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IRRIGATION MANAGEMENT NETWORK

USERS, OPERATORS AND HYDRAULIC STRUCTURES: A CASE OF IRRIGATION MANAGEMENT IN WESTERN MEXICO

Pieter van der Zaag

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Please send comments on this paper to the author or to:

Linden Vincent
Irrigation Management Network
Overseas Development Institute
Regent's College
Inner Circle
Regent's Park
London NW1 4NS
UK

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USERS, OPERATORS **AND HYDRAULIC** STRUCTURES: A CASE OF **IRRIGATION MANAGEMENT IN** WESTERN MEXICO[1]

Pieter van der Zaag[2]

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1 An earlier version of this paper was published as The Material Dimension of Social Practice in Water Management: A case study in Mexico, in Geert Diemer and Jacques Slabbers (eds) *Irrigators and Engineers* (1992) Amsterdam: Thesis Publishers.

2 Pieter van der Zaag completed his PhD at Wageningen Agricultural University, the Netherlands, with field research in Western Mexico. He is currently working in Uganda.

USERS, OPERATORS AND HYDRAULIC STRUCTURES: A CASE OF IRRIGATION MANAGEMENT IN WESTERN MEXICO

Pieter van der Zaag

1. INTRODUCTION

This paper analyses how physical structures in irrigation systems influence the social practice of water management. It argues that irrigation design is less of a determinant for particular water management patterns than is sometimes assumed by engineers, and that it may not be necessary to change the design of canal structures fundamentally for new management practices to emerge. This has implications for interventions in the management of irrigation systems.

Underlying this paper is a polemic between different approaches to understanding irrigation development, involving both physical and social phenomena. As yet, little theoretical exploration of the interaction between physical and social factors has been made. Practitioners, perhaps as a result of this, take either physical structures or social actors as a point of departure for planning. Their choice has far-reaching consequences in their conceptualisation of irrigation design and management. Exploration of this socio-technical no-man's land may develop when it is accepted that physical infrastructures have a social dimension, and that social practice has a material component.

Some authors argue that it is often forgotten that technology is socially constructed, because physical structures appear to us as mere objects and are usually viewed as culturally neutral. Diemer (1990) has convincingly shown that irrigation systems developed by farmers differ markedly from systems developed by European engineers.

The irrigation design, then, has an underlying sense of order which is absorbed by the users and influences the users' disposition (Bourdieu, 1977). At the same time, the physical irrigation infrastructure provides new opportunities to the users, who will devise a variety of strategies with regard to the system. In this way, social practice is influenced by the physical irrigation infrastructure, and in turn it actively shapes how that infrastructure is used.

This paper focuses on the interaction between social practice and physical infrastructure. It first examines an engineer's view of the type of canal infrastructure most likely to improve irrigation performance. This design assumption is then related to irrigation as practised in a system in Western Mexico, raising implications for future irrigation development.

2. DESIGN ENGINEERS AND THE CANAL SYSTEM

Engineers designing irrigation systems have responded in two ways to the problem of low irrigation performance. One group of engineers opts for a more sophisticated canal infrastructure, operated by continuous measurement of water flows and crop demand throughout the irrigated area, enabling the water distribution to follow changes in crop water requirements more precisely. They develop elaborate mathematical programming models which are fed with field measurement data, and which produce clear, unambiguous decisions to be implemented by the operators (Châvez-Morales et al, 1987; Boman and Hill, 1989).

A second group of engineers advocates a canal infrastructure which is easy to manage, but does not enable water distribution to be precisely matched to the changing crop demand for water. These engineers, such as Horst (1983, 1987), promote simpler systems with fewer decision-making points, and thus with lower skill requirements of staff. The premise is that simplicity of operation, even at the cost of some water loss, will eventually lead to higher efficiencies.

Both groups of engineers contend that a higher efficiency of water distribution will be attained by their strategies, and hence system performance improved. They share a view on how the canal infrastructure operates: both regard irrigation personnel in charge of operation with suspicion, and do not expect a positive contribution from them. Their attitude is that, in the former case, staff should follow the mathematical procedures prescribed and implement the resulting decisions or, in the latter case, staff numbers should be reduced to the absolute minimum in a simple system. Irrigation staff are expected to passively endure the canal system that the design engineers have concocted, by merely implementing actions which are wholly determined by the planning models.

From the design engineers' point of view, physical infrastructure (the canal system) takes precedence over actors (irrigation staff), and procedures over personnel. The following case study shows that in a complex irrigation system, with flexible structures, the practices of irrigation staff and water users are crucial to the smooth functioning of the system. They overcome some of the limitations presented by both canal structures and management.

3. WATER DISTRIBUTION: THE DUTIES OF THE WATER GUARD

Autlán-El Grullo irrigation system in Western Mexico, known as *El Opemdo* is used as a case study (van der Zaag, 1992). Constructed in the 1950s, it serves 8,700 ha of which 6,000 ha are currently planted with sugar cane. Water distribution efficiency, defined as the volume of irrigation water reaching the fields in proportion to the volume entering the system's head works, is around 60%. Water distribution and canal maintenance are performed by personnel of the District, the local office of the Ministry of Agriculture and Hydraulic Resources (SARH).

The head of the District operation department is responsible for water distribution, supported by staff at the District offices. The most junior staff are the six water guards *(canaleros)*, the field personnel who distribute the irrigation water. They ensure that water is diverted from the river into the main canals, from the main into the lateral and sub-lateral canals, and from these to the individual farm plots. The water guards physically move the weirs and sluices, and have elaborate rules of thumb as to how water flows change after lowering a particular gate by a certain number of screw threads. They work out (in their heads, not on paper) the water distribution programmes. Water guards form the frontline of the District, since they communicate every day with both farmers and District engineers. Farmers put forward a request for an irrigation turn to the water guard in his or her zone and, if the request is reasonable[1], the farmer will expect to receive water (normally within one to five days). Farmers themselves do not move gates.

Each of the six water guards is responsible for an area of approximately 1,500 ha, containing some 300 fields. One water guard deals with 250 water users, and controls the gates and sluices of 30 to 40 kilometres of lined

[1] For sugar cane, an irrigation interval of three to six weeks is observed, for maize between two and three weeks, etc.

canals (in the main canal alone there are 25 to 30 gates and sluices per water guard). Normally he 'carries' a water flow in the order of 700-2,000 litres per second. A water guard works some 60 hours per week. Every day of the week he rides 50 to 80 kilometres through his zone on his motorbike to check all irrigation turns that at that moment are 'running', adjusting gates and talking to between 20 to 30 farmers or their labourers. The water guard plans a water distribution schedule for all of his canals. Water demand may vary considerably from field to field depending on crop and soil, limitations set by the canal infrastructure and the requests from farmers themselves. This complicates greatly the pattern of turns within one lateral canal. The pattern evolves during the irrigation season, since water demand gradually increases from November to March with changes in climatic conditions and crop stage. The water guard, thus, gradually builds up a progressively more complex water schedule for his zone and along each canal.

4. HOW THE WATER GUARD HAS 'INTERNALISED' THE PHYSICAL SYSTEM

The water guards have a specialised knowledge of the specific characteristics of both the canals and structures in their zone, and of the characteristics of all plots (soil quality, ease of irrigation, crops sown). They also know well all the farmers, share-croppers and irrigators working the fields. Three examples, given below, illustrate how the water guard absorbs detail of the system's features and uses this in his work: the first example concerns his knowledge of the physical infrastructure; the second deals with his stock of information about farmers and plots; and the third shows the sense of responsibility the water guard feels for his canals, and how he tries to resolve problems created by others.

Water guards are regularly confronted with technical problems, often related to shortcomings in the canal infrastructure. When I was present, they frequently asked my advice. My suggested solutions were often dismissed, although the water guards could not explain why in detail. On one occasion, a water guard followed my advice, although he did not believe my solution was feasible. He feared that carrying out my suggestion would cause problems to his downstream colleague, which I refuted on the basis of 'hard' calculations. The problems he faced were pressing, so he followed my advice, which had disastrous consequences for the established water flows.

As the water guard had predicted, the next day his downstream colleague accused him of having taken 200 litres per second of water.

The water guard, through his experience of working with the canal structures, has learned the whims of the system and is able to predict the effect of new manipulations. His knowledge of the infrastructure is both situation specific and implicit. It is as if he can feel how the system reacts. He has assimilated and 'internalised' the whole system, including canals, plots and farmers, and constructed an adequate model of it in his mind. To exemplify this, consider the crucial link that the water guards form between the District and the sugar refinery. This link becomes apparent during the daily meetings that the water guards have in the District office with their superiors.

One of the regular topics in this meeting is sugar cane irrigation. The water guards are informed which sugar cane plots have received the order of 'suspension of irrigation', scheduled at four to six weeks prior to harvest. The operation department of the District receives this list of suspended plots every few days from the sugar refinery. However, this information is unintelligible to the District office personnel, because the refinery's nomenclature of plots is not compatible with the District's nomenclature system. The District registers all plots of *El Operado* with a 4-digit number recorded against the official plot-owner's name. This plot number is not used by the refinery. The refinery bases its administration upon the farmer owning the crop (which is quite often different from the one registered as the plot owner in the District's system), with each crop-owner having a 6-digit identification number. Furthermore, the area under sugar cane, as registered by the refinery, concerns the *net* area planted and thus is normally less than the area used by the District in its administration.

The water guards are the only people in the District able to decipher the refinery lists and translate them into terms intelligible by the District. Thus, they form the link between the two administrations. It is amazing to see the speed with which this is possible. The engineer reads aloud the sugar cane growers' name and cane acreage and normally, within seconds, the water guard has produced the corresponding District plot number which he writes down in his note book. Errors in the refinery's computerised list are immediately recognised by the water guards, causing some hilarity in cases where the plot, supposedly ready to be cut, has already been harvested some months before for use as planting material (this is an activity not administered by the refinery).

The refinery cannot enforce the irrigation suspension without cooperation of the water guards. Therefore, the water guards are also the frontline of the refinery, often acting as policemen, since the farmers usually hear first from the water guard that the irrigation service to their plots has been suspended. Farmers tend to disagree with this decision as an extra irrigation before the harvest increases the gross weight of the cane, and farmers are paid per ton of cane. Thus, water guards not only absorb detailed factual information about the physical system, they also assume responsibilities over sugar cane growers. They embody the relationship that these cane growers maintain with the refinery. Needless to say, the water guards also, for all water users, embody 'the District'.

A meeting of water guards took place at the District in November, when problems concerning silted canals were most notorious. Juan, a tail end water guard, complained, for perhaps the tenth time, that he needed 800 litres per second (lps) but that only 200 lps was running into his zone. The main canal had severely silted and was now at peak capacity with only 200 lps, whereas normally it could carry 1000 lps. He complained about it again to the head of the operation department four weeks later, and stated that the canal had to be cleaned by the hydraulic excavator because the water users badly needed their first irrigation. The head engineer responded as usual: "Yes, I have contacted the head of the maintenance department and we are looking into this matter, but the problem is that the machine has broken down and is being repaired". Juan insisted that the situation had become unbearable. Pedro, another water guard, exclaimed:

"Juan, you need 800 litres for your farmers? Why then don't you ask for it? Why worry that the canal cannot carry it? If it flows over and the canal breaks down, that is not your problem, is it?"

All the water guards nodded and the head engineer continued to say that they were working hard on it. The next day, 4 tail-end farmers threatened to beat Juan up if they did not get water, and Juan simply did not show up for a week in the tail-end part of his zone. Finally, the machine was repaired and the main canal cleaned. This illustrates how strong the tendency is for water guards to assume total responsibility for their zones, taking problems created by others as their own concern.

In conclusion, low-rank field personnel interact intensively with both the physical infrastructure and the farmers they serve. The water guard emerges as a key actor who makes the system work. It is not then so simple as the

head of the operation department makes out: "the water guard distributes the water, and we do the rest". Engineers in their offices have a limited view of what actually happens in the field. Water guards, through practice, have created their own autonomous system of action. The water guards' technical competence, and moreso, ability to deliver water efficiently, is directly related to the type of infrastructure he has to work with. The typical canal design is characterised by adjustable gates and intakes, which is potentially flexible in meeting the varying demands for irrigation water by users. However, to achieve flexibility the structures have to be operated correctly. The flexibility is therefore provided by the water guard.

Such flexibility is only achieved by water guards not strictly conforming to the District's organisation chart and guidelines, which are far too broad to be operational. If the water guard rigidly adhered to them, he would be confronted by many farmers in problematic situations: farmers with crops on sandy soils; farmers with flowering maize; those affected by the 'suspension' of a nearby sugar cane plot. The District guidelines are translated into far more complex actions by the water guards, which reflect the diversity of needs found in the field. The water guards have memorised the detail of the physical infrastructure through practice. Although designed by a distant institution or engineer and therefore alien at first to the water guards, the canal infrastructure is familiarised and manipulated to fit needs.

5. MAINTENANCE: FARMERS' APPROPRIATION OF CANALS

Water guards are not alone in taking some aspects of the complex irrigation system into their own hands; farmers also do so, illustrated by their approach to canal maintenance.

Whereas farmers are quite satisfied with the way water is distributed by the water guards, most are discontented with canal maintenance as performed by the District maintenance department. Each year after the rainy-season, many canals become silted up severely reducing flow capacities, and water shortages occur along many canals. As the maintenance department seems unable to cope with its task of cleaning these silted canals in time, farmers experience difficulties. During 1987 and 1988, numerous groups of water users took initiatives to solve their problems. Some groups opted to go to the District head engineer to complain and demand cleaning of their canal. Other groups decided instead to clean their canal themselves by hand. Of course, silted canals also existed where farmers were unable to unite, and instead they began to quarrel among themselves over the scarce water.

The remarkable difference in performance between the operation and the maintenance departments of the District causes problems each year concerning the silted canals. These problems give rise to intense interactions: among farmers served by a common canal; between farmers and District functionaries; and between farmers and the canal infrastructure. Since similar problems recur each year, different groups of farmers have developed different ways of coping vis-à-vis silted canals. This in turn has changed the way farmers perceive the canal system, the District, and each other.

There is an example of a small canal where farmers decided to organise a joint work-party or *faena,* and in half a day they had their canal cleaned. Remarkably, the water users of this canal made little reference to the maintenance department of the District when interviewed about the *faena.* They hadn't even considered going to the District to complain. The *faena* was exclusively between farmers and fellow villagers, with no place for the District. This is an important observation: through the *faena* the cultivators have reaffirmed their ultimate ownership of the canal infrastructure. The *faena* for them is an experience which will be remembered and which has changed them.

During the following year, the group of people engaged in the *faena* became involved in other joint initiatives concerning the canal system. The complete rehabilitation of the intake structure of the secondary canal, irrigating some 500 ha, stands out here. On several occasions the farmers had requested the maintenance department to enlarge their water intake, but received only negative responses. Discontent, they decided to do it themselves by collecting money. The water guard was very satisfied, as he could then direct sufficient water to that particular canal more easily.

The canal has gradually become a symbol for the farmers. They refer to it as an example of their successful communal operation, and of the successful 'domestication' of a government property. The *faena* has achieved a lasting effect, not only evident in the new intake structure, but also in the minds of the participating farmers. As one farmer put it:

"We have made up our minds. We, all water users of this canal, are ready to take over, to arrange our affairs ourselves without those engineers in their

offices." He smiles, *"We simply say that is it now our canal, and that we do not allow them to enter".*

Through demolishing the obsolete intake and constructing a new one, farmers have appropriated the canal. Formerly it had been unclear who owned the canals in this government-managed system. Now, after investing labour, organisation and money in the canal, it has become apparent that the farmers own it and the District has lost its control over it (Coward, 1986a, 1986b).

The case of the silted canal shows that social relationships change in response to particular problems which require users to act on physical structures. This is a very practical, down-to-earth process of appropriation, which has implications for planning the management of irrigation systems.

6. WATER MANAGEMENT: IMPLICATIONS FOR IRRIGATION DESIGN

This case study concerns an irrigation system with an on-request water delivery method. This leaves water users relatively free in taking individual farm decisions if the water delivery is efficient. It also implies that the canal system must be complex, all canal structures being adjustable. The degree of freedom left to water users enhances their willingness to concede authority to a specialised agency - the District operation department. Farmers participate little in water distribution, because they do not feel the need to do so. Farmers participate in cleaning the canals, a service they find unreliable, because they have no other option. The emerging farmer practices, however, have far-reaching consequences for the way they perceive the system. Gradually, they appropriate the canal infrastructure, thereby changing the relationship they maintain with fellow farmers, with District officials and with the canals. Pursuing the argument, the social relationships between major groups of actors found in an irrigation system are partially structured by the practical experience the respective groups have in coping with the physical infrastructure. This practical experience builds up social relationships.

The complex irrigation system, with an on-request delivery method, puts a burden on the specialised field staff distributing the water. To achieve their task, the water guards have absorbed physical detail and social characteristics of structures, plots, farmers and superiors. Interaction between people and physical structures is intense in this system. It is not that water guards simply *use* the physical infrastructure: water guards have become part of the structure, and the structures have taken a place in their minds. The practice of the water guard, then, cannot be separated from the physical object he uses to achieve his task. From these examples, it can be concluded that irrigation practice is comprised of a material dimension which impinges upon the social relationships that emerge around irrigation systems.

The irrigation system referred to here respects individual farm decisions, with water distribution being tailored to specific needs of plots, crops and cultivators. This makes the system complex, but not too complex to operate. The canal design has prompted water guards and farmers to observe, interpret, and to develop strategies. These have profoundly influenced the system's management and the social relationships between farmers, functionaries and water guards. The canal design has prompted and enabled water guards and farmers to become actors.

The processes of 'internalisation' of the system's detail by the water guards, and appropriation of the canals by the farmers have made the system work. This suggests that in inefficient irrigation systems, it may not be necessary to change the hardware (canal infrastructure) in order to enhance software (management). The problem may be that the irrigation infrastructure still stands as an alien, unarticulated object in the landscape. When managers start to acknowledge the crucial role and proficiency of field personnel, when responsibilities are re-allocated, and when property relations are defined more precisely, appropriate conditions may be set to stimulate the processes of both 'internalisation' and appropriation.

This conclusion is somewhat premature, being based on only one case study. It may not be valid for other irrigation systems in Mexico, let alone for other countries. It may therefore be worthwhile to study water guard and farmer behaviour in other contexts, to see whether the processes of internalisation and appropriation occur, and if so, how they influence the management of irrigation systems.

Design engineers who suggest that they largely select possible management options (Horst, 1990:12), and that efficiency will be obtained by operation staff blindly following a pre-determined set of technical procedures, appear to be wrong. This paper has attempted to show that, through practice, actors assimilate, understand and re-define the workings of the irrigation system. Consequently, operation of the irrigation system may change and evolve in to something very different from the designer's original vision. Not only does the final design result from a process of social construction, but the physical system also becomes involved in a process of socialisation. Analysing field practice in irrigation systems, as in this study, may thus offer a strategy for identifying ways to ensure that benefits to farmers are greater and more equitable.

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New York
NY 10017
USA

Overseas Development Institute
Regent's College, Inner Circle,
Regent's Park, London NW1 4NS
UK.
Telephone: +44 71 487 7413
Telex: 94082191 ODIUK
Fax: +44 71 487 7590