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ABSTRACT

Using the example of indigenous irrigation on Mount Kilimanjaro, Tanzania, this paper illustrates that operating beneath the formal rules of irrigation organization is a series of "working rules" that people use to actually obtain access to water. It is argued that one of the reasons that indigenous irrigation systems are sustainable and flexible is because the working rules allow water users to adjust their formal water right to an amount and timing of water that matches their needs more closely. If interventions into indigenous irrigation systems are to be effective and sustainable, and not undermine the institutions which govern water use within the irrigation system concerned, then development agencies need to understand, work with, and work through the working rules. This paper considers ways in which this may be achieved.

INTRODUCTION

It is widely recognized that the management of an indigenous irrigation system is complex and how the system "should" work is different from the way it "really" works. If several people using a particular irrigation system are asked how the irrigation system is managed, they will all give the same answer, establishing for the researcher how the system should work. However, if any one person is asked how he

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1. An irrigation system is defined as the physical and social infrastructure (rules and procedures) that ensures the operation of the technology involved and the delivery of water. See LINDEN VINCENT, HILL IRRIGATION: WATER AND DEVELOPMENT IN MOUNTAIN AGRICULTURE 34 (1995). An indigenous irrigation system is where irrigation technology is controlled, disseminated, and applied by the people who use the system. See W.M. ADAMS, WASTING THE RAIN: RIVERS, PEOPLE AND PLANNING IN AFRICA 70-76 (1992).

or she personally meets his or her water needs from that system, a very different answer is obtained, and that answer will vary according to who is answering the question.

Structural-functionalist models of irrigation systems have dominated the understanding of how irrigation systems are organized and are used to identify what should happen in terms of irrigation organization. Based on comparative studies of indigenous irrigation systems throughout the world, they attempt to identify the repeatable and predictable regularities in organizational structure. Structural-functionalist models identify the key organizational tasks within an irrigation system that need to be fulfilled. Coward's model identifies three basic organizational tasks: physical maintenance of the system, allocation of water, and conflict management. Uphoff's "irrigation systems activities matrix" builds on Coward's three basic tasks, also dividing activities into three groups: physical system activities (which include maintenance), water use activities (which include allocation of water), and organizational activities (which include conflict management and leadership). This matrix has been used to develop guidelines for the rapid rural appraisal of irrigation systems. The use of a rapid appraisal schedule identifies what are referred to here as the "formal rules" of irrigation organization. The models are also used as the basis for constructing "water user associations" to govern farmer-managed irrigation schemes.

These structural-functionalist models have been criticized for ignoring any macro-level or micro-level political dimension. At the macro level, the models do not incorporate the objectives of irrigation organizations. This is critical because objectives of resource users and resource managers may differ. Irrigation and water management advisors usually aim to increase crop yields and allocate water with maximum economic efficiency. In contrast, water users in Sub-Saharan Africa usually aim to minimize risk and establish collective security of a water supply. At the


4. See Coward, supra note 3.

5. See Uphoff, supra note 3, at 42.


micro level, the models fail to account for individual water needs within the system as they identify a set of standardized rules by which it is assumed the system works. The group of people using a particular irrigation system is heterogeneous in terms of area of land to be irrigated, crops grown, alternative sources of income to agriculture, and household size and composition. As a result, each individual water user has different water requirements and individuals' water needs cannot be met through the standardized, formal rules of irrigation organization as identified by the models of irrigation organization.

These problems with the structural-functionalist models of irrigation organization can be answered by the use of concepts from New Institutional Economics, which add the "real world of actual environmental behaviours" to studies of natural resource management. Ostrom defines institutions as sets of "working rules," which are those rules actually used, monitored, and enforced when individuals in a given situation make choices about the actions they will take. They may or may not closely follow the formal rules expressed in legislation, administrative regulations, and court decisions. Working rules include extensions, elaborations and modifications of formal rules, socially sanctioned norms of behavior, internally enforced codes of conduct, and social conventions. In the example of indigenous irrigation systems, the formal rules are those identified by the structural-functionalist models of irrigation organization as what "should" happen. The working rules are the rules that individual water users follow to actually gain access to water. It is these working rules which determine what "really happens" in terms of maintenance of the system, conflict management, and access to water.

This paper investigates the formal rules of water allocation at the organizational level and the working rules which people use to gain access to water at the individual household level within an indigenous irrigation system on Mount Kilimanjaro, Tanzania. It is argued that, although the working rules of access to water make the irrigation system complex, they also make it flexible and sustainable. Through the working rules, water users can renegotiate their formal water right in order to obtain an amount and timing of water that is more suited to their individual needs. Because individual users can meet their water needs, they contribute to the duties attached to membership of an irrigation system such as system mainte-

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9. See VINCENT, supra note 1, at 94.
nance. Each member of a resource user group has different resource needs and as a result the use of working rules differs between users. Also, each member has a differing ability to use the working rules, depending on knowledge of the working rules, social and economic position, and so on, which ultimately affects the amount of water that household is able to obtain.

Knowledge about how indigenous irrigation systems work is crucial to the success of any external development interventions into these systems. Such interventions are increasingly common throughout Africa because of the need to increase food production and increase the efficiency of water use in order to release water for downstream users.12 Having established the existence of working rules, this paper considers the ways in which working rules may be useful in helping development agencies and policy makers address the complexity of indigenous irrigation systems.

**METHODOLOGY**

Research was conducted over 14 months in 1994/95, focusing on four specific irrigation systems in the Hai District of the Kilimanjaro Region (figure 1). For simplicity and conciseness, this paper focuses on just one of these irrigation systems, called “Nshara Furrow.” Rapid Rural Appraisal techniques were used to acquire basic information about the social, economic, political, and resource use characteristics of the user groups, and the set of formal rules governing irrigation organization. The “user group” was defined as the households that have land along Nshara Furrow, even if they do not irrigate that land. Households that do not irrigate their land were included because, in a study that investigates how people gain access to water, the reasons why a particular household does not irrigate may be significant. This was followed by a socio-economic questionnaire survey of each household within the user group. Information collected included household composition, land holdings, crops grown, wealth, and sources of income.

The survey provided a census from which it was possible to randomly choose households for further qualitative interviews. The first 29 households for qualitative interview were selected randomly while the last 28 households were chosen selectively in order to supplement the sample with households with particular characteristics such as being female-headed. Fifty-seven out of a total of 91 households identified in the socio-economic survey were interviewed qualitatively.

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Figure 1. Location of Ilai District.
Qualitative interviews addressed the water needs of each household, how these needs were met, and factors which they felt advantaged or disadvantaged that particular person or household in their attempts to gain access to water. Such information from different households made it possible to establish how people really gained access to water, and which means of access were available to different people. Research was conducted at the household level because this was the unit to which the formal rules allocate water, and the unit at which there is a concern to get sufficient water onto the shared plot of land. Intra-household differences in access to water (notably gender) were addressed by interviewing different household members within households selected for qualitative interview.

It was found that there were differences in the use of, and access to, water between men and women within a household. In general, the system organization was dominated by men's water requirements. The issue of intra-household access to water is extensive and will not be addressed here.\textsuperscript{13}

\textbf{INDIGENOUS IRRIGATION ON MOUNT KILIMANJARO, TANZANIA}

The main settled area on Mount Kilimanjaro is the "upland" between 1,000 and 2,000 meters above sea-level, where there are approximately 900 persons per square kilometer, with an average \textit{kihamba}\textsuperscript{14} (homestead) size of 0.2 hectares.\textsuperscript{15} Contemporary resource management techniques on Kilimanjaro include agroforestry, irrigation, and stall-based cattle feeding. At the core of the agroforestry system (found in the upland area above 1,000 m) is coffee and banana cultivation. Around two-thirds of households also have a lowland (below 1,000 m) \textit{shamba} plot where they grow seasonal maize and beans. Since the 1950s, population pressure has resulted in the settlement of, and the extension of the irrigation system to, the lowland area. This paper focuses on the upland irrigation system alone.


\textsuperscript{14} Words in Kimachame, the local language in the field area, are given in italics.

since the newer lowland irrigation systems were found to work differently than those in the upland.\textsuperscript{16}

The irrigation system on Kilimanjaro is a "canal network system"\textsuperscript{17} in which water is distributed from source to farmland by dams and channels. There are several examples of these irrigation systems in East Africa, including those in Kerio Valley and Taita Hills in Kenya; and Sonjo, Mount Kilimanjaro, Mount Meru, Usambara Mountains, and Pare Mountains in Tanzania. They are usually referred to as "furrow" irrigation systems.\textsuperscript{18} On Kilimanjaro, it is estimated that there are over 500 indigenous irrigation furrows, with approximately 1,800 km of main channels abstracting 200 million m$^3$/year.\textsuperscript{19} Each village in upland Kilimanjaro (800–2000 m) is served by four to seven furrows, each serving 10–300 households.

This paper focuses on Nshara Furrow, which is typical of the majority of furrows found in upland Kilimanjaro. The layout of Nshara Furrow is illustrated in figure 2. The furrow begins with an intake made of logs, mud, and stones, which diverts water from the Makoa River into the furrow. The intake is susceptible to erosion by the river and, therefore, requires regular maintenance. With the first big rainstorm of the long rains (March–June) the intake is washed away and the furrow is left dry until it is rebuilt at the end of the long rains. From the intake, the channel gradually leads the water away from the river. The channel runs parallel to the river, gradually leading the water to the top of the steep valley side. The channel is an unlined earth canal of approximately 0.4 meters in depth and one meter in width. The average volume of water entering the furrow is between 40 and 60 liters per second, depending on the volume of water in the river. Where the furrow crosses steep ravines or other furrows, water is transported across by ilalo (aqueducts) made from hollowed out trees, banana plant stems, or corrugated iron sheeting. When the furrow reaches flatter ground, it branches into three diversions with smaller channels (approximately 15 cm deep and 50 cm wide), which sub-divide to lead to each individual kihamba. The discharge of water decreases as water is diverted away or lost through seepage, leaving the ends of the channels

\textsuperscript{16} See Mary Elizabeth Gillingham, Extending Upland Irrigation to Lowland Areas: The Example of Mount Kilimanjaro, Tanzania (1999) (unpublished manuscript, on file with the author).

\textsuperscript{17} See VINCENT, supra note 1.


\textsuperscript{19} See 1 MINISTRY OF WATER, ENERGY AND MINERALS, WATER MASTER PLAN: KILIMANJARO REGION 3 (1977) (United Republic of Tanzania).
Figure 2. Sketch Map of Nshara Furrow.

- Village boundary
- Main track
- Tarmac road
- VO Village Office
- DCA Direct Command Area
- Church
- Control gate
- River/Nshara Furrow

Scale: 0 m 100 m
dry. If surplus water reaches the ends of the channels, it drains into the next furrow (Mondri Furrow or the Estate Furrow) or back to the river. Near the top-end of Nshara Furrow there is an additional supply of water from Ikola Furrow, from which surplus water enters Nshara Furrow. The key uses of furrow water are for irrigation and domestic purposes. The furrow runs past each one of the 97 kihamba it serves, therefore providing a convenient source of water for domestic uses since there is no tap water in this area. Swynnerton, Masao, and Grove, in their studies of Kilimanjaro, all discuss the importance of furrows in providing a domestic water supply, and argue that the supply of water for domestic use may have been the primary purpose of the furrows when they were originally built about two hundred years ago. The main irrigated crops are bananas, coffee, and vegetables. Bananas and coffee require irrigation every six to eight weeks (depending on the arrival of, and extent of, the short rains in November or December), and vegetables every one to three days. During irrigation, water is diverted onto sections of the plot by a series of rivulets made by a hoe. The water is allowed to run freely over the soil until the soil is saturated. Both men and women can irrigate, but in male-headed households it is usually the male’s responsibility to apply for the allocation and to actually undertake the irrigation of coffee and banana plants. Irrigating vegetables is generally considered to be women’s work.

**FORMAL RULES OF FURROW ORGANIZATION**

Each furrow on Kilimanjaro has a leader called the “Furrow Chairman,” who is responsible for the organization of furrow maintenance and water allocation, and for imposing punishments on rule-breakers. The position is elected from the group of direct male descendants of the man who originally founded the furrow. The Chairman is elected for life, or until he is too sick or too old to be able to undertake the work. This was found to be the way in which most of the Furrow Chairmen in upland Kilimanjaro were chosen, although some inherit the position, while there were some who were elected from a Clan other than that of the original founder of the furrow.

The physical nature of the furrow means that it requires regular maintenance if it is to remain functional. The “annual cleaning” takes place in late June or July, when the long rains ease. The channels are scraped

clean of vegetation, any landslides along the course of the furrow (usually in the head reaches where the furrow traverses steep valley sides) are repaired, and the intake is rebuilt. This work can take two to three weeks, depending on the extent of damage caused by the long rains. If the short rains (the end of November or December) are heavy, the intake may need to be rebuilt. The intake and head reaches of the furrow require regular maintenance throughout the dry season. The household whose allocation it is on any one day is expected to walk the length of the furrow before irrigating, repairing any leaks as they develop. The Furrow Chairman organizes work parties every one to two weeks to maintain the intake and upper reaches of the furrow by packing more mud onto the retaining walls.

If there is no regular maintenance after the annual cleaning, the furrow soon falls into disrepair and becomes dry. Thus, the labor requirement for furrow maintenance is high, and the right to receive an allocation of water for irrigation purposes (the formal water right) is based upon the contribution of labor to furrow maintenance. Each household using Nshara Furrow is expected to send at least one male representative to furrow maintenance work. Because it is taboo for women to participate in furrow maintenance, female-headed households are excused from furrow work. However, if a household is female-headed because the husband works away from Kilimanjaro, the household is expected to pay for a laborer to do the work, or give a cash contribution to the Furrow Chairman.

After the annual cleaning, the Furrow Chairman holds an allocation meeting, during which the allocation sequence for the following dry season is decided. Water is allocated from 6 AM to 6 PM to one household, then to another household the next day. No one household receives a second allocation until all other households within that furrow user group have received an allocation of water. Water is allocated to a household on one diversion for one day, then to a household on the second diversion for the next day, and then to a household on the third diversion on the third day. Water is left to run freely throughout the furrow from 6 PM to 6 AM so that women may have easy access to water for domestic uses and for vegetable irrigation between these times. Water is not allocated on Sundays, as the Christian day of rest is widely respected in Kilimanjaro, where 90% of the population is Christian. An allocation meeting is held every Monday to confirm the allocation order for that week, to provide an opportunity to discuss problems relating to the allocation sequence, and to organize furrow maintenance.

Punishments are necessary to ensure that furrow users adhere to the formal rules. Most disciplinary action occurs over non-attendance at maintenance. The punishment for failing to send a representative to furrow

work is a fine called *ifua*. Those who attended the day's work visit the defaulter's *kihamba* and take something deemed to be of the same value as one day's labor. If a household continually fails to contribute to furrow maintenance, that household is no longer allocated water for irrigation and the diversion to their *kihamba* is filled in. If someone is caught taking water for irrigation when water is allocated to someone else in the user group, the fine is 2,000 Tanzanian Shillings (TSh) (U.S. $3.64).  

Therefore, each household with a plot along Nshara Furrow that participates in furrow work receives an equal 12-hour allocation of water. However, there is wide differentiation in water needs within the user group. Because of scattered land ownership, 34 households with a plot of land along Nshara do not actually live on that plot. Several such households do not actually irrigate their Nshara plot (and therefore do not need to do furrow work for Nshara), while others only take water in very dry years. There is also differentiation in the size of a plot (varying from 0.1 to 1.6 hectares) and in sources of income. Some households have no alternative source of income to agriculture, so need to maximize yields by maximizing their access to irrigation water, while others having large off-farm incomes do not have the time or the need to maximize their access to water. Four households in the Nshara user group have no one under 60 years of age and find irrigation difficult, but, because the household is small, they do not need to maximize yields. Conversely, households with several young children need not only to grow enough food to meet subsistence needs but also need a surplus which can be sold to pay school fees. There are 60 households with plots of land along Nshara Furrow that regularly request an allocation, and each household can only receive an allocation every ten weeks. However, most households want to irrigate their plot every six to eight weeks. In order to obtain the desired frequency of irrigation water, furrow users use alternative means of access to water, which are governed by a series of working rules.

**ALTERNATIVE MEANS OF ACCESS TO WATER AND WORKING RULES**

For Nshara Furrow users there are five possible alternative means of access to water. The first is to borrow water from the formal allocation of friends and family along Nshara Furrow. The second is to divert water from the upper furrow, Ikola Furrow. This can be done in three ways: by diverting a formal allocation from Ikola Furrow (if the household in question has access to an Ikola allocation), by borrowing water from the Ikola allocation of a friend or relative, or by taking water at night. The third

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24. All monetary values given at 1994 values.
alternative means of access to water is to buy water from the allocation of other Nshara Furrow users. The fourth is to irrigate at night when water is not formally allocated to anyone, and the fifth is to steal water.

Borrowing Water

With an adequate volume of water in the furrow (over 40 liters per second), 0.4 hectares of land takes seven or eight hours to irrigate. As most households own less than 0.4 hectares, there are often several hours of an allocation remaining after irrigation has been completed. This can be lent to others who are in need of water. Borrowing is most common from August to October, when there are relatively large volumes of water in the furrow. By January the volume of water is low (especially if the short rains have been poor) and most households need the full 12-hour allocation. Borrowed water is used to irrigate vegetables or cattle feed grasses (which require small amounts of water once or twice a week), as well as to irrigate coffee and bananas if the soil is becoming dry but the formal allocation of water is not yet due. Borrowing is common and 44 percent of the respondents obtained water in this way.

Water is borrowed by asking an allocation holder who does not use the full 12 hours to irrigate their plot if it is possible to use the water that is in the furrow once they have finished irrigating. Because of the weekly allocation meetings, who holds the allocation on which day is common knowledge. People ask neighbors for water first, as they are known to each other (possibly they are relatives), there is no distance involved, and it is easy to see when a neighbor has finished irrigating. The borrower may help the lender irrigate, ensuring they finish early. Arrangements are often reciprocal—if person A borrows from person B, person A will give person B priority if he or she should need water when A has an allocation.

The key working rule governing borrowing is that anyone lending water must only lend water to a household which contributes to furrow work (and therefore has the right to water from the furrow) or to households which are formally excused from furrow work. This ensures that all who are using the furrow are contributing to furrow work and that it is not possible to “free-ride.” Free-riding is when a person enjoys the benefits of a resource management system (in this case water) without contributing to the duties attached to the use of that system (participating in furrow work and respecting other people’s allocations of water). This is important because several households not living on their Nshara Furrow plot borrow water as and when they need it and do not actually apply for an allocation. However, they still attend furrow work because they know that they will not be lent water otherwise. The household lending water should lend water freely, there being a strong belief that water is a freely given “gift from God.” Should furrow users obtain their full irrigation requirement by
borrowing, they do not apply for an allocation, which shortens the allocation cycle.

Not all furrow users are equally able to borrow. Those who find it most difficult to borrow are households where the main irrigator (usually the male head of household) has full-time employment and therefore has little time to negotiate with other users for water. Ten respondents said that they do not borrow water, as they are unable to reciprocate due to large plot size or living at the tail end of the furrow where less water reaches the plot and therefore it takes longer to irrigate. However, Chi-Squared tests showed that the plot sizes of households borrowing water were significantly larger (at the 95 percent confidence level) than for those households not borrowing. This is because households with larger plots need more water. Two female heads of households, recently married and with husbands who work away, also find borrowing water difficult. They do not know their neighbors well and are too shy to ask. Three other female-headed households that do not borrow water reported that other factors are more significant in determining their ability to borrow (such as plot size). Three of the eight female-headed households interviewed know their neighbors well and have no trouble borrowing water as and when they need to. Older men (over 30) find it easier to borrow water as they are better known and respected in the area than younger men. Most respondents said that when they have surplus water they give priority to requests from people who have lent them water, followed by older men and female heads of household, because households with younger men are more able to acquire water at night.

**Diverting Water from Ikola Furrow**

Surplus water from Ikola Furrow drains into Nshara Furrow. It is possible to divert all of the water from Ikola Furrow into Nshara Furrow and use that water to irrigate a Nshara Furrow plot. Diverting water from one furrow to another furrow serves to "top up" the volume of water available for irrigation, especially in January and February. Ikola Furrow is spring-fed and, therefore, flow in the furrow is reliable at the hottest, driest time of year when flow in stream-fed furrows such as Nshara Furrow is notoriously unreliable. In total, 32 percent of respondents use Ikola water.

There are three ways in which water is diverted from Ikola Furrow to Nshara Furrow. First, eight respondents who have plots along both Nshara and Ikola Furrows transfer their Ikola allocation to Nshara Furrow. They do furrow work for both furrows and, therefore, receive an allocation for both furrows. For example, one household lives on a small plot along Ikola Furrow, with only room for the house and a vegetable garden. Most cultivation is done on their Nshara Furrow plot. If the volume of water in
Nshara Furrow is low, they divert water from their Ikola allocation to Nshara. It is necessary to negotiate with the Nshara Furrow allocation holder for that day in order to share the water diverted into Nshara Furrow. Whether a household is able to transfer water from an Ikola allocation to Nshara Furrow is dependent only on having a plot along both Nshara Furrow and Ikola Furrow and is independent of other household characteristics, such as household composition. However, two households with no plot along Ikola Furrow attend furrow work for Ikola Furrow and, therefore, obtain an allocation there that is transferred to Nshara Furrow. Both of the men involved in this transaction are in their 40s and 50s, well-known to the Ikola Furrow Chairman, and widely respected by the other members of Ikola Furrow. They are therefore allowed to contribute to Ikola Furrow work and obtain an allocation without actually owning land there.

The second way to obtain Ikola water is to borrow water from a person who holds an allocation there, which seven respondents do. The working rule is that people from Nshara Furrow can take Ikola water without doing furrow work as long as they borrow the water from the allocation of someone who does do furrow work for Ikola Furrow. People who most often do this are older men who are well known and respected throughout the community, and households which live at the top end of Nshara Furrow, and who are therefore neighbors with Ikola Furrow users. The one female head of household obtaining water in this way has a relative living along Ikola Furrow from whom she borrows water. Other female-headed households reported that it is easier to borrow from within the Nshara Furrow user group, as they do not know the men along Ikola Furrow from whom they would be borrowing water.

The third way of obtaining water from Ikola Furrow is by taking it at night. To take water from Ikola Furrow at night, all diversions of the Ikola except the main channel have to be blocked in order to divert all the water into Nshara Furrow. This is against the formal rules, as water should flow in all diversions at night. It also contradicts formal rules if those taking water at night do not do furrow work for Ikola Furrow. The formal rule of not taking water from Ikola Furrow at night is enforced if an Ikola member notices water being diverted to Nshara Furrow. However, as few like going out at night, it is rare that anyone from Nshara Furrow is caught taking water from Ikola Furrow. Because the formal rule is rarely enforced, it is not a working rule and young men who are willing to go out at night are able to take water from Ikola Furrow. All six households that admitted to taking water in this way contain young men who are the ones who actually do the night irrigation. The issue of night irrigation within Nshara Furrow is addressed in more detail below.

Several respondents were aware that people take water from Ikola Furrow but did not know how to obtain this water themselves. Some said that they could ask other users or the Furrow Chairman how to get this
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water, but had not had need to do so as they manage to obtain water through other means. Others believed that unless a person owns a plot or has a relative along Ikola Furrow, there is no way to get water from Ikola. If they took water at night and were caught, they would be fined. This illustrates that not all furrow users have the same level of knowledge about the working rules, which can, ultimately, affect their ability to gain access to water.25

Buying Water

"Buying" water is defined as a cash exchange as a result of one household being "lent" water by another. Strictly, this is against "formal rules," as there is a strong belief throughout Kilimanjaro that water is a gift from God and should be free for all to use. If someone does not want to irrigate, they should not do furrow work but leave water for those who really need it and not use furrow work as an indirect form of paid labor. Four households admitted to buying water to meet their water requirements. All have higher than average plot size and grow surplus bananas and vegetables for commercial purposes. Thus, buying water for these households is a profitable investment. Also, although these households also irrigate at night and take water from Ikola Furrow, they still need to buy water in order to meet their water requirements.

The process of buying water is as follows: person B (the seller) approaches household A offering to irrigate A's plot with B's allocation. A then pays B for his labor to irrigate the plot rather than for the water per se. This is within the rules, as it is person B's labor that is paid for, not his water. Person B is given 500 to 1,500 TSh (U.S. $1.00 to $2.75) depending on the length of time water is taken for and the time of year. If questioned as to why A's plot is being irrigated when it is B's turn to irrigate, B explains that he has lent water to A, but A is too busy to irrigate himself. As a good friend of A's, he has offered to irrigate for him. If the Furrow Chairman were to find out that a particular household was selling their allocation, they would be stopped from using the furrow. The household purchasing the water would go unpunished.

Therefore, either the buying and/or selling of water from the allocation of someone in Nshara Furrow was not necessarily against the working rules. It again illustrates that some people have greater knowledge about the working rules than others. Most respondents stated that they did not buy water, as it was against the rules to make a cash profit from water, and if they were caught buying water the Furrow Chairman would disallow their next allocation. However, four households were aware that

it is the seller who is punished, not the buyer, and, if the seller can convince anyone who may confront him that he is selling his labor, not his water, then he too will go unpunished. In this respect, all of the households that admitted to buying water contain someone with a leadership position (for example, on the Village Committee), who would be more aware that it is the household caught selling the water that is punished rather than the household caught buying the water.

Night Irrigation within Nshara Furrow

Although it is against the formal rules of Nshara Furrow to irrigate at night, 42 percent of respondents do so. Night irrigation means taking water after dark (7 PM) until 12 AM or 1 AM, although in very dry years people stay out until 6 AM. The majority of those who irrigate at night do so most years from one to six times, depending on the severity of the drought in the dry season. A few, notably female-headed households and older people, will irrigate at night only in the driest years, while households containing young men will irrigate their plots at night on a more regular basis. When people go out to irrigate at night they do so with family or friends. Generally, people do not like going out at night to irrigate, so those who can afford to pay someone else to do the work for them do so. It is young men who are employed, as night irrigation is considered a task for the young and strong. They are paid from 1,000 TSh to 4,000 TSh (U.S. $1.80 to $7.27). Payment is made the next morning when there is evidence of a successfully irrigated plot.

The working rule of night irrigation is that households taking water at night should attend furrow work. It is also considered more acceptable for tail-enders to irrigate at night than top-enders. This is because water has already passed the majority of households, so when water is diverted to a kihamba for irrigation, few households are affected. However, in reality, top-enders are as likely to irrigate at night as tail-enders. Only two female-headed households of the eight interviewed irrigate at night. In one there is a teenage son who does the work, and, in the other, a son that is working away sends money to his mother so she can pay someone to irrigate at night for her. The other female heads of household are too afraid to go out at night alone or do not have the money to pay someone to do the work for them.

Stealing Water

There are two ways in which water is considered stolen. Firstly, if someone takes water from the furrow for irrigation purposes when it is another household’s allocation but does not have their permission to use that water, it is stealing. Secondly, if water is taken from the furrow for
irrigation purposes without doing furrow work for that furrow, that too is stealing. The stealing of water in either of these two ways in Nshara Furrow is rare. Because of the high population density and open nature of the furrows (the main diversions generally run parallel with pathways), who is doing what with furrow water is highly visible. This, combined with the fact that who has been allocated water on which day is common knowledge, makes stealing difficult and rare. Even if water has been left to run free in the furrow by the allocation holder before the end of their allocation, anyone wanting the water will ask the allocation holder for permission to use the water before taking it. Taking water from Nshara Furrow without doing furrow work there is nearly impossible. Very little water reaches the end of the furrow, so it is difficult for users of Monri Furrow (into which Nshara drains) to take Nshara water in the same way that Nshara users take Ikola water. Anyone within the user group who fails to do furrow work is either punished through ifua (a fine), or, if they continually fail to contribute, their diversion is blocked, and any of the other furrow users seeing them irrigating will report them to the Furrow Chairman. Therefore, the working rules reflect and reinforce the formal rules, which do not allow people to take water without doing furrow work or to take water from another person's allocation.

**THE SIGNIFICANCE OF WORKING RULES**

It is clear that the formal rules of water allocation do not provide a full explanation of how furrow users gain access to water. The fact that 75 percent of respondents use one or more alternative means of access to water illustrates the importance of working rules in this regard. The flexibility that the working rules provide is crucial to the allocative efficiency and sustainability of the irrigation system. Through working rules the majority of households obtain an amount and timing of water which is more closely suited to their needs than their formal allocation. If all furrow users were to be restricted to the use of their formal allocation only, the furrow irrigation system would meet the irrigation water needs of only a few furrow users. This would reduce the incentive to attend furrow maintenance work and make the furrow more liable to run dry due to cumulative leakages that have not been repaired as and when they occurred.

However, knowledge of, and ability to benefit from, the working rules varies between households. For example, households with young men present find it easier to irrigate at night, while households with older men present find it easier to borrow water. Only one of the eight female heads of household interviewed does not use any alternative means of access, but the other seven use only one alternative means of access each, not having the time or ability to use two or three alternative means of
access. In this respect, access to water within Nshara Furrow tends towards equity, since those unable to use one particular alternative means of access to water (such as night irrigation) are usually given priority in using another alternative means of access to water (such as borrowing). As a result, relatively disadvantaged households, such as female-headed households, have some chance of adjusting their access to water. Those not using any alternative means of access are mainly households living away from their plot along Nshara Furrow who do not irrigate that plot, and households with an alternative means of income to agriculture and therefore not having such a strong need to maximize agricultural production as other households. Because different water users use different working rules to different extents, it is not possible to say how an irrigation system “really works” because each water user’s reality is different.

The fact that the working rules of access to water for Nshara Furrow reflect the basic principles of the formal rules also contributes to the sustainability of the system. Firstly, in order to use the working rules (for example, to borrow water), people still have to attend furrow work for Nshara Furrow. Secondly, because stealing is against the working rules as well as the formal rules, the formal allocation of water is reliable. If it were not reliable, there would be less incentive to contribute to furrow work in order to obtain an allocation. This cohesion between the formal and working rules takes time to develop and is the result of decades of continual negotiation. The cohesion between the formal and working rules in more recent (1950s) lowland furrows was found to be not as well developed as in the upland. This was due to the more recent time scale, drier climate, more scattered population, and greater social diversity in the newly settled areas.

It is important to be aware that the portfolio of working rules changes with time. In the short-term, the use of working rules fluctuates with the weather. For example, in a wet year when the rains continue through to August or September, there is not so much need of irrigation, so there is not so much need to borrow water, irrigate at night, and so on. In a very dry year, water users may lobby the Furrow Chairman to temporarily change the formal rules so that each allocation lasts only six hours, ensuring each household receives some water before the streams run dry. In the long-term, the increased number, but decreased size, of plots has meant that borrowing has become more common over the past 40 years, while there have been no changes in the allocation system. Thus, it

26. Oral histories established that the oldest furrows on Kilimanjaro began in the 18th century. The process of furrow building has been continuous, with new furrows being built as new areas have been settled.

27. See Gillingham, supra note 16, at 6-7.
is the working rules that slowly and incrementally adapt to changes in the external social and economic environment rather than the formal rules.

From the example of indigenous irrigation on Kilimanjaro, it has become apparent that indigenous irrigation management is complex and of considerable depth. The concept of working rules developed from the use of the language of New Institutional Economics is useful in describing how the irrigation system on Mount Kilimanjaro works. However, it is necessary to go beyond the descriptive level to consider what development interventions into indigenous irrigation systems are taking place, and how policy-makers and development agencies can account for the complexity of indigenous irrigation management in their work.

RESEARCH, DEVELOPMENT AND WORKING RULES

Current development interventions into indigenous irrigation on Mt. Kilimanjaro are focused around river basin management initiatives that aim to reduce the amount of water used upstream, releasing more water for downstream uses—most notably for hydroelectric power generation, but also for lowland irrigation and urban water supply. With respect to the indigenous furrows, the policy is to increase the efficiency of water use, thereby reducing the amount of water abstracted by the furrow systems.28 The policy includes the introduction of statutory water rights for each furrow with a concomitant annual water user fee (WUF) based on the total volume of water abstracted by a furrow in a year. The aim of the WUF is to achieve cost recovery for the River Basin Authority as well as to make water users aware of the economic value of the water they are using. Previously, the indigenous furrows were considered to have a "traditional" water right, which was held on behalf of the furrow users by the District Council. The introduction of statutory water rights and WUFs for indigenous furrows requires the formalization of furrow management into a legally recognized entity such as a Water User Association (WUA). The WUA is then responsible for collecting the money for the statutory water right (a one-time payment of 35,000 TSh or U.S. $64.00) and a water user fee (30 TSh or U.S. $0.05 for every 100m³),29 as well as ensuring that the volume

29. The initial rates set in 1994 were TSh 40,000 (U.S. $72.70) for the application fee and TSh 15 (U.S. $0.03) for every 100m³. These rates were revised to the ones given above in 1996 because the high application fee was thought to be discouraging furrow users from applying for a statutory right. However, the WUF was increased so that the water management authorities could still recover their costs. See Gillingham, supra note 13; Mary E. Gillingham, Imposing Efficiency: Indigenous Irrigation and State Water Management, Kilimanjaro, J. INT’L COMMISSION IRRIGATION & DRAINAGE (forthcoming 2000) (Netherlands).
of water abstracted by the furrow they manage does not exceed the amount stated in the statutory water right.

To date there have been few external interventions into the indigenous irrigation system on Mount Kilimanjaro because it has been felt that the irrigation furrows have been well-managed and efficient in terms of meeting the water needs of the local people. The current attempts to introduce statutory laws and fees to indigenous furrow users will add a new dimension to the organization of the irrigation system. If the initiatives are not sensitive to the way the furrows are managed at present, they may, at best, be ignored by furrow users as irrelevant to the way in which the furrow currently operates, or, at worst, they may undermine the indigenous formal and working rules that ensure that the system is sustainable and flexible.

Therefore, if development interventions such as the one described above are to be successful and sustainable, development agencies must understand, work with, and work through the working rules. The first step in addressing the complexity of indigenous irrigation systems is to develop research strategies that allow development agencies to begin to understand how an irrigation system “really” works. Irrigation systems are far more complex than rapid rural appraisal itineraries for irrigation systems that identify “formal rules” would suggest. Ways of obtaining more detailed information about the working rules of an irrigation system are needed. To identify the working rules it is necessary to ask different groups of users (top-enders and tail-enders, men and women, young and old, rich and poor) how they personally gain access to the water they require under different circumstances (when there is drought, when water is plentiful, when the male head of household is working away, and so on). By asking different users within a system what their water needs are and how they meet those needs, it should be possible to establish what the working rules are, who is able to benefit from which working rules, and the extent to which the working rules reflect the formal rules. This research will take time (over one year). This is because research needs to cover at least one complete agricultural cycle (while being aware that there can be dramatic fluctuations in weather patterns between years); it takes time to develop water users’ confidence in telling the researcher what they “really do” to obtain access to water; and it takes time for the researcher to develop a good understanding of the social, political, and economic context in which the irrigation system is operating.

An essential part of the research process is the development of communications between the development agency and water users. These communications are important in ensuring that water users participate in deciding whether an external intervention into the irrigation system is appropriate, and, if so, what the intervention should involve. Detailed group and individual interviews with different sections of the user group
should address the problems that they, as individuals, face in gaining access to water; how they personally think that the irrigation system can be improved, if at all; the aims of the research and any subsequent projects involving the irrigation system; and how these aims might be met in a way that would be mutually beneficial to both parties. It may also be relevant to include different user groups such as upstream farmers and downstream hydroelectric power engineers in discussions.\(^{30}\)

The water users themselves need to participate in the decision as to whether an external intervention is actually appropriate. Wade\(^{31}\) suggests that collective action situations (where resource users work together to use and manage the resource in question sustainably, such as with indigenous irrigation systems) have a better chance of success where there is minimal external interference, especially from the state. Ill-advised interventions will, at best, be ignored by the water users as inappropriate, and at worst may undermine the working rules that ensure that the system is sustainable, resulting in the collapse of the irrigation system. If an external agency were to undertake to decrease water losses along Nshara Furrow—thereby releasing water for downstream users—by lining the furrow with cement, furrow users may see the agency as having become responsible for the maintenance of the physical infrastructure. This will result in a decline in water user participation in system maintenance, and after the agency involvement in the system has finished, the cement structures (and possibly the whole system) will fall into disrepair. Intervention should only take place if there is general agreement among different sections of the water user group that there are improvements that could be made to the system with which an external agency could assist, and if the external agency itself feels that this is so. For example, with the relatively successful Netherlands Development Organization "Traditional Irrigation Programme" in Tanzania, assistance has only been given if there has been a request from the user group themselves.\(^{32}\)

If the mutual decision is made that the development agency should intervene, there needs to be negotiation between the aims of the development agency and the aims of water users. The water users themselves need to continue as an integral part of the project. It might be necessary to develop new fora for negotiations that involve different sectors of the user group. For example, if there were to be external interventions into Nshara

\(^{30}\) See Gillingham, *supra* note 29.


Furrow, it would be unwise to base communications around formal furrow meetings, as women do not attend these meetings. Thus, it would be necessary to use pre-existing, or create new, women's groups in order to develop and maintain communications with this sector of the user group after the initial research about working rules had been completed. It is essential to include all members of the user group in the decision making process since water needs within the user group can be in conflict, and, therefore, it is important to ensure that any interventions do not benefit one group (usually the more prolific elite, such as wealthy, educated men who are well able to express their needs and desires to people from outside the community) at the expense of other users. Through continual research, communication, negotiation and participation the mutually decided aims of the project will have a greater chance of becoming an integral part of the working rules.

As with any development project, constant monitoring and evaluation of impacts will be needed. Knowledge of the working rules can assist greatly in this process. Research throughout the lifetime of the project should help to establish how the intervention is altering the working rules that govern people's daily water use. This will include identifying the direction in which change is occurring, which sectors of the user group are benefiting the most from the changes, and if there are any sectors of the user group which are being disadvantaged by the changes. There will then be a need to respond to any problems identified, again through negotiation and participation. Therefore, any external intervention cannot be based on a blueprint plan but has to be adaptive and responsive.

There will also have to be a long-term commitment to the project of decades rather than years as the processes of research, negotiation, and monitoring cannot be hurried. Neither can the changes in the working rules that such a project might aim to achieve be rushed, since changes to the working rules, by their very nature, are gradual and incremental. The projects may also be small in scale. This is because each water user group is unique in terms of social composition, physical location, infrastructure, and working rules, and, therefore, each water user group has to be taken as an individual case. For example, with any intervention into the irrigation systems on Mount Kilimanjaro, each furrow user group would have to be researched separately in order to identify the vulnerable sections of the user group, physical infrastructural problems, and the working rules; to build up communications with different sections of the user group; to establish if external intervention is desirable; and to develop a project strategy. However, in aggregate a large number of small-scale projects can have a significant impact.

33. See Adams et al., supra note 18, at 30-31.
The flexibility and sustainability provided by a set of working rules is also an important consideration in the construction of water user associations for the management of farmer-managed irrigation systems. Water user associations are modeled on the structural-functionalist models of irrigation organization and are, therefore, designed with a standardized set of formal rules to ensure that organization. From the example of Nshara Furrow, it is apparent that within these farmer-managed irrigation systems there needs to be room for working rules to develop, as it is not possible to predict every water user's water requirements at every moment in time. However, in a newly established management regime, it may take time for sets of working rules to develop. Fora for negotiation between water users may help the development of working rules, as well as ensure that they develop in a direction that ensures compliance with the basic principles of the formal rules, rather than undermining or contradicting them.

CONCLUSION

Models of irrigation organization based on studies of indigenous irrigation systems identify the formal rules of what "should" happen. However, operating beneath the formal rules in an indigenous irrigation system are sets of working rules that determine how the irrigation system "really" works for an individual water user at a particular moment in time. Working rules are crucial to the flexibility and sustainability of an irrigation system. Current policies for improving the efficiency of water use upstream in order to release water for increasing demand downstream will continue into the future. If these policies are to be successful, there is a need to take the concept of working rules seriously, and to consider ways of working with and through them. If the working rules are not researched and are not considered as an integral part of a project, at best, the project will be ignored by the water users as irrelevant to their daily water needs and practices, and, at worst, it may undermine the institutions which ensure the sustainability of the system. However, by considering the complexity of an irrigation system, and by working with and through the working rules, any intervention which is decided to be appropriate to undertake will be more relevant to water users' needs and their own institutions, and, therefore, will ultimately be more sustainable.