2. WATER RIGHTS IN THE STATE OF NATURE: THE DYNAMIC EMERGENCE OF COMMON EXPECTATIONS IN AN INDONESIAN SETTLEMENT

Douglas L. Vermillion

ABSTRACT

This study examines how a socially recognized and predictable pattern of water rights and allocation emerged from a process of trial and error with water allocation and negotiations in a resettlement area in North Sulawesi, Indonesia. Balinese farmers in two newly developed irrigation systems recognized that the traditional rule of water allocation that divides water proportionately to area served was a simplistic first approximation. Through inter-personal exchanges a set of socially-recognized criteria emerged to justify certain farmers in taking more than proportional amounts of water, "borrowing water," in response to diversity among fields in soils, access to secondary water supplies, distance from the headworks and other factors. A decision tree model uses field observations of water distribution over two seasons to assess criteria used for modifying distribution. Such criteria constituted a second approximation for more equitable water allocation among farmers.

INTRODUCTION

This study analyzes the emergence of locally-defined water rights among Balinese settlers in two newly-developed irrigation systems in North Sulawesi, Indonesia.[16] Two farmer-built irrigation systems located in a recently deforested resettlement area provide a setting for examining the origins of water rights and cooperation in a socio-ecological "state of nature", before the arm of the state became a significant factor in the irrigation systems.

With rising populations and diversifying economies, competition for water is rapidly intensifying in many developing countries, especially in Asia (Seckler 1996; Arriens et al. 1996). At the same time, due to financial pressure and management failure, many countries are devolving management for irrigation systems to local farmer organizations (Johnson, Vermillion, and Sagardoy 1995). These changes have brought about widespread interest in how to create farmer organizations that will cooperate in sharing water (EDI 1996; Meinzen-Dick et al. 1997). They have also renewed interest in developing formal water rights and markets in developing countries (Pradhan et al. 1997; Rosegrant & Binswanger 1994).

These changes point to the need to better understand what makes cooperation possible, what is the process whereby locally-valid water allocation principles emerge, and to what extent local groups have the ability to solve problems of resource allocation. This paper provides insights into the basis for cooperation by examining the origins of common property rights among people sharing a scarce resource in a newly settled environment.

Michael Taylor's (1982, 1987) theoretical analysis of the origins of cooperation and community in a "state of anarchy" (that is, without the coercive role of the state) identified shared beliefs or norms, direct social relationships among people, and repeating reciprocity as the key elements of cooperation. Normally, these features exist only in relatively small groups where direct, personal interaction is possible. Schofield states that the main theoretical problem for explaining the rise and maintenance of cooperation is:

> ...the manner by which individuals attain knowledge of each others preferences and likely behavior....the problem is one of common knowledge....what is the minimal amount that one agent must know in a given milieu about the beliefs and wants of other agents to be able to form coherent notions about their behavior and for this knowledge to be communicable to the others? (Schofield 1985, 12-13)

Macpherson's (1978) sociological theory of property posits that rights to resources are the outgrowth of social relationships. Rights are based upon a socially recognized justifying theory about who has rights in or to things. They are, in essence, common expectations about how people relate to each other vis-à-vis resources. Rights to resources are shaped by social institutions but evolve through social interactions and the interplay of contending interests—all of which (not to mention the physical environment) are subject to constant change. Following Ostrom (1992), this paper considers social rules to have both a cognitive and behavioral aspect. They are not rules unless to a significant extent they are practiced (as rules-in-use) by a common group.

Combining the above points about cooperation and property, the primary concern of this study is to examine the process whereby common knowledge about water rights emerges among farmers who are learning to share water in a new environment. This includes an examination of the extent to which common conceptions about water rights shape the actual behavior of farmers in obtaining water for their fields. This will uncover the principle of equity that underlies the emergent water rights.

The problem is analyzed by answering a series of questions:

- What is the nature of the process whereby common conceptions about water rights emerge among farmers?
- What is the justifying theory (a la Macpherson) that differentiates individual water rights among farmers?
- To what extent do farmer conceptions about water rights determine behavior and its outcomes?
- How does water allocation respond to fluctuations in water supply and demand?
- What are the equity implications of this process?

BALINESE TRANSMIGRANTS IN THE DUMOGA VALLEY

The two irrigation systems in this study are located in the villages of Mopugad and Werdi Agung in the Dumoga valley of North Sulawesi, Indonesia. The Dumoga valley is a major government transmigration area. It is located one degree north of the equator at an elevation of 170 meters. Figure 1 shows the location of the valley in Indonesia. The valley has 30,000 hectares of arable land surrounded by steep mountains. Average annual rainfall is 1,937 millimeters, with a bi-modal and monsoon pattern. Average temperatures vary between 25 and 27 degrees centigrade year round. Soils range from alluvial soils of sandy clay to clay of basaltic and volcanic origin. Farmers in both systems are transmigrants from Bali. Differences among farmers in land holdings and wealth are small relative to more established agricultural settings elsewhere. Farmers in both systems produce two rice crops per year. Average yields for rice crops during the study period (1982/83) generally varied between three and six tons per hectare.

[Figure 1—Location ofDumoga Valley, North Sulawesi, Indonesia]

The Mopugad system is a 28-hectare river diversion system located on the sloping northern rim of the valley. It was built by farmers in 1977. Water is diverted from a small river by a one-meter high concrete weir, built with 150 sacks of cement that were contributed by the 30 original farmers whose land allocations happened to be within the service area of the system. Farmers designed and constructed the weir and network without external assistance The highest level of education among them was the high school degree held by the subak secretary. The weir was still in its original sound condition in 1983. The irrigation water supply is dependent on fluctuating stream flows and can be rather erratic and unpredictable. The Theoretical Relative Water Supply (TRWS) for the system varied between 0.6 and 2.5 during the two seasons studied. Theoretical Relative Water Supply is the ratio between water supply (effective rain plus irrigation supply) to potential water demand (estimated potential crop evapotranspiration plus water conveyance loss—see Levine 1982).

The system in Werdi Agung was first built in 1970 and served 50 hectares. In 1980 it was incorporated into block 18, in the middle area of the 5,500-hectare Kosinggolan irrigation system that was built by the government. Originally, water was diverted from a small river on the southern rim of the valley. But after the main canal of the Kosinggolan system cut across the path of the traditional supply canal, the area began receiving water from the government-built canal. The Werdi Agung "sub-system" experienced relatively less fluctuation in its water supply than did Mopugad, because its source, the Kosinggolan main canal, was regulated. However, it also experienced periods of scarcity; its TRWS varied between 0.7 and 1.7 during the two seasons studied.

The Mopugad and Werdi Agung systems are approximately 12 kilometers apart. Farmers in both systems were resettled under the Government's transmigration program, which allocated two hectares of land per family. Hence, differences among farmers in landholdings and physical capital are minor. Most farmer families own two to four hectares of land. Because of the geographic quota system of the program, farmers in both systems originated from various places in Bali. The villages of Mopugad and Werdi Agung are not natural or indigenous groupings but are amalgams of Balinese from different parts of Bali and even include some Christians amongst the dominant Hindus.

STAKING CLAIMS

Considerable literature exists on the traditional Balinese subak ("irrigation society"), much of which depicts the subak and the broader Balinese social order to be in a state of well-adapted cultural and ecological equilibrium.[17] Little information exists about social organization and resource management in Balinese settlements outside Bali (see Vermillion 1986; Davis 1977).

The researcher came to the field sites aware of the literature on the remarkably elaborate Balinese system for managing irrigation. Traditionally, it is based primarily on proportional allocation of water according to land area served, subject to occasional adjustments made for variations in soil and other factors (see Geertz 1980). The expectation was of finding something similar to Bali, though perhaps a little crude because of the newness of the irrigation systems.

Preliminary interviews with farmer leaders indicated that service area proportionality was indeed the basic rule for water allocation among farmers' fields. But the first several inspections of both systems revealed something else going on in practice, that appeared to be more than a little crude. Downright anarchy seemed to be the rule. There was an apparent rampant disregard for the traditional tektek, or temuku as it was called by the settlers (the wooden log cut out so as to divide water proportionately). It was frequently undercut, blocked, circumvented by breaches or just pulled out and tossed aside. Each day the whole configuration of water division and tampering was different, even though the current official rule was continuous flow with proportional allocation- to fields. The first observations seemed to confirm the views of local officials of the agriculture and irrigation departments—that the farmer organizations were not yet "functional" and water distribution was anarchic.

Given the apparent gap between rules and practice, it was necessary to make a detailed examination of both rhetoric and behavior relative to water allocation- in order to determine whether this was a situation of loosely-structured "anarchy" or whether there was a deeper structure that was not readily apparent on the surface. Inspections of all canals, from head to tail, in both systems were made three times per week during the first season. During the second season, two inspections per week were sufficient in order to document the pattern of water distribution in effect. During each inspection a record was made of how the water was actually divided. Interviews were held with *subak* leaders and farmers encountered in the field in order to elicit farmer perceptions and rationale for how water was being divided.

In both Mopugad and Werdi Agung, membership in the subak (or renting water and maintaining channels as a tenant) established a right to a standard share of water based on the size of the irrigated field. Membership was granted to all those who owned land in the irrigated service area and who helped build the system originally. "Standard share" or division refers to the socially-designated proportion of the total water supply that is based solely on the relative land area served by a channel or field outlet. The subak decided that this would be the best and simplest basis for allocating water in the beginning. Because farmers built the the system, the government had no role in the allocation of shares. The subak formally established shares. The subak makes no permanent changes unless there is a significant change in the amount of rice land irrigated, or unless some more permanent exception to the land size basis for a division emerges, due to some extreme physical condition.

Subak authorities reported only three official cases in both systems of permanent enlargement of the share beyond service area proportionality. The one case in Mopugad was for a small plot near a ravine that had high infiltration rates and did not receive any drainage from neighbors. The two cases in Werdi Agung were plots next to gullies that had exceptionally high infiltration rates. Each of the systems had one case of a farmer who petitioned subak authorities to enlarge the permanent allocation beyond the standard share because of unusually high seepage rates. In both instances the requests were denied on the basis that subak leaders judged that the farmers were failing to create an adequate hardpan floor in their rice basins due to poor plowing practices. Subak leaders felt that the farmers were not plowing deeply enough, were not making enough passes with the plow and were not doing enough plowing sessions.

In both systems farmers frequently altered the standard proportional division of water by temporarily taking extra amounts of water (or "surplus shares"). "Surplus shares" refers to a share of water taken at a given point of time, that exceeds the "standard share" based on land size proportionality. Farmers used the following methods to alter the standard division:

- Widen one's intake,
- Cut a breach or hole in the channel bund that runs alongside one's field in order to bring extra water onto one's field,
- Block the channel below the intake to one's channel or field in order to divert more water onto one's field,
- Make a hole below or on the side of the temuku, or tektek, in order to add to the flow to one's field,
- Block the flow into a neighboring channel in order to direct more water into one's own channel,
- Close the intake for a channel neighbor's field upstream, and
- Re-direct the drainage from a neighbor's field, which normally enters a canal, into one's own field (such as with use of a small aqueduct, crafted from bamboo or wood).

In the vast majority of cases, this activity was done informally and unilaterally by farmers when they happened to be at the farm and felt the need or felt justified in taking extra water (or sometimes when they wanted to cut it off). If the farmer who was adjusting the flow happened to encounter another farmer whose field was affected by the action, he or she would typically explain why the farmer needed extra water and that it was only temporary. Farmers in the system held the view that as long as one had talked to the neighbors at the outset of the season about the general timing of planting and one's justifications for borrowing extra water sometimes, one need not seek permission each time before doing so during the season.

Normally, the water taker would not return the water division to the standard division. It was considered to be the responsibility of each water user to visit their field regularly and inspect and help control the division of water. Farmers told me more than once, "Whoever goes to the field often gets the water." Farmers indicated little respect for those who were too lazy or so busy opening and working land elsewhere that they did not go to their irrigated field often enough to control the water situation. So it was left to those affected by the adjustments to return the situation to "normal" when they came to their field.

In their incidental discussions about water distribution, farmers emphasized flexibility, tolerance and experimentation. This was a response to both the newness of the environment and ancient cultural norms. At the time of the study many fields were still new and farmers were still creating the hard pan or, in some cases, were gradually expanding the area of their field that was irrigated. Farmers were still learning about micro-level variations in physical conditions and farming practices among their fields and themselves and they preferred, in this early stage, a temporary and tentative approach, rather than a permanent and official approach, to deal with the physical and technical diversity among fields.

The notion of rukun is prominent among Balinese. This is both a norm of solidarity and a civic process of "mutual adjustment", that has as its purpose "the creation and maintenance of order" (Geertz 1980, 48, 84). When asked farmers what they thought of this or that act of "stealing" water, they would normally refer to it as "borrowing" water (pinjam air) and express the importance of flexibility, give and take (baku tarik) and patience with one's channel neighbors, whom were referred to as "friends" (teman or kawan) Farmers often admitted that there was reciprocity, they themselves also "borrowed" water from a farmer who happened to be "borrowing" water from them at the moment of an interview.

Kesadaran (understanding) and sabar (patience) were considered to be the proper responses to water taking. More than once farmers could be observed inspecting an altered division of water that was against their favor and then leaving the alteration in place. Patience was not only a virtue, it was an investment meant to invoke a patient response from others in the future when one would need to borrow extra water.

Malu (social shame), not formal sanctions, was the primary motivation for limiting excessive water taking, avoiding making a scene in front of others and limiting the amount of problem-solving that had to be dealt with through formal channels. Farmers liked to say such things as, "As long as my field is wet, the water is enough," to convey the impression that their demand for water was, in fact, only modest. These norms emphasized moderation in a learning environment characterized by frequent mutual adjustments to physical differences among fields. Acts of "borrowing" were meant, in part, to test the degree of tolerance of one's channel neighbors towards one's assertion of a right to a temporary surplus share of water.

Only a small fraction of these actions of "borrowing" extra water evoked complaints that were taken to the *subak* leadership. Fines for first offenses of water theft were relatively low; they went up for subsequent offenses.

So the mostly informal process of "mutual adjustment" of the division of water can be understood as a dynamic response to a recurring problem of allocating a resource in a new environment where there was considerable micro-level diversity and incomplete knowledge among farmers regarding each other's field conditions and differential levels of demand for water. It was a process of trying to measure the appropriateness of one's standard or surplus share of water against that of one's neighbor, largely by taking extra water as needed, waiting to observe the response of those affected, and when encountering a channel neighbor, attempting to persuade him or her that one should have a right to take a surplus share. The farmer asserting this "right" would then appeal to some justifying criteria, hoping that neighbors would accept it. The tentative and incomplete knowledge among farmers necessitated that adjustments to the standard share be tolerated and be done on a temporary basis, until perhaps in the future, when things would be clearer and more permanent adjustments could be granted officially.

EMERGENCE OF A JUSTIFYING THEORY

Through regular occurrences of farmers "borrowing" extra water and frequently engaging in inter-personal persuasion, debates, and negotiation, farmers gradually developed a commonly recognized set of justifying criteria for augmenting their supplies beyond the standard proportional share. The criteria gradually became socially recognized less through formal decision-making than inter-personal assertions and the decentralized reciprocities between experimental assertions and tolerant or intolerant responses.

Particularly in the early years, the range of rhetoric exceeded what later became socially acceptable criteria for asserting a surplus share. The following are a few examples of exchanges observed, with a note after each indicating whether the criteria stated was socially accepted or rejected:

- The water in my field seeps through my sandy soils very quickly, so I need to take extra *(accepted):*
- My channel neighbors get water from small streams, springs or drainage from other fields, in addition to the channel. My field doesn't have access to any other sources of water but the channel; therefore, I must take extra water now and then *(accepted).*
- My field is at the tail end of the channel. A lot of the water that is supposed to come to my field disappears on the way, so sometimes I have to go upstream and redirect extra water to my field *(accepted).*
- I am constructing new rice terraces and need extra water to soften and level the hard, virgin ground *(accepted).*
- I need to have a fish pond to raise enough money to send my children to school. I have to take extra water for the pond, but it all goes back into the channel anyway *(accepted).*
- Since I drain all of my water back to the channel, it doesn't matter whether I

borrow extra water for my paddy field, because it all goes back to be used by my friends downstream. *(rejected)*.

- Since the channel cuts through the middle of my field and prevents me from getting full production, I should have a right to take extra water to increase my production and make up the difference *(rejected)*.
- The channel I receive water from cuts through the middle of my upstream neighbor's field, so it is easy for him to always be taking extra water. So I have to take extra water to make up the difference *(rejected)*.

Through a gradual process of experimental assertion, validation and rejection, the clash of rhetoric was gradually distilled to a limited set of justifying criteria that was generally recognized as acceptable rationale for asserting rights to a surplus share. Whether or not application of the criteria in a particular case was acceptable was, of course, another matter.

At this early stage of development of the irrigation systems, when hard pans were still under formation, area irrigated within fields was still changing, and knowledge about each other's field conditions was incomplete, farmers preferred a tentative approach. The justifying criteria only applied to temporary acts of borrowing extra water and only in so far as the actions, in the aggregate, did not prevent others from receiving their standard shares.

The somewhat ephemeral "surplus share" was approximated through temporary acts of borrowing extra water. Although the justifying criteria came to be socially accepted, and probably served to reduce the range of rhetoric and level of chaos that otherwise might have prevailed without it, debate and tolerance-testing continued over application of the criteria to specific cases and the frequency with which extra water was "borrowed" by certain farmers.

The process of creating "rights" evolved through the following steps:

- Adoption of a preliminary, simple allocation rule (around which further refinements could be negotiated),
- Individual and ad hoc assertions and claims to extra water above the simple allocation rule,
- Social acceptance or rejection of the assertions and claims,
- Emergence of common expectations about who had valid rights to take extra water above the standard allocation rule, and
- Possible eventual formalization of the expectation into a right to a permanent surplus share.

EXTENT OF COMPLIANCE WITH THE JUSTIFYING THEORY

This section turns to an examination of two questions:

- Which farmers in the two systems regularly asserted their right to a surplus share of water and which did not? and
- To what extent did this behavior fit the local model of justifying criteria?

During participant observation the author saw indications of opportunism among water users. Nevertheless physical inequalities, such as relative soil infiltration rate, channel position, the availability of alternative water sources, or forms of land use with high water demand (such as new terracing or keeping fish ponds) were clearly at the hub of the rhetoric about water allocation. We will now see to what extent the "justifying theory" was reflected in practice.

The first step is to identify the irrigated plots in each system whose farmers took extra water frequently in comparison with fellow water users. It was not possible through observation, informant accounts, or farmer interviews to obtain reliable quantitative information about how often each farmer took extra water during a given season or other period. However, key informants could readily make a categorical comparison between farmers who "often" or "did not often" take extra water. Extensive data from participant observation was used to validate or correct categorizations by informants. The categorizations were found to be consistent from season to season.

Taking extra water "often" was defined as taking water above and beyond the standard proportional division on a regular basis (that is, more frequently than just during peak water demand periods). To "not often" borrow water meant to borrow water only during intermittent, high demand periods, if at all

Figures 2 and 3 are, respectively, maps of the Mopugad and Werdi Agung systems which indicate all channels and farm parcels in each system. Farm parcels are shaded to distinguish parcels whose farmers borrowed water "often" and "not often." The Mopugad system consists of only 34 farm parcels. It had a pattern of frequent alterations in the standard division of water that tended to be concentrated near the top of the system in ways that affected most of the plots in the system. The Werdi Agung system had a larger number of farm parcels (78) and a more segmented or intra-channel pattern of borrowing practices.

[Figure 2—Parcels which frequently added water beyond the standard share, Mopugad]

[Figure 3—Parcels which frequently added water beyond the standard share, Werdi AgungJ

Figures 2 and 3 show the distribution of farm parcels whose farmers adjusted the division of water "often" or "not often", as defined above. As can be seen, the habitually frequent "borrowers" do not group together in either the upper or lower reaches of the channels, in either system. Factors other than mere channel position are clearly involved in the predisposition to take extra water often or not, relative to one's channel neighbors.

Based upon key informant interviews and personal observation, it was possible to construct models that represented the configuration of locally-accepted justifying criteria for taking extra water, plus certain disincentives. Somewhat surprisingly, the models were basically the same in both systems. They are presented in the form of decision tree diagrams.[18]

Testing the Model in Mopugad

Figure 4 shows the model for Mopugad. The three factors on the left are the primary justifying criteria identified by farmers. The first criteria is whether or not the infiltration rate on one's field is significantly higher than the average infiltration rates on other fields in the system. The second criteria is whether or not one's field is in the lower end of the channel (defined here as the lower third of the channel). The third criteria is whether or not the field, during the period of observation, had a form of land use that had a particularly high water demand (for example, land leveling, new terracing or fish ponds). *[Figure 4—Model of justifying criteria to exceed standard water share, Mopugad]*

There are two additional factors that act as disincentives for taking extra water. The first is where a parcel depends more on non-channel sources of water, such as, neighbor's drainage, groundwater recharge, or other surface sources, than on the channel. The second disincentive to taking a surplus share is where a farmer passively obtains extra water through the frequent borrowing practices of an upstream neighbor. The method used by the neighbor to augment water supply tends to direct additional flow to one's own field as well.

In Mopugad, 20 of the fields had at least one of the justifying criteria and 14 did not. Of the 14 fields not having one of the criteria, ten of them did not take extra water "often," as the model predicts. However, the behavior of four of the "often" cases was unexplained by the model. They did not have any of the justifying criteria in the model and yet were frequent takers of surplus shares. These were parcels Cl, Bl, M6, and Al.

Sixteen of the 20 cases that met the justifying criteria did not have either disincentive and pursued a pattern of taking extra water relatively often. Four of the 20 cases were constrained by disincentives and did not take surplus shares. Of the four that were constrained by disincentives, one had low dependence on the channel and three were downstream from other frequent "borrowers." The model "explained" the borrowing patterns of 30 of the 34 plots, or 88 percent of all farmers.

Testing the Model in Werdi Agung

The model for the Werdi Agung system is given in Figure 5. Fifty-seven of the cases had at least one of the justifying criteria and passed to the disincentives in the model. Eighteen cases did not have any of the criteria and 14 of them did not often borrow water. As can be seen, 19 cases were constrained from frequently taking extra water by the disincentive of low dependence on the channel as a source of water. This reflects the prevalence of groundwater recharge and alternative water sources that exist in the lower portions of the system. This is in contrast to Mopugad, which generally lacks return flow lower in the system. Six others were downstream from other borrowers, and did not often borrow water themselves. There were 32 cases that had incentives but no disincentives. Of these, 25 were frequent borrowers, as the model predicts, but seven were not. The model successfully explains the relative borrowing patterns of 85percent of the farmers.

[Figure 5—Model of justifying criteria to exceed standard water share, Werdi Agung]

Of the 11 unexplained cases in Werdi Agung, seven had justifying criteria and no disincentives but still did not often take extra water. Two of these, Zl and A2, had high infiltration rates but were at the top end of channels, where the flow is relatively high and reliable. Most of the unexplained cases were not those who frequently took extra water without justification, but those who did not often take extra water, despite so qualifying relative to the justifying criteria.

In Mopugad four cases (Bl, Cl, M6, and Al), or 12 percent, were frequent borrowers who did not have apparent justifying criteria. In Werdi Agung four cases (J2, L2, Kl, F2) or five percent, were frequent borrowers who did not have apparent justifying criteria, as specified in the model. So 85 to 88 percent of the cases observed are either farmers who frequently take extra water and qualify to do so under the justifying criteria or farmers who do not take extra water and do not qualify under the justifying criteria.

Clearly, farmers in the two systems considered the traditional standard share system based on land area proportionality to be only a first approximation of an equitable allocation of water Except for a few cases of abuse, farmers in both systems were, through interaction with their environment and channel neighbors, gradually forging a "second approximation," that was a customized response to the inherent and unique variations throughout the systems.[19] The principle was thus not one of simply delivering equal amounts of water to each farmer proportional to land, but of equitable distribution adjusted according to needs, as influenced by supply from other sources and demand caused by porous soils and other factors. The essence of the local theory was to provide a fair allocation- of water among farmers taking account (in so far as was practically possible) inherent differences in soils and access to water.

MUTUAL ADJUSTMENT DURING TWO SEASONS

This section analyzes water distribution in each system over two seasons, with the objective of answering this question: "How was the practice of informal mutual adjustment of the standard division of water related to the fluctuating conditions of water supply and demand during the two seasons observed?"

Mopugad System

In Mopugad, the first season (from June to September) began with a decision to stagger final land preparation and transplanting in three blocks. This was done because of water shortages and also because of a desire to facilitate the use of exchange labor among farmers who were at different stages of land preparation or transplanting. At week two of the season (after transplanting) the Theoretical Relative Water Supply (TRWS) dropped below 1.0. Farmers of parcels C9 and D3 requested a formal rotation, which began thereafter. The TRWS remained in the range 0.7-1.0 until week seven, during which time the intensity of informal alteration of the standard division escalated considerably. Soils were cracking in the fields at the lower reaches of channels A, C, and D. The author observed numerous incidences of altering the division of water, both in accordance and not in accordance with official arrangements.

After week eight the TRWS again dropped below 1.0 and continued to decline. Finally the subak decided that the full flow of water for the entire system would be allocated to single parcels for twelve-hour turns, starting in order of need and request. The subak head, secretary, and treasurer took turns guarding the water at night. This arrangement continued, although with numerous exceptions, until well into the ripening phase, when pre-harvest drying began.

During the second season transplanting was staggered over a longer period than was the case in the first season. After a period of abundance, by week eight the rains tapered off and the TRWS began another gradual decline. The subak agreed to keep the standard division intact overnight and allow borrowing to be arranged interpersonally during the daytime. This continued through the rest of the season, despite the high frequency of borrowing and the tensions among farmers. It was felt that direct arrangements between farmers would work as well as or better than formal rotations arranged through the subak.

By the ripening phase eight members had been fined for water theft. This was the first time the subak levied any fines for water theft. The fines were set at half the established rate of about US$2.50 for first infractions because of the difficult economic condition imposed by the drought. Almost all who reported thefts were those adversely affected, except for a few cases where a subak official felt disposed to report them due to the extreme circumstances.

Werdi Agung System

Because of rainfall in May and early June, water in Werdi Agung was adequate during the land preparation period in the first season. Nearly all farmers planted within a week's time (in the first week of June). Soon after transplanting however, the TRWS dropped and remained low for three weeks.

During the reproductive phase the TRWS was on the decline. When it dropped below 1.0 in the seventh week, numerous complaints emerged about water scarcity and an upsurge occurred in water borrowing. After week nine the TRWS rose and remained above 1.0 until pre-harvest drying began. During the last five weeks of the season mice and birds became a serious problem and this kept more people than usual in the fields, to scare them away. Having more people continuously in the fields may have discouraged some water theft during this time. Partial blocking of channels and field inlets were more common during this period than complete blocking and other more brazen methods frequently observed when fewer people were in the fields. This suggests that some of the "borrowing" activity was not socially acceptable and such behavior was inhibited when a lot of people were in the fields.

In latter October water from the main canal was permitted to flow through Gate 18 for land preparation for the second season. When continuous flow irrigation proved to be enough to soak only about one-half of a terrace per parcel, farmers decided to rotate the full flow for a channel to individual plots for 20-hour turns. This made it possible for most farmers to plow about one-half of a hectare per rotation turn.

Hence, there was considerable variation throughout the system in dates of transplanting. By the last week in December, or week three after transplanting began, nearly all farmers had finished transplanting and continuous flow with the standard division was the official arrangement for the rest of the season. However, interpersonal borrowing continued as a regular feature of the system.

The intensity of alteration activity was measured by recording all alterations in the standard division of water that were observed during each field inspection and taking weekly averages. These were correlated with weekly values for TRWS. Generally, declines in TRWS prompted a rise in alteration activity, and vice versa. In Mopugad, for both the first and second seasons, the correlation coefficient for the relationship between alteration intensity and TRWS is -.35.[20] There was no significant correlation between alteration intensity and TRWS in Werdi Agung.[21] This is mainly due to pervasive return flow within the system and supplemental water sources, that served to moderate the need for farmers in the tail and middle areas to seek extra water by manipulating the division of channel water.

IMPLICATIONS OF THE ADJUSTMENTS FOR EQUITY

We now turn to the question of what were the implications for equity of the informal practices of adjusting the standard division of water. Specifically, "Did the patterns of regular alteration of the standard division of water result in more or less equity than would be the case if the standard division based on service area proportionality was implemented strictly?"

One way to address this question is through examination of the total number of occurrences of each type and location of observed alteration in the standard division of water, based on observations of the water distribution over two planting seasons. This documents the directions of net gains and losses of water distribution among parcels as a result of the patterns of adjustments.

In Mopugad the net effect of channel division alterations is in the direction of sending extra water to the lower end of channel C. This is where the largest group of parcels are that had the lowest relative water adequacy (that is, the lowest proportion of inspections with water covering the sample parcels).

Of the five channel division points in Mopugad, three of them were found to have a net effect of directing extra water toward fields with relatively lower levels of water availability (as measured by the proportion of field inspections for which sample fields had standing water on them). The observed directional biases in the alterations at the channel division points in Mopugad represents a pattern aimed generally at counteracting the unequal distribution of relative water adequacy created by the physical characteristics of the system.

In Werdi Agung alterations of six of the eight channel division points had a net effect of directing extra water towards fields with relatively less water available, compared to the alternative directions. So the pattern of alterations at the level of channel division points is also in the direction of counteracting or moderating inequalities in water availability that exist within the system.

We can also see the net effects of the patterns of altering parcel-level intakes by analyzing alteration practices for farmer field intakes, by location. At each inspection during two irrigation seasons, a record was kept of whether each parcel intake was enlarged or closed. After tallying results over both seasons, if there were more intake enlargements than closings observed, the field is categorized as having a net gain in water supply from the adjustments. If there were more intake closings than enlargements, the field is categorized as having a net loss in water supply from the observed adjustments. Some parcels had a balanced number of enlargements and closings.

Table 1 shows, for Mopugad and Werdi Agung, how many parcels had 'net gain' or 'net loss' effects from the adjustments observed over two seasons, grouped by location within each system (upper, middle, lower).[22] In Mopugad, seven of the 10 parcels with net gain effects are located in the middle or lower parts of the system, whereas 10 of the 12 parcels with net loss effects are located in the upper and middle part of the system. In Mopugad farms are dependent for access to water almost exclusively on the channels. Given the convex shape of the landform, drainage is dispersed and there is little return flow. As in the case of the channel-level alterations, the field-level alteration patterns indicate a tendency toward equalizing the unequal effects of the physical characteristics of the system, especially its unique landform and elongated network.

[Table 1—Effects of field intake alterations, Mopugad and Werdi Agung systems]

In Werdi Agung the picture is not so simple. There are about as many parcels with net gain effects from field intake alterations in the head and tail reaches, but there is a large number of net gain parcels in the middle reaches. However, parcels with net loss effects are concentrated in the lower and middle sections of the system. Given the convex shape of the landform and extensive return flow within the system in Werdi Agung, there are numerous lower enders who receive a large share of their water from return flow from upper fields (either from horizontal seepage, springs, streams or field-to-field drainage). Many lower end farmers frequently close their field intakes because they have enough water from alternative sources. Middle section fields are in the least secure position because of having less access to return flow and often have more sandy soils than lower enders.

Hence, in Werdi Agung, as in Mopugad, there is a discernible tendency for alterations at the field intake level to counteract the water-related inequalities imposed by the physical characteristics of the system.

CONCLUSION

In contrast to communal, highly programmed images of the Balinese subak (water society), in the Mopugad and Werdi Agung systems in North Sulawesi the proportional water shares rule was routinely altered through ad hoc competitive acts of "borrowing" extra water by a large number of the farmers in each system. What might appear to the casual observer as anarchy was in fact a socially-validated pattern of individual adjustments to the standard allocation of water. The "state of nature" observed in this study was neither complete communal harmony nor brutish opportunism. It was somewhere between Rousseau's (1762) and Hobbes' (1651) depictions of the state of nature, and could perhaps best be characterized as a social struggle for balance between justice and enterprise.

Through numerous temporary acts of taking extra water and negotiating among farmers, a commonly accepted set of "justifying criteria" gradually emerged at the group level. In the aggregate, without central coordination, these disparate actions resulted primarily in counteracting the inherent inequality in landform within the systems.

Interpersonal interaction among water users in the two study systems is primarily a second approximation for allocating water, following the first approximation of the share-based division of water. The traditional rule of farm-area based proportional allocation of water was found to be only a starting point in the search for equity in an environment characterized by considerable micro diversity among farms in access to different sources of water, soil porosity and location along canals. In a setting riddled by pronounced inequalities among fields but not among farmers, the set of justifying criteria and informal interactions among farmers created a more equitable and socially acceptable pattern of water allocation than would have resulted from strict reliance on area-based proportional allocation of water.

These results provide insights into how cooperation and water rights emerge. They also provide rationale for making some suggestions about how management transfer and organizing farmers should be done. The key elements of cooperation in this study were:

- Relative social homogeneity among a relatively small group of farmers,

- Motivation of farmers to avoid social conflict in a setting where numerous cross- cutting social pressures to avoid conflict exist,
- Existence of a standard (if incomplete) allocation rule to structure and simplify negotiation and problem solving,
- Forum for frequent, inter-personal interaction among farmers to exchange information and requests, which acted to build common knowledge about physical differences and identify valid justifying criteria for adjusting the standard allocation rule, and
- A process of reciprocal give-and-take, that encouraged tolerance, experimentation, and information sharing among farmers.

The study suggests that group objectives, at this small scale, can often be achieved through inter-personal interaction without centralized information processing and control. At the level of interaction among 30 to 50 farmers, water distribution is more an art than a science. Water user associations need not function, or be trained to function, as mini-bureaucracies with elaborate and standardized administrative procedures. Elaborate standard organizational structures should not be imposed from above, especially before farmers have had experience with self management.

To a significant extent, time and local experience with problem solving should be precursors to organizational structuring and formulation of water rights. Perhaps the more complex the environment and uncertain the decision-making, the less structure should be imposed at the beginning of management transfer or projects to organize water users associations. And, conflict mediating arrangements are needed in order for inter-personal interaction to produce common knowledge and cooperation.

The study also implies that efforts to monitor and evaluate the performance of water users associations should avoid the "bureaucratic fixation with means" typical of many benefit monitoring and evaluation methods. Number of meetings held, percentage of farmers attending meetings or formal organizational structure should not be seen as ends in themselves. Rather, emphasis should be given to measuring management outcomes in terms of equity, efficiency and productivity, although local processes may continue to escape the understanding of outsiders.

ENDNOTES

16. This study is based on field research conducted by the author between 1982-83 The study employed semi-structured group and key informant interviews, sample surveys, repeated inspection of canal networks and water discharge measurements through two seasons (June to September 1982 and December to April 1983).

17. See for example, Lansing 1987; Geertz 1980, 1972; Boon 1977; Liefrinck 1969; Grader 1960.

18. See [____?] for a discussion of decision tree models.

19. See Vermillion 1989. This paper examines the adjustments made by farmers to their irrigation infrastructure to make it more compatible with the micro-level diversity which was not adequately incorporated into the network as designed by engineers.

20. With one-tailed tests of significance, the p value was . 11 and .09 for the first and second seasons, respectively.

21. Correlation coefficients were only -.10 and -.05 for the first and second seasons, respectively, and were not significant at the .90 level.

22. For simplicity of presentation, data on parcels with balanced effects of alterations is not included in Table 1.

REFERENCES

Arriens, Wouter Lindclaen, Jeremy Bird, Jeremy Berkoff, and Paul Mosley, ed. 1996. *Towards effective water policy in the Asian and Pacific region, Volume one: Overview of issues and recommendations*. Proceedings of the regional consultation workshop, May 10-14. Manila, Philippines: Asian Development Bank.

Boon, James. 1977. *The anthropological romance of Bali, 1597-1972: Dynamic perspectives in marriage and caste, politics and religion.* Cambridge, U.K.: Cambridge University Press.

Davis, Gloria Jean. 1977. *Parigi: A social history of the Balinese movement to Central Sulawesi, 1907-1974*. Ph.D. diss., Stanford University, Stanford, Calif., U.S.A.

EDI (Economic Development Institute of the World Bank). 1996. *Handbook on participatory irrigation management*. Washington, D.C.: Economic Development Institute of the World Bank.

Geertz, Clifford. 1980. *Negara: The theatre state in nineteenth century Bali*. Princeton, N.J.: Princeton University Press.

Geertz, Clifford. 1972. The Wet and the dry: Traditional irrigation in Bali and Morocco. *Human Ecology* 1:23-39.

Hobbes, Thomas. 1651. *Leviathan*. New York: Collier Books edition, 1962.

Johnson, S. H.; Douglas L. Vermillion, and J. A. Sagardoy. 1995. *Irrigation management transfer*. Selected papers from the International Conference on Irrigation Management Transfer, September 20-24, 1994, Wuhan, China. FAO Water Report 5. Rome: International Irrigation Management Institute and Food and Agriculture Organization of the United Nations.

Lansing, Stephen J. 1987, Balinese water temples and the management of irrigation, *American Anthropologist* 89: 326-341.

Levine, Gilbert. 1982. *Relative water supply: An explanatory variable for irrigation systems.* The Determinants of Developing Country Irrigation Project Problems Project. Technical Report No. 6. Washington, D.C.: U.S. Agency for International Development.

Macpherson, C. B., ed. 1978. *Property: Mainstream and critical positions.* Toronto: University of Toronto Press.

Meinzen-Dick, Ruth, Meyra Mendoza, Loic Sadoulet, Ghada Abiad-Shields, and Ashok Subramanian. 1997. Sustainable water user associations: Lessons from a literature review. In *User Organizations for Sustainable Water Services,* ed. Ashok Subramanian, N. Vijay Jagannathan, and Ruth Meinzen-Dick, 7-87. World Bank Technical Paper Number 354. Washington, D.C: World Bank.

North, Douglass C. 1990. *Institutions, institutional change and economic performance.* Cambridge, U.K.: Cambridge University Press.

Ostrom, Elinor. 1992. *Crafting institutions for self-governing irrigation systems,* San Francisco, Calif: ICS Press.

Pradhan, Rajendra, Franz von Benda-Beckmann, Keebet von Benda-Beckmann, H. L. J. Spiertz, Shantam S. Khadka, and K. Azharul Haq, eds. 1997. *Water rights, conflict and policy.* Proceedings of a Workshop held in Kathmandu, Nepal, January 22-24, 1996. Colombo, Sri Lanka: International Irrigation Management Institute.

Rosegrant, Mark W. and Hans P. Binswanger. 1994. Markets in tradable water rights: Potential for efficiency gains in developing country water resource allocation. *World Development* 22 (11): 1613-1625.

Rousseau, Jean Jacques. 1762. *The social contract.* New York: E. P. Dutton edition, 1950.

Schofield, Norman. 1985. Anarchy, altruism and cooperation: A review. *Social Choice and Welfare* 2: 207-19.

Seckler, David. 1996. *The new era of water resources management: From "dry" to "wet" water savings.* IIMI Research Report 1. Colombo, Sri Lanka: International Irrigation Management Institute.

Taylor, Michael. 1987. *The possibility of cooperation.* Cambridge, U.K.: Cambridge University Press.

______. 1982. *Community, anarchy and liberty.* Cambridge, U.K.: Cambridge University Press.

Vermillion, Douglas L. 1989. Second approximations: Unplanned farmer contributions to irrigation design. *ODI/IIMI Irrigation Management Network,* Paper No. 89/2c. London, U.K.: Overseas Development Institute.

Vermillion, Douglas L. 1986. Rules and processes: Dividing water and negotiating order in two new irrigation systems in North Sulawesi, Indonesia. Ph.D. diss., Cornell University, Ithaca, N.Y., U.S.A.

Table 1—Effects of field intake alterations, Mopugad and Werdi Agung systems

Channel Location	Net Gain to Parcel	Net Loss to Parcel
Mopugad		
Upper	3	4
Middle	2	6
Lower	5	2
Total	10	12
Werdi Agung		
Upper	6	3
Middle	15	12
Lower	9	16
Total	30	31

Source: Vermillion 1986

Figure 1—Location of Dumoga Valley, North Sulawesi, Indonesia

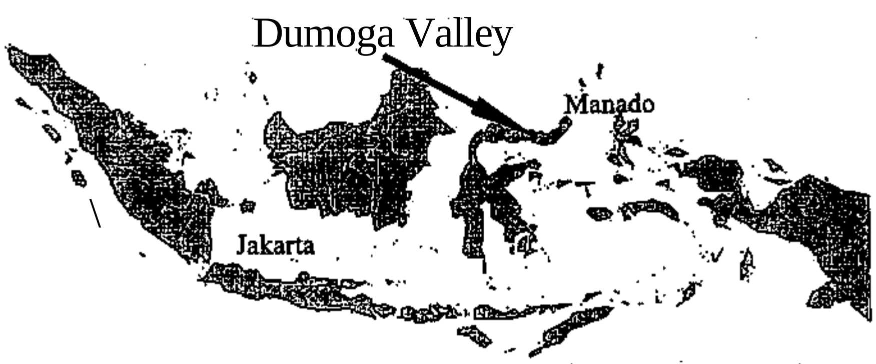

Figure 2—Parcels which frequently added water beyond the standard share, Mopugad

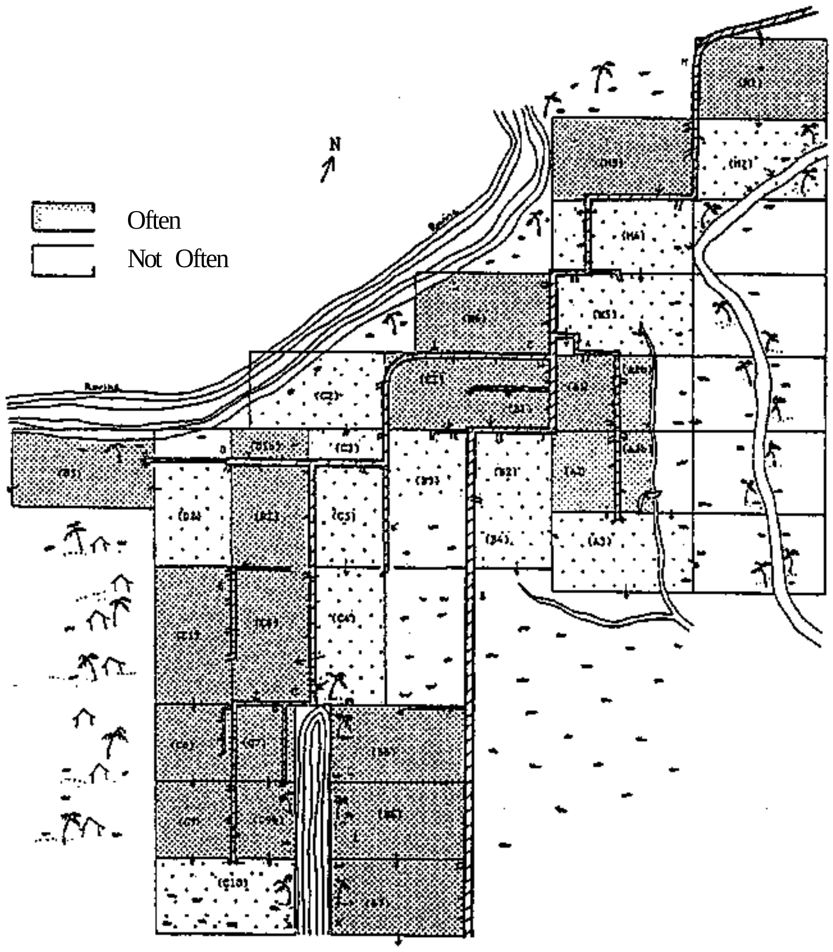

Figure 3—Parcels which frequently added water beyond the standard share, Werdi Agung

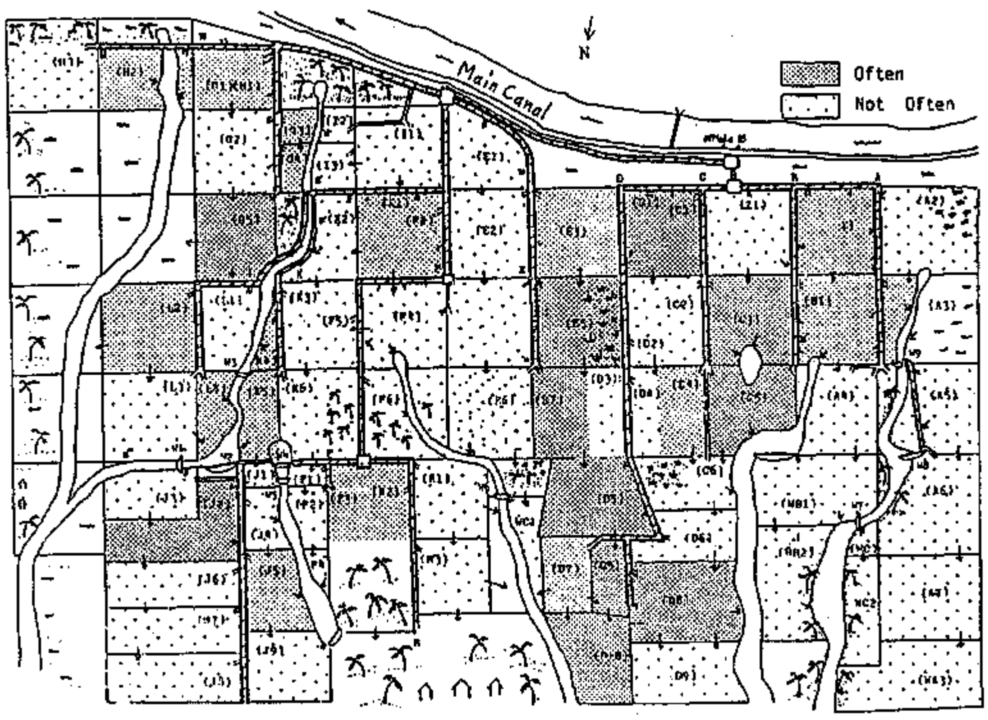

Figure 4--Model of justifying criteria to exceed standard water share, Mopugad

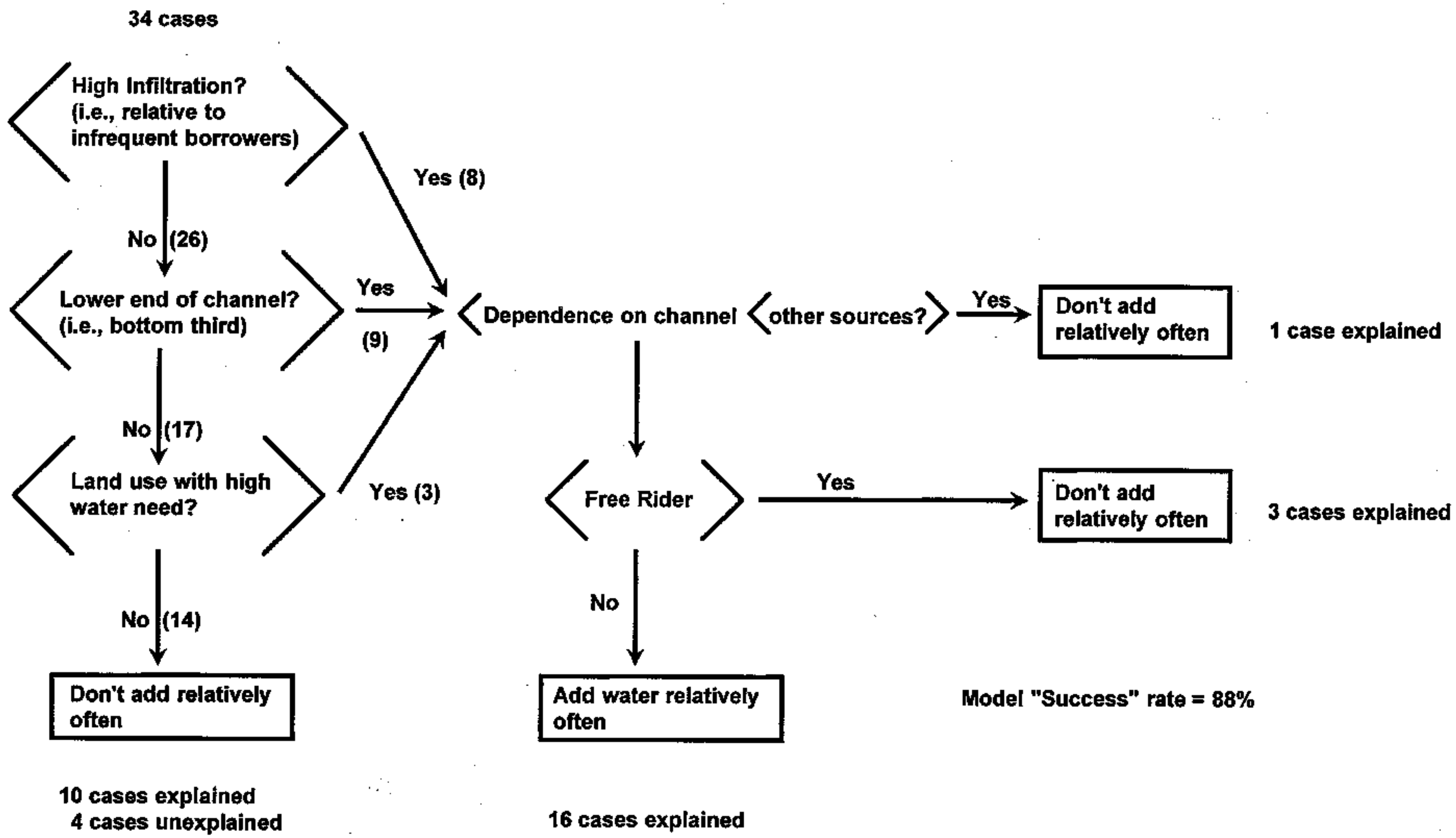

Figure 5—Model of justifying criteria to exceed standard water share, Werdi Agung