THE MAN SWIMMING AGAINST THE STREAM KNOWS THE STRENGTH OF IT

HYDRAULICS AND SOCIAL RELATIONS IN AN ARGENTINEAN IRRIGATION SYSTEM

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ABSTRACT

In this paper we discuss hydraulic behavior of irrigation infrastructure within a context of spatially distributed power relations in an Argentinean irrigation system. In the Río Dulce basin the irrigation area known as the Proyecto Río Dulce (PRD, command area 350,000 hectares) is the main irrigated area . An interesting characteristic of the PRD is that the larger landowners are mainly situated in tail end areas. Despite this potentially disadvantageous position, downstream farmers do not encounter problems. This should not be regarded as self-evident: the hydraulic properties of the canals induce a need for downstream farmers to take deliberate action to ensure proper water delivery to their farms. When upstream farmers do not irrigate, too much water can flow downstream; when they irrigate too much, or manipulate cross regulators, downstream water scarcity can be the result; when canals are not maintained, extensive plant growth will increase hydraulic resistance and decrease discharges. It is not a coincidence that the downstream farmers invest heavily in canal maintenance. These investments appear to be appropriate, as larger farmers tend to irrigate much more on average compared to the smaller farmers upstream.

INTRODUCTION

The best known debate on power and irrigation was born from studying the formation of the ancient civilizations. Most of these are located in hydrologically distressed regions, usually arid plains with a single (rain dependent) large river running through them. Within such an agricultural landscape, water is the natural variable par excellence. Irrigation has played a crucial role in cultural development, and in the formation of these states. In the (semi-)arid regions of early civilizations with their large rivers water is not only highly mobile, but also quite bulky. This bulkiness relates to mass organization; as such a large quantity of water is supposed to be channeled and kept within bounds only by the use of mass labor. Although he was certainly not the first to stress the importance of irrigation and water control in societal

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development, Wittfogel was the first to develop a general theory about this importance. A crucial argument of Wittfogel (1957) is that the required mass labor must be coordinated and disciplined: it must subordinate itself to a directing authority. Small-scale irrigation farming involves a high intensity of cultivation on irrigated fields too, but Wittfogel preserves central control for situations when large quantities of water have to be manipulated. Up to today, many scholars studying development of large irrigation works assume, in the spirit of Wittfogel, that these irrigation works always were constructed in one phase, requiring a strong institution (a central state) to supervise and organize such massive work. It is quite likely, however, that larger systems are the result of many smaller scale actions in a longer time period (Ur 2002). Furthermore, “large scale” does not necessarily mean “strong central authority” (Hunt and Hunt 1976; Hunt 1988).

In such processes of many smaller scale actions, irrigation systems are both result of actions and the (material) context of new actions. Developing (and managing) irrigation infrastructure is a social practice; irrigation (infra)structures become concrete through human action in (continuous) use, design and construction. Actions and infrastructure together create spatial and temporal patterns of water flows, which are very likely to provoke new actions on either individual and/or collective level, which are constrained by hydraulic properties, and other factors. We argue that hydraulic infrastructure in irrigation systems can be conceptualized as structures as Giddens defines them: structures are medium and outcome of social practices through everyday actions, in which routines are an important phenomenon (Giddens 1984; 25). Structures like irrigation systems become concrete through human action in (continuous) use, design and construction. Canals and other objects set the material and spatial reality, within which social interaction shapes spatial patterns of water flows and related actions through time. An important issue in irrigation related to water control is the nature of unstable water availability during seasons and over the years. Many rivers have an irregular flow pattern, with large fluctuations in and over seasons and very low flows in the dry season. It is precisely this unpredictability which has been the drive for major changes in the Río Dulce irrigated area in Argentina discussed in this paper.

Our paper shows that large-scale irrigation development in this semi-arid area with its one major river needs to be understood in terms of series of actions by smaller groups of stakeholders within a context of changing positions of central state authority. All this has not resulted in stronger central management; within the process, several groups from state institutions and irrigators competed over water control. It should not be a surprise that, given that in human society control of knowledge, possessions and power is skewed, the outcome of this competition is socially stratified too. In many irrigation systems, as in the Río Dulce area, water is unevenly allocated. Water management roles are actually power roles, which are directly linked to control of production. To control flows of water, or in other words to be(come) powerful, resources need to be enrolled, like canals and division boxes. Social relationships are re(shaped) and changed when agents struggle with and upon artefacts (Van der Zaag 1993). Power is not something hidden, negative or obscure; it is expressed daily in the capacity to achieve outcomes successfully through enrolment of resources (Giddens 1984). Some irrigators have managed to increase their control over irrigation water flows. We will show in this paper that this increase is not something which has to be taken as granted. The hydraulic reality of the irrigation system requires continuous efforts from some irrigators to maintain (let alone increase) their control.

To develop and substantiate our argument further, we will start with discussing the development process of and water use patterns in the Río Dulce irrigation area. These two paragraphs will be followed by a description of the Canal San Martin, our main case study linking hydraulics and power. Then we will explain our modeling approach and present our results. The paper will be closed with a discussion, in which we will elaborate on some considerations for understanding power relations in irrigation.

HISTORY OF THE PROYECTO RÍO DULCE, ARGENTINA

In the Río Dulce basin, Argentina, irrigation is the main water user and consequently providing water for irrigation has been one of the main goals for activities in the basin. The basin is small in relative terms (rough estimation: about 100,000 km^2). The importance of irrigation in the basin makes it an excellent case to discuss (some) possibilities of using historical studies to evaluate and appreciate the meaning of irrigation in a river basin. Within the Río Dulce basin, the irrigation area known as the Proyecto Río Dulce (PRD, irrigable area 122,000 hectares in a command area of around 350,000 hectares) has an immense influence on the catchment water balance in absolute and relative terms. A total of 122,000 hectares has water rights, about 50,000 have been irrigated in the last two decades; about 100,000 hectares are irrigated in recent years. Before 1968, the irrigation infrastructure provided two or three irrigation turns for each farmer in late spring and summer, when the water levels in the Río Dulce were sufficiently high. The building of a reservoir in 1968, the Embalse de Río Hondo, has shaped the potential for irrigation all year round. Discussing the history of the system will show how sizes and directions of water flows have been changing by human interference, and how these have influenced the behavior of the system at different scales.

The province of Santiago del Estero counts 150,000 square kilometers, inhabited by a little over 800,000 people. The climate of the Gran Chaco, of which Santiago del Estero forms the western border, is continental: winters are relatively cold and summers are hot. Annual precipitation, mainly summer rains (November-April) ranges from 500 mm to 850 mm, with winters being almost totally dry. In this dry and remote landscape two rivers are searching their way to the sea. Although small in comparison to Argentina's major river the Río Parana, these two rivers are the vital sources for life in Santiago del Estero. Along these rivers agricultural and pastoral activities have been the foundation for the economy of Santiago. One of them, the Río Salado has succeeded in reaching the Río Parana. The other river, the Río Dulce flows into the salt-lake La Mar Chiquita. In 1577, the Spanish built their first irrigation ditch (*acequia*) in Santiago del Estero. In 1583 this reached a length of 5 kilometers. The Río Dulce repeatedly destroyed the original ditch, until in 1650 a permanent canal was constructed. In 1680 an irrigator's register was established. Many individual landowners dug a ditch until they reached their land. This is part of the explanation why the larger landowners (still) are situated in many tail end areas: they automatically became tail-enders, as their canals ended on their lands. The map of the irrigated area shows that in modern times larger landowners are still situated in the downstream areas (figure 1). In 1873, 73 acequias existed. These canals were not the small ditches one would perhaps expect: most were longer than 10 kilometers, some extending even up to 50 kilometers with a width of 6 meters. Official records indicate that about 8,000 hectares were irrigated by the acequias, but in practice this figure would have been higher (Michaud 1942).

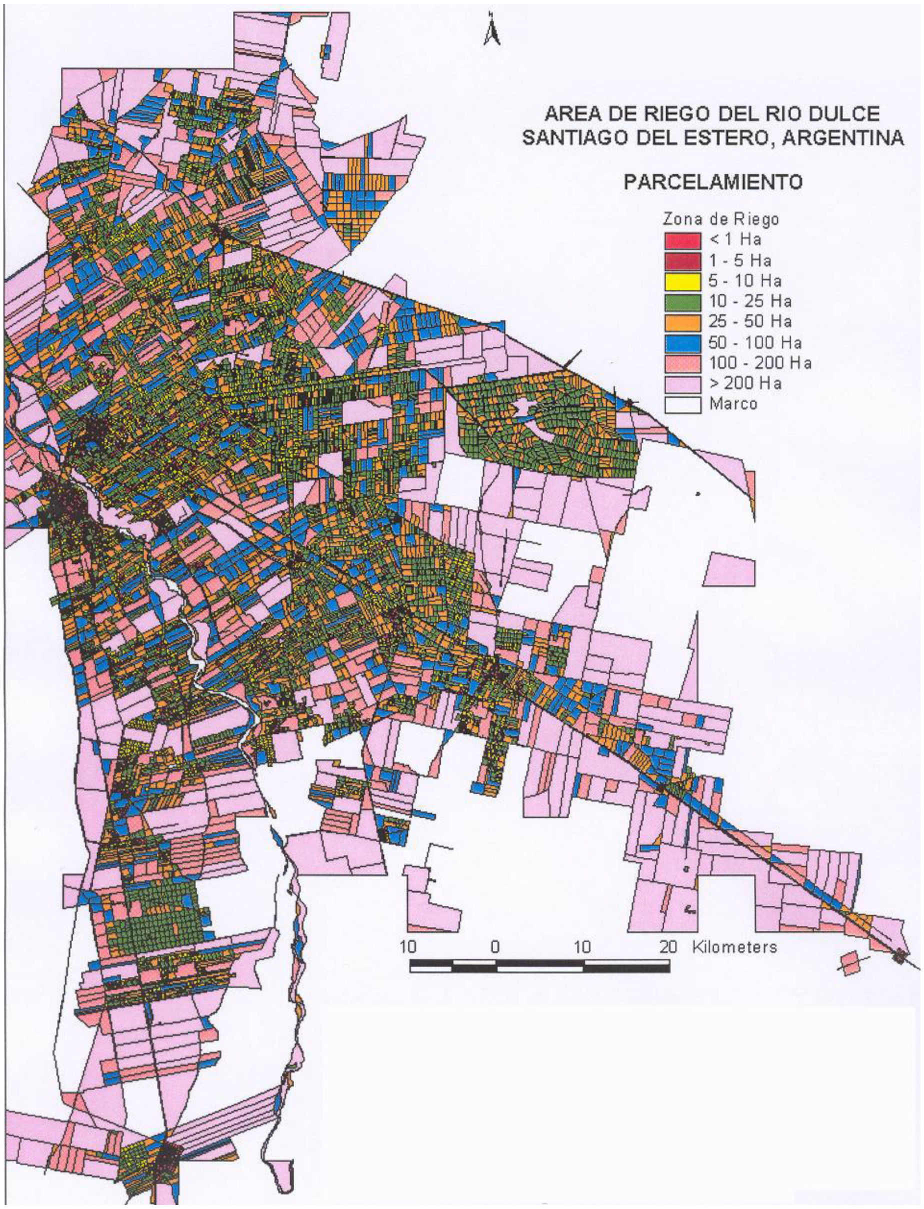

Figure 1. Land distribution in the Río Dulce area

In 1878 canal *La Cuarteada* was built to pass floodwater from the Río Dulce to the Río Salado (Michaud 1942, Achaval 1988). However, instead of diverting excess water, the canal inundated the land around it. Not before long individual agriculturists began to build their acequias from La Cuarteada, thus changing a canal basically built for flood control (drainage) into an irrigation canal. In 1886 an intake structure was constructed for La Cuarteada (Michaud 1942, Achaval 1988). In addition, a program to develop the irrigated area by building more acequias in the command area of La Cuarteada was formulated. The intake structure did not hold long; the Dulce River washed it away. As the agricultural interests in the area had grown, plans were made to build a new structure. The new intake came in use in 1898 (HARZA 1965). Massé (1906) calls this structure the largest intake in Argentina of those days. In 1905 the existing irrigation infrastructure was further extended. From then on, the intake diverted water to a main canal, at the end of which (*La Darsena*) *Canal Norte*, *Canal Sud* and Canal La Cuarteada branched off (Michaud 1942). This was the first public irrigation system in Santiago del Estero. It has become the basis for the existing infrastructure on the left bank of the modern Proyecto Río Dulce. It irrigated about 38,500 hectares; 14,500 hectares were irrigated from private acequias (HARZA 1965). In 1913 a communal canal on the right bank was constructed, *Canal San Martín*, with a length of 64 kilometers (Michaud 1942).

The canal systems on both banks derived water when flow and water level of the river was sufficiently high. The diversion dams in the river (*diques de ramas*) collapsed when discharges were very high. Water derivation could hardly be regulated, since no storage was available. Water was usually (sometimes too) abundantly available in the wet season (December-April), but scarce in the dry period (*estiaje*) (July-October). Farmers had to make use of the start of the rainy season (November/December) to prepare their lands and sow their crops. During the rainy summer, one or two irrigation turns were usually available, but water availability and thus the number of turns changed from year to year. Due to this insecurity of the water supply, farmers never could be completely sure of receiving sufficient water to grow their crops. Alfalfa (grown at about 12,700 hectares) and maize (about 10,000 hectares) were important crops, together with cotton (about 9,000 hectares) (Michaud 1942). Most farms were relatively small: on the left bank, more than 1,000 farms (of a total of nearly 2,000) were between 1 and 5 hectares, where only 9 were more than 100 hectares (Michaud 1942). Around 1923, many European farmers arrived in Santiago, resulting in a sharp increase in the amount of irrigated hectares, with a clear decrease of available water per hectare as a result. According to normal irrigation practice in the area these farmers received water at the end of an irrigation turn. Soon they realized that irrigation water availability was not enough to sustain the needs; farmer representatives approached the Provincial Government and later the National Government to employ works to increase the amount of water (Prieto 2006). In 1947 the federal organization for water affairs *Agua y Energía Eléctrica* (AyEE) began to build a permanent diversion weir in the river, the *Dique Los Quiroga* (Gastaminza 1989, Michaud 1942).

At first, the main canal fed by Los Quiroga, *La Matriz*, only diverted water to the La Cuarteada system. San Martín continued to derive water directly from the river, as did the remaining private acequias. However, these canals downstream of Los Quiroga had difficulties getting water, in particular during periods of low flow. Most of the flow was diverted to the La Cuarteada system on the left bank. Again, assistance from the National Government was looked for. As a solution, the San Martín system was connected to La Matriz through a siphon around 1954 (Prieto 2006). Some private acequias remained in the San Martin area, but they did not take water directly from the river any more; they were connected to the San Martín network. The main reason for the owners of the acequias to agree with this arrangement was that it secured their water delivery. It has not been possible to determine in detail how Los Quiroga has influenced water availability, as data are not available. Although water availability would have increased (as the issues in the San Martín area indicate), it is highly unlikely that the increase has reversed the sharp decrease of water availability in l/s/ha sketched. Given the uneven distribution between left and right banks, it is possible that the left bank did have an increased water availability (the irrigated area increased relatively more in that area), where the right bank canals saw their water availability decrease (Prieto 2006).

Overall water availability was to be improved by a reservoir in northwest Santiago, the *Embalse del Río Hondo*. AyEE presented plans in 1957 and the reservoir was completed in 1968 (Gastaminza 1989). The reservoir has shaped the potential for irrigation all year round. However, its capacity is insufficient to provide more than annual regulation. Consequently, in a year with less than average rainfall, the reservoir cannot fully meet the diversion requirements for the total irrigable area. In 1966 the Proyecto Río Dulce was formulated (Gastaminza 1989). New canals were to be constructed, old canals rehabilitated and the acequia system was to be replaced by a tertiary unit system. Activities could not be extended to all the irrigated areas of the PRD. Two existing areas (parts of the former La Darsena system and the Canal San Martin) and one new area (Colonia Simbolar) can be considered modernized, with the remaining (larger) area virtually unchanged. The three development phases of the relationship between water, engineering and landscape described by Petts (1990), although probably too simple, are illustrative for developments in Santiago del Estero. The first phase, management of perennial water sources for local agriculture and domestic supplies and the opportunistic use of seasonal floods and rains for agriculture, extends until about 1870 in Santiago del Estero. The second phase, involving the management of rivers for waterpower, informal regulation of seasonal floods for irrigation agriculture and drainage of wetlands can be defined between 1870 and 1968, with 1950 being a first step in the direction of the third phase, during which rivers have been regulated by large structures, often as part of a complex basin or inter-basin development, for hydro-electric power generation, water supply and flood control. In the Río Dulce basin, this period extends from 1968 onwards. Data from the PRD show that inflows per hectare are significantly higher in the third period than in the second period (before Los Quiroga was built) (figure 2). For the period when Los Quiroga was in use we have no data.

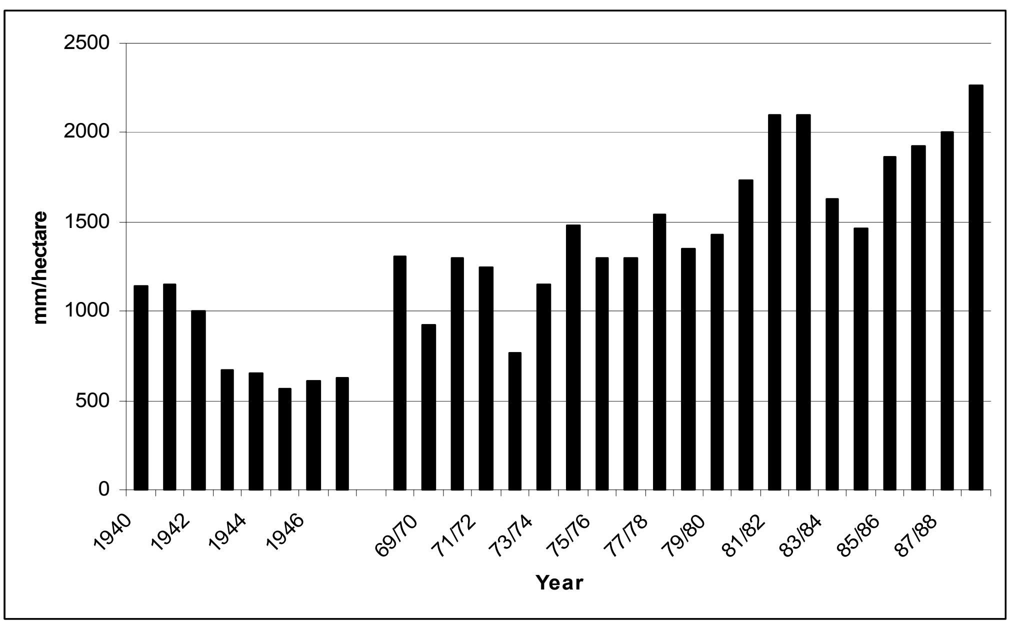

Figure 2. Water use in the PRD (1940 – 1990) (data from Ertsen et al 2004; Prieto et al 1994)

INSTITUTIONS, FARMERS AND WATER MANAGEMENT

To arrange water distribution the Río Dulce irrigated area has known a differentiated pattern of institutional settings for irrigation management throughout its development process. The first irrigation related initiatives were private, in which (groups of) individuals constructed their own canal (sometimes very close parallel to each other). The system of La Darsena, although started with a drainage canal, was an irrigation system, built by federal and managed and controlled by provincial authorities. Further downstream the private acequias were still in use. In 1947 the federal organization for water affairs Agua y Energía Eléctrica (AyEE) was installed (Gastaminza 1989), which had three divisions: construction, water exploitation and energy exploitation. The first division constructed all the works for the other two. One of the first actions of AyEE in Santiago del Estero was the building of a new diversion work, the *Dique Los Quiroga*, connecting La Darsena on the left and San Martin on the other bank and constructing a new main canal, *La Matriz*. In 1964 the *Corporación Río Dulce* (CRD), a working group of the provincial authorities, was established, which should formulate plans in order to stimulate the integrated development of the Río Dulce region (note that the CRD should work in the total catchment of the Dulce river, not just in the Quiroga system). When in 1966 the Proyecto Río Dulce was formulated, the division of work between AyEE and the CRD was that AyEE managed all water affairs (construction, distribution and maintenance) within the PRD and that the CRD was responsible for the socio-economic development of the project.

In 1991 it became clear that because of budget cuts in the federal government Agua y Energía Eléctrica would no longer be responsible (and thus pay) for the PRD management. The irrigation-related tasks of AyEE became the responsibility of the province of Santiago del Estero. The province created the *Unidad Ejecutora del Servicio de Riego del Río Dulce* (UESRRD, in practice UER) (Sosa 1994b, UER). The role of the users in this process was very interesting. Involvement of users in system management was foreseen for the PRD (AyEE 1971, Reglamento 1970), but formal organizations did not exist. General farmer organizations did exist, but these did not interfere in water management as such, as they focused on marketing (especially cotton). This does not mean that producers had no influence on water management. They did, but as individuals. It will not be a surprise that those individuals were the larger farmers[4]. In the situation of unstable co-management between AyEE and the province, which did not secure workable water distribution on the longer term, producer organizations came up. In a relatively short period of time, two new producer organizations were established and two existing ones started to extend their activities to water management. The UER signed agreements with all these organizations. The UER would remain responsible for the main system (Los Quiroga and Matriz), the farmer organizations were responsible for the secondary canal. Resources needed for secondary canal maintenance were given in usufruct to the producers by the UER. The first agreement was signed on the 2d of April 1993 with the *Asociación de Productores Agropecuarios Zona IV*, the farmer organization in the San Martin area, our main case study within the PRD.

[4] No written material is available on this more subtle type of influence, but it sometimes happened that bigger farmers paid for repairing canals when AyEE had no resources available. Once a farmer blocked a canal called Jume Esquina (maximum flow 20 m3/s) and diverted it to his fields. He was fined, but he apparently never paid.

As one of the new farmer organizations, the Asociación of Canal San Martin was specifically established to secure water distribution within the canal area. As in the Río Dulce irrigated area as a whole one of the important features of this canal area is that the larger and most powerful farmers can be found in the tail-end of the area. This sets the scene for potentially interesting interaction between the larger farmers in the downstream and the smaller farmers in the upstream parts of the canal. As Van der Zaag puts it "[t]he social relationships between major groups of actors found in an irrigation system are partly structured by the practical experience the respective groups have of coping with the physical infrastructure." (Van der Zaag 1993; 81). Within the context of institutional change in Santiago del Estero the mechanism of appropriation of the canal is especially important. Van der Zaag discusses a case in Mexico, in which farmers took the initiative to collectively clean their canal and construct a better intake. Through investing labor and money they practically appropriated the canal. This is what happened in the San Martin area too. The larger farmers appropriated the canal when in their view the scheme management was unable to guarantee water delivery and maintenance.

The object of appropriation, the canal itself and its associated structures is probably as interesting itself as its socio-spatial context (see figures 3, 4 and 5). Canal San Martin serves an area of about 19,000 hectares, and is the only secondary canal on the right bank of the Rio Dulce. Water is diverted to the canal from the main canal Matriz through a siphon under the river itself. The official capacity of the canal is set at about 10 m^3/s, in practice 5 to 6 m^3/s are diverted into the canal. The total canal grid in the area amounts to about 152 km. Canal San Martin itself is lined for the first 38 km, its total length is a little over 60 km. Apparently the original design anticipated upon demand based irrigation management, as the off-takes in the canal are AVIO gates. The canal itself seems to miss the storage usually associated with downstream control. Furthermore, the lined part of the canal includes three cross regulators in the shape of sliding gates. Each cross regulator has an emergency overflow side weir directly upstream. In daily practice, the AVIO gates are not used at all. The off-takes are managed through a simple open or closed routine, in line with the general distribution pattern described above, in which farmers are allowed to irrigate once a month. The combination of downstream controlled off-takes, upstream controlled canal regulation and side spills would not support demand management easily. Even more interesting is that this hydraulic layout appears to be a potentially large disadvantage for downstream users. Manipulation of cross regulators could easily result in lower discharges downstream, especially since overflows caused by such manipulations would be spilled out of the canal and thus no longer be available for downstream uses.[5]

MODELING CANAL SAN MARTIN

To study the effects of interventions, management actions and hydraulic constraints posed by the canal we modeled the Canal San Martin. As information about cross sections and slopes were not available for the unlined part of the canal we limited our modeling to the first 38 km. It is known that the unlined canal serves a considerable number of (larger) farmers. Therefore, we did check how much water was available immediately downstream of our modeled section. Length

[5] The overflows spill in the drainage canal roughly parallel to the irrigation canal. In fact, the current drainage canal is the old Canal San Martin (unlined). To what extent drainage flows are usable and used downstream is not clear.

profiles and cross sections of the first 38 km were known, as were detailed measurements of the hydraulic structures at the location of the first cross regulator (side spill, intake for Carloz Lopez canal and cross regulator). Carloz Lopez is a canal delivering water to a sub-system of several tertiary units; therefore it continuously draws water up to 3 m^3/s. Measurements of cross regulators 2 and 3 were not available, but we assumed that these were in proportion to cross regulator 1. Measurements of a typical off-take were available. As the AVIO gates are not used, we modeled the off-takes as simple orifices able to deliver the required discharge as defined by the irrigable area downstream of the off-take. With this model several scenarios were simulated. We focused in particular on the influence of canal maintenance, manipulation of cross regulators and setting off-takes. Maintenance of the canal is very important. Officially the whole system is closed for one month per year to clean and repair canals (usually in May). The San Martin is a particular case. Its canal side slopes are lined with concrete slabs; the canal bed is lined with stone blocks. Water plants can easily grow on the canal bed, which they do abundantly. To remove the plants Canal San Martin is emptied during the irrigation season several times. The fierce sun kills the water plants, which are flushed away the next time the canal is operated again.

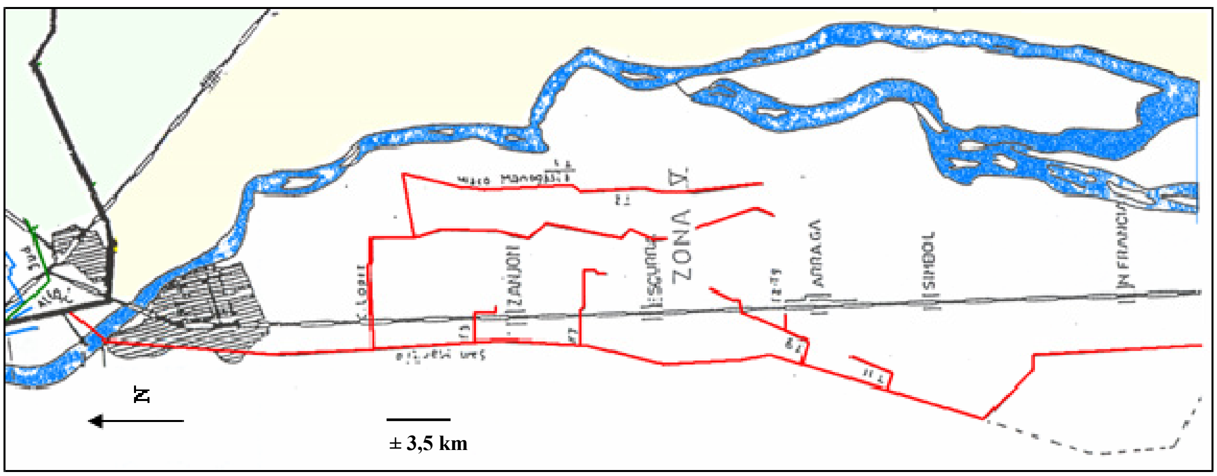

Figure 3. Schematic overview of Canal San Martin

Our first few runs were to estimate 'normal' behavior of the canal. Apparently, the settings of the first side spill are very sensitive. With a water level increase of just a few centimeters above what apparently has been defined as target level, water is spilled in the drainage canal. As we remarked before, the canal seems not to have been designed for storage. We used the Strickler roughness coefficient to tune the canal to the discharges measured in the canal. For a discharge of 5.5 m3/s, which seems to be the normal discharge, the Strickler coefficient would be about 30 $m^{1/3}/s$, which is very low for a lined canal. With a design discharge of around 10 m^3/s, however, obviously the roughness factor would have been higher. The increased roughness caused by vegetation was included in the model by lowering the roughness coefficient to values of 20, 15 and 10 $m^{1/3}/s$, respectively. A lower coefficient obviously results in lower discharges and increased water levels (figure 6). This means that the side spill upstream of the first cross regulator will start to divert water to the drains (0.2 m^3/s, 0.6 m^3/s and 1.5 m^3/s respectively).

These are substantial values, given the target discharge of 5.5 m^3/s.

Figure 4. Impression of the San Martin area from Google Earth

Upper left: San Martin downstream of first cross regulator
Middle left: emergency spill upstream of first cross regulator
Lower left: farm intake from field canal to field

Upper right: first cross regulator
Middle right: tertiary canal
Lower right: typical farm

Figure 5. Images of the Canal San Martin

The water discharged over the side spill only influences availability downstream of this location. Canal maintenance is thus vital for downstream farmers to secure water delivery to their farms. Another way to influence the downstream flow is to manipulate the cross regulators. When the sliding gates of the cross regulators are lowered, downstream discharges (obviously) decrease.

With the sliding gates set at openings of 0.1 m, only 1.5 m^3/s flows through the gates to the downstream users. At the first cross regulator all the excess water is discharged into the drain. Assuming that water users would only manipulate structures in irrigation systems to increase the flow to their own units or fields, we wanted to know if that would be successful. The results show that if upstream users would take their water simultaneously, the exact setting of the cross regulators does not influence downstream flows that much anymore. Furthermore side spill discharges decrease. The simulations clearly show the key role of the configuration at the site of first cross regulator. Basically, the users of the Carloz Lopez canal, which draws considerable volumes from the incoming discharge, could determine water availability for their (larger) colleagues downstream. It is current practice that smaller farmers irrigate their cotton or alfalfa on average three to four times per year and use about two and a half times more water per turn than allowed (240 mm/event). Before the reservoir two or three irrigation turns were available for each farmer in late spring and summer, when water levels in the Río Dulce were sufficiently high. Irrigators were used to handle such larger flows on their relatively large fields (Romanella 1971). Apparently, smaller farmers reproduce the distribution schedule of the unregulated period[6]. Thus, improved water security and control has apparently not changed the water use practices of these farmers much. The larger farmers, with more diversified cropping patterns, do take advantage of the new potential made possible by the reservoir. They combine the irrigation strategy of the smaller farmers (irrigating crops a few times), but take water during 6 to 8 turns because they irrigate only a fraction of the area available to them each turn. They sometimes irrigate a larger area than officially allowed (Prieto 2006). Therefore, it can be concluded that these larger farmers are able to arrange irrigation matters in their favor despite their potentially disadvantaged position in the tail of a canal with a hydraulic behavior favoring upstream users.

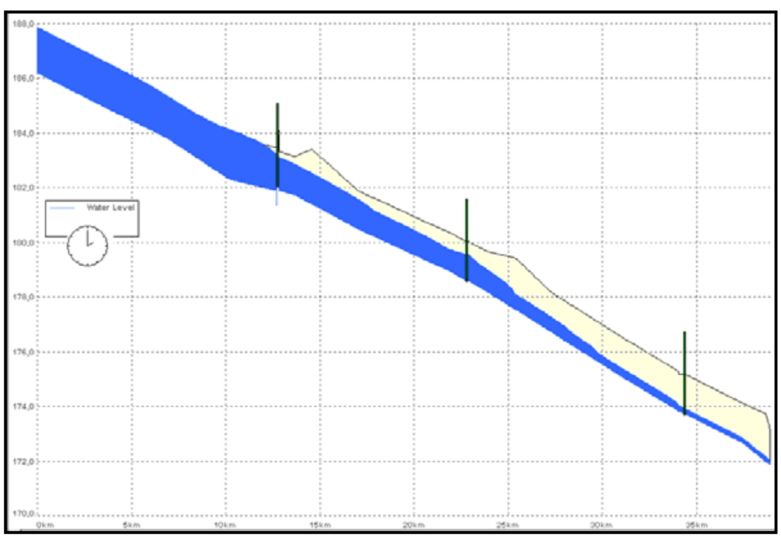

Figure 6. Typical output graph: side view of case with increased roughness in upstream canal stretch. The resulting increase in water levels cause higher side spill discharges and thus a lower flow into the downstream canal stretches

[6] Two main differences may be noticed: the stronger regulation of the available flows allows better-secured starting conditions for the crops and a better regulated growing season; however, the crops grown nowadays respond less well to this distribution than the types grown before.

CONCLUDING REMARKS

In this paper we tried to discuss the relation between social economic context, power relations and irrigation infrastructure. We start from the idea that irrigation systems are assembled from elements into a physical object with a certain form, which orders the space encompassed by these elements into a pattern. Irrigation systems are therefore transformations of space through objects. We argued that the ordering of space in irrigation systems is really about the ordering of relations between people (Hillier and Hanson 1984). Spatial structures like irrigation systems are the material form of social structures and relations. Such a social production of space is socially reproduced in daily actions. We have stressed the structuring role of hydraulic infrastructure in irrigation related power relations. Obviously, we do not want to argue that hydraulics determine the social. We do think, however, that the physical shape of irrigation, including spatial positions of farmers, canal layout and control structures, does matter when trying to understand social relations within irrigation systems.

Our tentative modeling results confirm that the hydraulic design and behavior of Canal San Martin is generally disadvantageous for downstream users. Although the design suggests that demand based management has been one of the considerations, the canal system as a whole cannot materialize this consideration appropriately. That downstream users do make more extensive use of the modernized infrastructure than their upstream smaller colleagues is not strange itself. At the same time, we should not take such a confirmation of what would be expected from social point of view for granted that easily. Powerful as they are, downstream users still need to continuously re-establish their control over the system. These users need to make efforts to maintain their power, for example in the political arena (as in the early 1990's) or within their own canal system (through maintenance). At the same time, these continuous efforts confirm the existing power relations already expressed in land ownership and political influence.

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