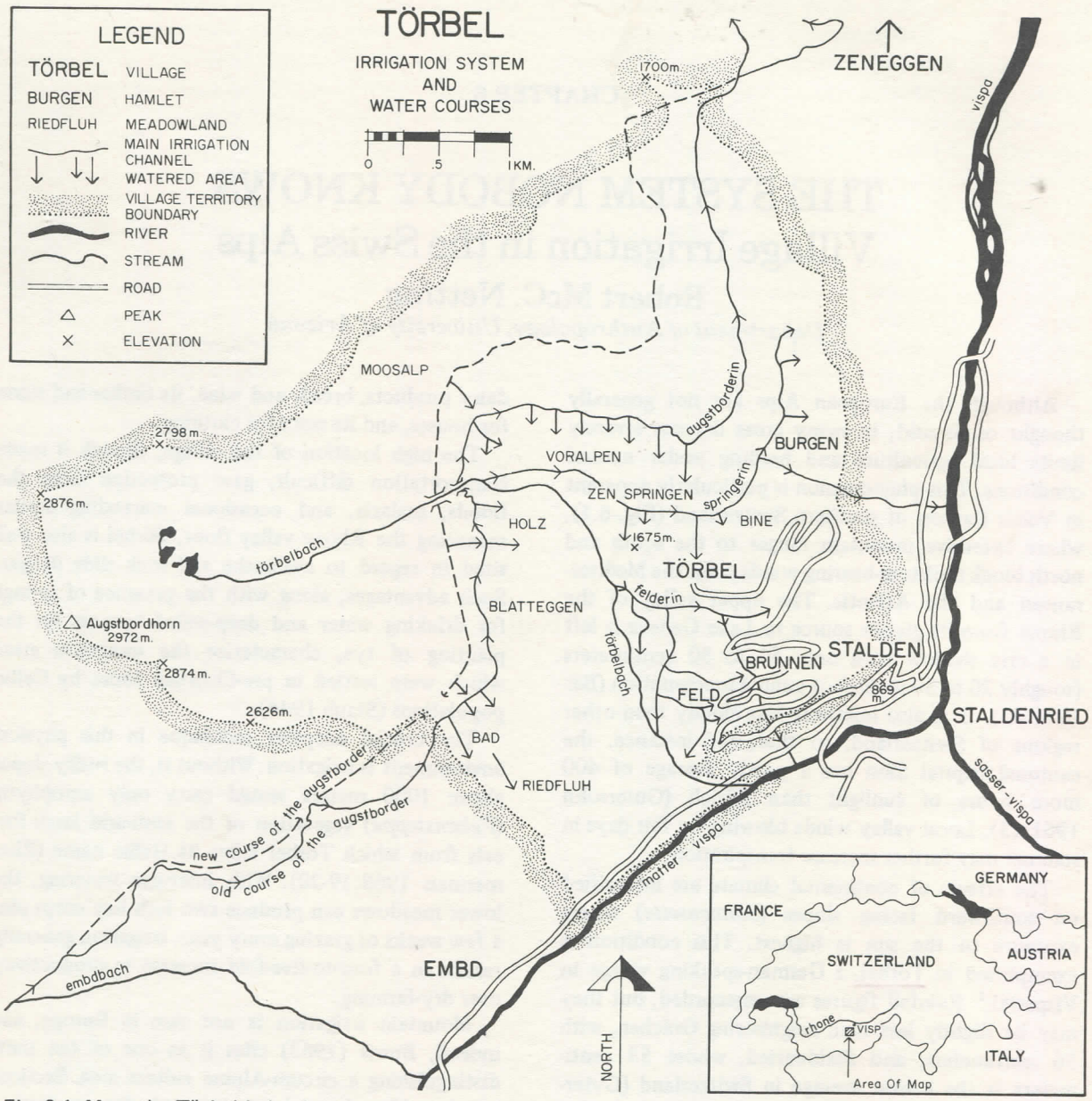

Fig. 6.1 Map: the Törbel irrigation systems.

the main branches of the system by wooden sluice gates (*Schieber*) or temporary earth and stone dams. Beginning at the downstream end, the feeder ditches are blocked at several points by stone plates (*Steinplatten*) thrown down with enough force to lodge in the earth sides of the trench. The partially interrupted flow spills out of the ditch and downhill. When the water reaches the base of the meadow, the stone plate is removed and placed a meter or two farther back to water the next strip of land. The same method is used to distribute the water of small spring-fed catch basins, which are drained several times a day as rapidly as they fill up.

Most Törbel farmers have meadows scattered at various altitudes and in widely separated parts of the village territory. A larger-than-average landowner might have water rights requiring irrigation of some plot almost every day of the week. To actual watering time of one to four hours, must be added a round trip of up to an hour and a half. Irrigation is most efficiently done by a team with one person (often a child) reporting the arrival of the water at the foot of the meadow. It is no wonder that one computation puts hours of irrigating at double the entire time spent mowing, raking, and transporting the hay produced (Stebler 1922:81). Watering chores also fall

at the height of the summer agricultural season, when time is at a premium.

Törbel has three irrigation systems (Fig. 6.1). The two lower networks, the Felderin and the Springerin, are simpler, smaller, and very probably older than the uppermost Augstborderin. Both tap the Törbelbach, a brook which originates from snow-melt water and springs in a large mountain basin (Törbeltelli) on village territory. The Springerin takes two thirds of the brook's flow at approximately 1900 meters, while the remaining water is captured by the Felderin at 1500 meters to irrigate a wedge-shaped section of some 19 hectares just below the village. The highest tier of meadows (die Voralpen) and the outlying areas to the southwest and northeast are irrigated by a 10-kilometer canal called the Augstborderin or Niwe.

According to one account, water rights in the Embdbach were purchased from the valley town of St. Niklaus in 1270 by Törbel and the neighboring community of Zeneggen, which together constructed the channel and continue to share its water (Bichsel and Hämmerli 1967). Another source refers to a similarly ancient canal in much the same location which served five villages and was built by the Count of Visp. Though the origin of the system is unclear, documents indicate that it was independently controlled by an association of Törbel and Zeneggen residents in 1343 (Stebler 1922:71-72). The watercourse was rebuilt in the seventeenth century, in 1901, and most recently in 1947, when underground concrete conduits were installed at a cost of 2.2 million francs.

Each irrigation system was formerly managed and maintained by an association of users (*Geteilschaft*), whose annual labor contribution and infrequent cash assessments were in proportion to the water share of each member. The two lower systems are now nominally administered by the village council, while the long canal remains in the hands of an association, formally chartered, which elects officers, and is responsible for any necessary major financial expenditures. Water is allocated from the Augstborderin in a regular sequence, beginning at the downstream end and going to each successive section for a quarter-day (*Viertel*) of six hours. These quarter-days are used by one or more property owners with the order and time of individual shares listed precisely in hours and minutes. Traditionally the cycle (*Kehr*) was 21 days, with each community having approximately 42 quarter-days. With an increased water flow resulting from the last reconstruction, Törbel and Zeneggen use the water concurrently, dividing the volume in half. At various times, shares have been bought from one community by members of another. These purchased rights entitle the owner to receive water in terms of the geographical position of his meadow in the previously established sequence. Each cycle starts six hours later than the previous one so that watering times for an individual rotate regularly through the 24-hour period. Prior notice of the beginning of a cycle is given as one of the civil announcements in the brief public gathering after Sunday Mass. Supervision of the system is provided in yearly succession by one man (*Niventeiler*) from each group watering within the same quarter-day. In the past, the members from the two villages worked for a few days in the spring to repair breaks in the canal caused by fallen trees, avalanches, or gullying over the winter. A guard (*Wasserhüter*) was employed by the association to walk along the channel during each day of its operation to check for leaks and obstructions.

The two lower, older, and more spatially restricted systems are regulated without central authority or official mechanisms for adjudication. Upkeep is provided by a half dozen men working communally one day in spring, and the system is then left to run itself. Water rights are not publicly recorded, and no one knows even in outline the entire pattern of water distribution. Indeed informants universally deny the possibility of comprehending the total system. Each individual can supply information on when and where he is entitled to water, but no one can accurately list the shares for a whole day, much less an entire cycle. The usual phrase, accompanied with a vague, outflung gesture, is "Das Wasser ist bald her, bald da," meaning "the water is now here, now there."

The lack of definite knowledge and standardized administration contrasts with the elaborate codes of rules and detailed on-going records with which voluntary associations and the community as a whole regulate their activities. Written documents covering land ownership go back in some cases to the medieval period. Management of the common grazing ground on the alp and the division of cheese produced there require extensive listing of participants and quantification of their contributions. Vital statistics, cattle insurance, communal vineyard work, health plans, and the minutes of a multitude of voluntary organizations are all handled locally. Literacy is general and most adults can perform quite complex bookkeeping and bureaucratic chores. The Augstbord canal is managed with typical efficiency and organizational skill, though by a voluntary association which is unconnected with village political leadership. Why then are the two smaller irrigation networks so obviously lacking in centralized control and clearly stated rights in this valuable resource?

Unified knowledge and administration of irrigation is rendered difficult by the timing of shares and the complex rotation of individual turns in successive cycles. The following examples come from the Felderin, a system which I attempted to describe fully by collecting and collating bits of information from 33 members. For the Felderin, the standard cycle consists of 16 twenty-four hour days beginning the first Saturday in April and continuing, with the exception of Sundays, for every weekday through early September. The duration of water use on a particular plot is fixed with reference to the movement of sun and shadows on the surrounding landscape, e.g. *Dreifurren* (three terraces) is the time at which the sun first touches a particular field with three terraces above the village of Staldenried on the opposite slope, and *Schattigwasser* (shadow water) marks the moment when a shadow reaches a specified point on the Saaser Vispa River. The periods based on a variety of these *Wasserziele* (water markers) expand and contract according to the changing length of days and nights over the five-month season. The only fixed points are *Mittag* (midday), timed by the clock at 11:30 A.M. and *Mitternacht* (midnight), at 12:30 A.M. Table 6.1 lists the most common markers, the times at which they occur, and the average length of periods they define.

In describing his water rights, a farmer or his wife (women do a great deal of irrigating and may be better informed in these matters than men) notes first the day of the cycle, the distinctive name of the area where the meadow is located, and the markers defining each period through which the turn rotates. He may or may not know the named area (often not

TABLE 6.1 Natural Markers Timing Irrigation Shares in Törbel*
(Irrigation season for Felderi approximately April 11-September 4).

Marker	Approximate Times			Average Minutes in Period	
	Earliest	Latest	Average		
Tagaufgang (Daybreak)	2:50 a.m.	4:15 a.m.	3:30 a.m.		
				220	
Stadeldibschinu (Little granary shadow)	6:30 a.m.	7:45 a.m.	7:10 a.m.		
				115	
Dreifurren (Three terraces)	8:30 a.m.	9:40 a.m.	9:05 a.m.		
				145	
Mittag (Midday)			11:30 a.m.		
				205	
Schattiwasser (Shadow water)	2:10 p.m.	3:45 p.m.	2:55 p.m.		
				110	
Ottava (Place name in valley of Saaser Vispa)	4:00 p.m.	5:30 p.m.	4:45 p.m.		
				50	
Ober Ottava (Upper Ottava)	4:45 p.m.	6:30 p.m.	5:35 p.m.		140
				90	
Schattogspon (Shadow at Gspon hamlet)	6:15 p.m.	8:00 p.m.	7:05 p.m.		
				325	
Mitternacht (Midnight)			12:30 a.m.		
				180	
Tagaufgang (Daybreak)	2:50 a.m.	4:15 a.m.	3:30 a.m.		

*Times were taken from incomplete records kept by individual irrigators and rough records of times on the longest day in Stebler (1922).

contiguous) from which the water comes or the one to which it goes. A few meadows have fixed periods, recurring at the same time in each cycle. Most, however, rotate through a succession of periods, alternating at each time slot with one to six other meadows. The progression may be simple as in Table 6.2, where each meadow gets water in successive cycles at Period 1, 2, and 3. The initial order is determined by a representative from each meadow area drawing straws on the first Sunday in April. This order is then maintained throughout the summer, and some people make a note of it and mark the appropriate days on an almanac calendar when their water is due.

In any one meadow area, there may be several owners with varying proportions of the period, e.g. one-half, one-fourth, or two-thirds. Rotations may be more complicated as indicated by Table 6.3. Though Gapil Meadow follows a regular succession of periods, Bodman I and II divide each period and show an internal alternation, exchanging first position in successive cycles. Once the sequence is worked out in full, it accurately predicts irrigation times, but individual farmers find the schedule amazing because they reckon only the periods in which they are due to receive water. As patterns emerge in the analysis, gaps in time for which no user has been identified may suggest the presence of another meadow group, just as expected contrasts predict the presence of phonemes in a linguistic analysis. Table 6.4 shows a complex rotation in which one meadow (Ägerta) switches back and forth from day to night positions while Period 3 remains stationary, though this period is held by three meadows in successive years. Each day of the cycle shows different combinations and permutations.

Some flexibility is introduced into the system by allowing a member to use water during his allotted period for any meadow he owns in the area served by that irrigation network. Thus an inadequately

TABLE 6.2 Felderin First Day.

Period	Meadow	No. of Owners
Tagaufgang – Stadeltibschinu (fixed)	Hogiblatt	1
1) Stadel. – Mittag	Kapellenmatte	3
2) Mittag – Ottava	Rosmatte	3
3) Ottava – Tagauf.	Hubel, Sälli, Gufer	3

TABLE 6.3 Felderin Fourteenth Day.

Period	Cycles: 1st	2nd	3rd	4th
Tagaufgang – Stadeltibschinu	Bodmen I	Hinter der Egge	Schluocht II	Gapil
Stadel. – Dreifurren	Bodmen II		Schluocht I	
Dreifurren – Mittag	Gapil	Bodmen II	Hinter der Egge	Schl. I
Mittag – Schattigwasser		Bodmen I		Schl. I
Schattigwasser – Ottava	Schl. II	Gapil	Bodmen I	Hinter der Egge
Ottava – Schattogspo	Schl. I		Bodmen II	
Schattogspo – Mitternacht	Hinger der Egge	Schl. II	Gapil	Bodmen II
Mitternacht – Tagaufgang		Schl. I		Bodmen I

NOTE: Bodmen I and II alternate in first position in successive cycles. Schluocht I and II alternate in first position in successive years (odd numbered year shown in table).

watered plot can be supplemented from water which is not needed in another area belonging to the same person. Neighbors may trade water, one taking two continuous shares in one cycle while the other does the same in the next. People who find watering at night unnecessary and inconvenient may lend such shares to someone else, often in return for help at plowing or harvest. Additional water may be purchased from the church, which has rights to all water on Sundays (*Sontagswasser*). One-hour periods are available on this day to landholders in order of their geographical arrangement. On main channels the sequence goes downstream on the right and then back upstream on the left. The series is again unrecorded and leads to lively arguments, which the church warden (*Kirchenvogt*) in charge of water sales makes no effort to resolve.

Given the agricultural necessity for water, its limited availability, and the sizable expenditure of labor involved in irrigation, one might expect either attempts to rationalize the system or frequent controversy. Neither of these occurs. The complex rotations through periods of unequal length build a self-correcting element into the system. Two owners (A and B) who attempt to take water at the same time may not have periods of equal length. If A takes the water, only to find that a third party (C) appears to claim it before the original period is over, or conversely that no one arrives to take the water from A at the end of his time, it is apparent that A is out of order. Those people whose periods are immediately affected can usually work out such problems among themselves, though the resolution may involve a recapitulation of all the cycles since the beginning of the season. Older farmers who are reputed to have a good head for these intricacies may be consulted by less experienced or confused neighbors. Dispute over the exact shadow marker to be observed is also settled privately. Everyone is aware that water is wasted when it must be led hither and yon, requiring time and the wetting of dry channels enroute, but it is deemed impossible to institute a regular progression of watering contiguous plots, as in the Augstbord system.

It is possible to steal water by leaving a sluice gate "accidentally" propped open or "forgetting" to remove completely a stone plate from a channel being used to convey water to another farmer out of sight in a down-slope meadow. Theft is difficult to prove, but if such apparent mistakes happen repeatedly, the injured party may give a warning and later resort to self-help, throwing the suspect's stone plates into the middle of the meadow. Harsh words may be exchanged, especially when water is in short supply, but informants do not remember more serious conflicts. The only local controversies known to have been brought to court are those in which ditches were

TABLE 6.4 Felderin Third Day.

Period	Cycles: 1st	2nd	3rd	4th
Tagaufgang – Stadeltibschinu (fixed)	Halbamatt	Halbamatt	Halbamatt	Halbamatt
Stadel. – 9:30 a.m. (fixed)	Unter der Kapelle	U. d. K.	U. d. K.	U. d. K.
9:30 – 10:30 (fixed)	Feld bei der Kapelle	F.b.d.K.	F.b.d.K.	F.b.d.K.
1) 10:30 – Mittag	Ägerda	Feld II	Lengseich	Feld I
2) Mittag – Schattigwasser	Feld I	Lengseich	Ägerda	Feld I
3) Schattigwasser – Schattogspo	Boden	Boden	Boden	Boden
4) Schattogspo – Mitternacht	Feld II	Ägerda	Feld I	Lengseich
5) Mitternacht – Tagaufgang	Lengseich	Feld I	Feld II	Ägerda

NOTE: Position 3, which remains stationary, is occupied in successive years by Boden, Feld I, and Feld II.

poorly maintained or water was allowed to flow unsupervised (*herrenlos*) through the system until it broke into a meadow and soaked the earth, causing a mud slide. The individual or association responsible can be sued for damages. Litigation over water rights or resort to higher authority is almost wholly confined to intercommunity relations. Törbel has had centuries of controversy with neighboring Embd over the amount of water which each draws from the Embdbach and over the maintenance of the Augsborderin, which crosses Embd territory (Imboden 1956:34, Stebler 1922:72).

There are several possible explanations for the development and preservation of an acephalous system of ordered anarchy in irrigation. The natural period markers obviously predate the clock, and the division of water may reflect a system which grew by gradual accretion over time. Little organized community activity was required to build the main channels, and as individuals extended the ditches into new meadow areas, they worked out limited and idiosyncratic agreements for water sharing. Though water rights accompany land, they are seldom specified in the elaborate deeds of land transfer that appear from the seventeenth century onward. It is reasonable to assume that inheritance and sale have subdivided properties and at times led to exchange and limited reapportionment of water rights. Some meadows with evidence of ditches are no longer entitled to water. A rationalized system of water sharing is resisted by those who derive advantage from the current arrangement. Convenient watering periods during the day are valued, and owners are reluctant to accept other times. Though everyone recognizes that some unfairness of distribution is perpetuated by the existing system, larger owners claim (1) that their water is as much a possession as the land and is subject to similar inequalities in tenure, (2) that any reorganization would be dreadfully complicated, and (3) such a project would inevitably arouse suspicion and animosity in all concerned. The most qualified individuals say they would refuse to plan a reorganization, and that successful change could only be brought in with the installation of a pipe and sprinkler system that would radically alter the amount and nature of work involved in watering.

Preliminary calculations of the holdings of nine farmers in the Felderin system support the contention that there are gross inequalities in amount of water available per unit of land. Table 6.5 shows that some plots have a minute of water for 3.7 square meters of area, while the same amount of time must serve for an average of almost 50 square meters in other meadows. The legacy of centuries of private deals and tinkering with details of the system has resulted in a variety of vested interests. Frequent movements of water from one area to distant parts of the network, reliance on natural periods of changing duration, and a multitude of incomparable rotation orders within the cycles all join to obscure the nature and inequities of the system. The lack of standardized public records and central control prevent any individual from enlarging his own circumscribed practical knowledge. It is easier to make up a lack of water by shifting supplies among plots, buying from the Church, and bargaining with neighbors and kin than to attack the system and its entrenched supporters.

From the Törbel case, it would appear that small-scale irrigation systems[2] which grow essentially without plan and are maintained with a minimum of cooperative effort can function on the basis of an intricate series of water-sharing agreements, each meshing with the others but known to individuals only insofar as their own use rights are exercised. When geographical factors limit the amount of arable land and/or water, and when cultivators control their own water source, be it a well, an impoundment, or a stream, there is no possibility for expanding the system. The association of users has no need to be coercive if its members' rights are conditional on obligatory contributions of labor and capital. Central control and direction of work is unnecessary if upkeep is minimal and routine. Emergency demands for work are self-evident, and the sanction for participation is simply loss of the water on which the individual's own agricultural success plainly depends. Experienced members of the association all have whatever engineering knowledge is required to keep the system functioning, and they are able to act as ad hoc or elected leaders when circumstances demand cooperation.

A system in which no one possesses comprehensive and comprehensible knowledge of its total operation has a kind of organic stability. Mistakes in order or efforts to take a larger share than one is entitled to attract notice and encounter immediate resistance from those whose turns are most closely integrated with one's own. Regulation and self-correction are paradoxically more effective when the parts of the system are *not* interchangeable and their interdigitation is an impenetrable maze. As Leach (1961:165) pointed out with respect to Pul Eliya's traditional water distribution, "the complexity of the arrangement is itself relevant. . . since such a system is virtually unalterable." A higher authority is not only

Table 6.5 Relation of Irrigated Meadow Area to Duration of Water Supply.

Farmer	Day	Location	Area (sq. meters)	Average Time (minutes)	Square meters irrigated per minute of water
A	1st	Kapellenmatte	1190	77.5	12.8
	5th	Hausmatte	1200	25	48.0
B	5th	Feld	1240	25	49.6
	5th	Reft	2000	336	5.96
	11th	Börter	670	45	14.9
C	3rd	Ägerda	1500	48	31.25
	13th	Stahlschier	850	102	8.3
D	1st	Kapellenmatte	530	102	5.2
	4th	Kapellenmatte	360	20	18.0
	5th	Blattmatte	110	30	3.7
	8th	Hublen (Feld)	900	240	7.5
	6th	Hogiblatt	3020	112	18.0
E	1st	Hogiblatt	2750	220	12.5
	16th	Schluocht	1450	360	8.1
	7th	Boden	1041	30 (60 every other kehr)	34.7
F	12th	Bodmen	1105	85	13.0
	14th	Bodmen	1050	56	18.75
G	4th	Bodmen	1660	252	6.6
	3rd	Boden	1580	128	12.3
	5th	Feldhalmerin	320	90	3.6
H	2nd	Krumenstückini	3000	92	32.6
I	14th	Hinter der Egge	1330	100	13.3
	9th	Hofmatten	1150	94	12.2

unneeded but actually irrelevant to the settlement of disputes about a distribution based on shadowy points of reference, eccentric rotations, and rigidly uncodified rights. In such a system, an uninformed, voluntarily cooperative association of users would seem the most appropriate social institution.

The tendency toward rationalization of water distribution, clarification of rules, formalization of rights, and centralization of powers may appear under the following circumstances: 1) when the source of water is not locally controlled, and rights in it must be purchased, rented, or acquired by force and thereafter defended from other communities competing for the same resource, and/or 2) when the building and maintenance of the canal system require the joint efforts of several otherwise independent communities. These factors are evident in the uppermost Törbel irrigation system, which relies on a distant water source and is tapped with the cooperation of a neighboring village. Conflict within the community of irrigators appears small in proportion to cooperation. Disputes, litigation, and hostility characterize relations between competing settlements, but even here, there is no evidence of the identification of control of irrigation and political leadership. The hardy Alpine variety of hydraulic society, even with the introduction of order and rules, must still be classified as an occidental democracy.

NOTES

[1]Field research in Törbel from July 1970 to August 1971 was supported by a fellowship from the John Simon Guggenheim Memorial Foundation, a grant from the University Museum of the University of Pennsylvania, and National Science Foundation Grant No. GS-3318.

[2] "Small scale" is less a matter of relative size of system or amount of water distributed than of the investment of labor and resources necessary to construct and maintain a particular irrigation network, as Spooner (this volume) points out. "Scale" may also refer to the limited number of participants involved in water sharing and the presence of numerous cross-cutting ties of kinship, marriage, residence, common ritual activities, and cooperative economic endeavors which promote informal methods of dispute settlement.

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