Informing irrigation districts development in Nicaragua: challenges from a social capital and collective action perspective

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1. Introduction

The Dublin Statement (1992) on Water and Sustainable Development put forward four guiding principles for an integrated water resources management. Based on grounds of increased efficiency, equity and democratization, the second principle establishes that "Water development and management should be based on a participatory approach, involving users, planners and policy-makers at all levels". Therein, it is often suggested that small-scale, local common-pool resources are best managed at the community-level as resource users, compared to bureaucrats, have better information and incentives for managing these resources more efficiently (Araral, 2009). This argument involves very often a certain degree of collective action. In this respect, a large body of literature on natural resources management has been devoted to identify the factors that influence collective action in the commons, the conditions under which cooperation is maintained and how social-ecological systems deal with disturbances (Anderies *et al.*, 2004).

This study examines the case of Nicaragua, where the new water law, enacted in September 2007, represents the first attempt for putting into practice the principles of integrated water resources management. As in many other countries, in Nicaragua agriculture is the major water consumer, in this line, the new Water Law introduces the concept of irrigation districts and defines them as the territorial area around which farmers might be organized for better water, land and infrastructure management. However, establishing formal irrigation institutions is not a straightforward task in countries with little collaborative experience in the rural areas. Whether or not this process occurs smoothly is closely linked to the structure of incentives that farmers perceive. These incentives might not only be related to economic and environmental factors, but also to the social organization. In this sense, the notion of social capital is often considered, together with the role of certain key agents, as an enabler of collective action (Coleman, 1990; Putnam, 1995; Pretty and Ward, 2001; Krishna, 2004; Meinzen-Dick *et al.*, 2004).

Putnam (1995) refers to social capital as the "features of social organizations such as networks, norms, and social trust that facilitate coordination and cooperation for mutual benefit". Pretty and Ward (2001) identify four key aspects related to social capital: trust, reciprocity and exchanges, common rules, norms and sanctions and connectedness, networks and groups. These four aspects are often inter-connected. Thus, as found by Krishna (2004), responses related to group membership, trust, solidarity and reciprocity are highly correlated. In addition, as acknowledged in Pretty (2003), higher social capital is very often related to higher levels of economic and social well-being. Grootaert and Narayan (2004), in their study in Bolivia, recognize the contribution of local social capital to household welfare, in particular, for the poor.

Collective action can be conceptualized in different ways, but according to Meinzen-Dick *et al.* (2004) most definitions agree on four common aspects. Thus, collective action implies the involvement of a *group of people* with a *common interest* in carrying out a *common* and *voluntary action*. In our study, we limit the definition of collective action to

the study of collective irrigation systems, which in this case refer to irrigation based on common canals and/or wells.

In this paper, we make use of both concepts of collective action and social capital to examine whether a new institutional approach, as reflected in the 2007 Nicaraguan water law, could be implemented given the specific socioeconomic, environmental and institutional features of the region. Based on a survey implemented in 8 communities in the Upper Rio Viejo Sub-basin (North Nicaragua) and including a total sample of 98 household heads, the research focuses specifically on collective action for irrigation purposes and explores its link to both structural and cognitive social capital. The analysis of these experiences may provide interesting insights for the development and formalization of irrigation groups as defined in the new Water Law.

2. Methods

2.1. Measuring social capital and irrigation management

In order to understand the relations between irrigation management and social capital we have used a mixed-method research approach, which involves the collection of both qualitative and quantitative data, providing a richer pool of data for the analysis. Thereby, the use of both qualitative and quantitative methods can reduce the disadvantages of certain methods and enhance the quality of the research by providing complementary information and insights (Teddlie and Tashakkori, 2003).

Focus groups and a survey on social capital and agricultural production were administered in the Upper Rio Viejo Sub-basin (see Figure 1), which is located in the Jinotega department in Nicaragua. According to the Community Level Human Development Report (HDRN, 2002), Jinotega ranks 16th out of 17 departments. The Upper Rio Viejo sub-basin includes six major municipalities, covering 360 km². Our study focuses in two of them where irrigated horticultural production is mostly located. The region is located along the Central America drought corridor. Thus, in this region rainfall levels are usually under 1200 mm annually with marked seasonal variability (INETER 2010).

Five focus groups were gathered in the Upper Rio Viejo Sub-basin in April 2010 with the objective of collecting information on: (i) the problems related to agricultural production that farmers face (ii) their knowledge about the new Water Law and its effects, (iii) how they perceive public organizations; and (iv) whether there is any potential for organizing in irrigation districts, as defined in the 2007 Water Law. Participants were selected from the sub-basin based on the information provided by key informants, mostly community leaders and representatives from credit and savings cooperatives.

Focus groups provided key information for survey design, which was based on the 2005 Nicaragua Living Standards Measurement Study Survey (LSMS), on the World Bank Social Capital Accounting Tool (SOCAT) and on a comprehensive literature review (Krishna and Uphoff, 1999; Grotaert and Narayan, 2004; Krishna, 2004 and Meinzen-

Dick *et al.*, 2002). Sample selection included all participants in the focus groups plus all other individuals located along the sub-basin and who irrigate crops. The total sample included 98 household heads.

Figure 1. Map of Nicaragua River Basins

Source: INETER (2009)

The survey included 64 questions and was divided into three parts. The first part gathers general household information. The second part focuses on the agricultural production features and includes specific questions related to irrigated production, irrigation system and organization, land tenure system, commercialization and the major problems affecting production. The third part is devoted to social capital, distinguishing between structural and cognitive social capital. Relevant variables included in this part are related to the characteristics and density of organizations, networks, previous collective action, solidarity, trust and cooperation and conflict resolution mechanisms.

Group participation is considered at the household level by estimating a participation intensity index, in terms of participation per capita, in each group. In addition, major features of group members are addressed in the survey, including whether group members belonged to the same community, family or political party. Another aspect taken into account is how decisions are taken within the group on a scale from top-down decisions to group consensus. With respect to networks, two issues are considered. On the one hand, how people would act when a pest infests all crops in the community. On the other hand, who would take the role of the leader and what are the major leader attributes. Since past collective experience might be linked to future collective action expectations and performance, this study takes into account how often community members have come together to apply for community development projects to the government and to political leaders, and whether they have been successful.

In relation to cognitive social capital, most attention is given to measuring solidarity, trust, cooperation and conflict resolution at the community level. Thus, solidarity is considered in terms of monetary support in case of a large and unexpected economic loss. In addition, we measured trust in people both in monetary terms, i.e. for lending to and

borrowing money from people from the same community, and in personal responsibilities, i.e. for managing their properties in case they have to leave the community for a while. In this way, both bonding and bridging trust are considered. Linking trust is taken into account indirectly in the measure of previous collective action, as well as in the focus groups questions. Conflict resolution mechanisms are explored at two levels, depending on the conflict intensity and procedures.

2.2. Hypotheses

This study attempts to assess the formalization process of the irrigation sector in Nicaragua by analyzing the link between agriculture, social and institutional organization. Figure 2 summarizes the conceptual framework of this study that posits a number of testable hypotheses.

Figure 2. Conceptual framework for analyzing the link between agriculture, social and institutional organization
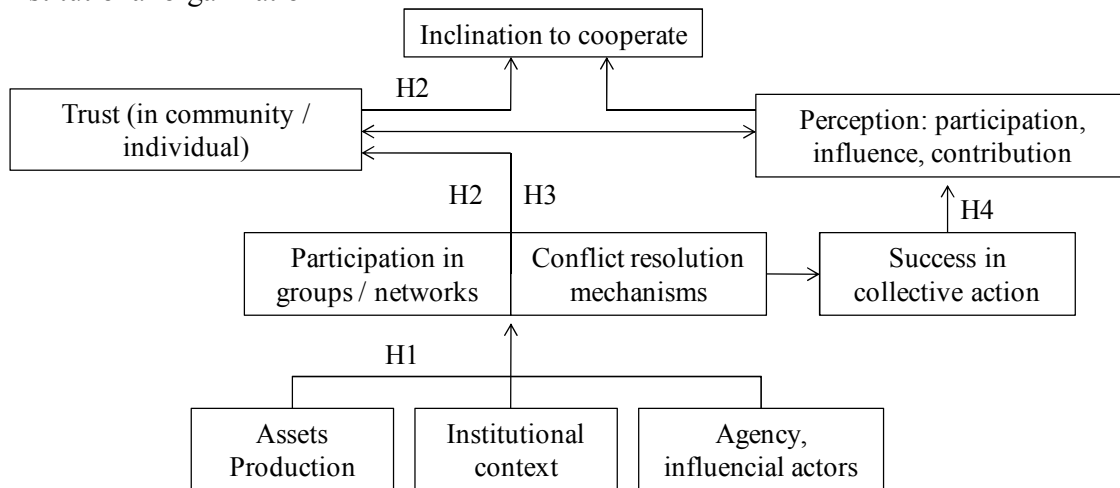
Note: H1, H2, H3 and H4 refer to hypotheses 1, 2, 3 and 4, respectively
Source: Own elaboration

These hypotheses are:

1. Household's capital, measured in terms of total land and land per capita, increases incentives for participation in collective entities such as cooperatives. The reasoning would suggest that, as households' stakes are higher, there is more interest in entering into formal arrangements. One would expect little capacity or willingness to cooperate in households with little per capita assets, because there is little to be gained from such social investment to the extent there would be little financial leverage in the household's economy. But one would also expect that households' owning large assets would gain little from cooperation, because individualistic strategies would pay-off better than complex collective endeavors.

2. Trust and inclination to cooperate grows with past experience sharing irrigation systems. This hypothesis does not need much elaboration: those households' with positive collaborative experience would exhibit more willingness to collaborate, because they have had the chance to experiment with actual collaboration schemes.

3. Institutions in place for conflict resolution very often depend on the type and intensity of conflict addressed, but these conflicts are more likely to be solved within the community without external interference in cases in which community-based collective entities operate within a common framework. This hypothesis is based on previous studies which show that the norms of cooperation and collective actions are positively associated with the perceived democratic functioning level of groups (Bodin and Crona, 2008; Adhikari and Goldey, 2010).

4. Past collective experience increases individuals' willingness to participate in collective entities. Therefore, successful collective experience is expected to be positively related to both valuation of participation and contribution to the community.

2.3. Estimation models

In order to test some of the previous hypotheses, the following model to estimate the likelihood of cooperating in the six major communities included in the study is posed:

$$P(LS = 1|x) = \alpha + \beta_1 IS + \beta_2 SIR + \beta_3 SIRPC + \beta_4 VP + \varepsilon \qquad [1]$$

LS is a binomial variable that denotes the preference to own 7 ha individually or 18 ha jointly. It measures the likelihood of land sharing depending on the previous experience sharing an irrigation system, as defined by the dummy variable *IS* which takes value 1 when the individual has had previous experience and 0 otherwise, the total irrigated land owned by each household, as denoted by *SIR* and measured in hectares, the total irrigated land per capita, measured in hectares per household member and indicated in *SIRPC*, and the valuation of participation within the community, measured on a scale from 1 (very low valuation) to 5 (very high valuation) in variable *VP*.

A second model includes controls for six communities, C_k. There are a total of 6 dummy community variables in this model. Once major geographical differences are controlled by coefficients δ_k, model 2 allows for testing the hypothesis of whether having previous collective experience and higher valuation of participation and household assets determines a higher preference for cooperative solutions regarding production systems.

$$P(LS = 1|x) = \alpha + \beta_1 IS + \beta_2 SIR + \beta_3 SIRPC + \beta_4 VP + \sum_{k=1}^{6} \delta_k C_k + \varepsilon \qquad [2]$$

A logistic regression analysis is used to modeling the probability of choosing either an individual or shared land property alternative.

3. Empirical findings

3.1. Testing hypothesis about social capital and collective action

The following section is a summary of the main results obtained at household and aggregated levels for the area of study in Nicaragua. Our data generation process allows for testing the hypothesis 1 that households' capital stimulates participation in collective entities as credit and savings cooperatives. In this case, capital is defined in terms of total agricultural land and per capita is defined as the ratio between total and per capita (by household member) agricultural land. Intensity of household participation considers the degree of participation in cooperatives, defined on a scale ranging from a leader to a non-active member position. The results, summarized in Table 1, show that the relation between participation and household assets is only relevant when considering irrigated land, both in total and per capita terms.

Our results suggest that in order to engage in collective entities, such as cooperatives, in which economic gains represent the major incentive to participate, a certain level of assets is required. However, merely irrigating or sharing an irrigation system is not related to participation in credit and saving cooperatives, since investments in irrigated agriculture are mostly based on individual decisions and contribution to the collective irrigation system is basically in the form of labor supply.

Table 1. Relation between households' capital and participation in credit and savings cooperatives

Intensity household participation in cooperatives	Total land		Land per household member	
	Ha	Irrig. ha	Ha/cap	Irrig. ha/cap
None	6.61	1.65	1.21	0.30
Low	10.91	1.93	1.84	0.29
Moderate	12.48	2.61	3.05	0.61
High	9.61	2.86	2.60	1.03

Source: Own elaboration

Regarding our hypothesis 2 on trust and willingness to cooperate, the results confirm that trust and inclination to cooperate grow with past experience sharing irrigation systems. Trust is measured as the perception of confidence in the community for borrowing and lending money to community peers. It represents a personal assessment of what would be expected at community level in a situation of money need. Table 2 shows that those who share an irrigation system also place a higher trust in the community, but causality cannot be established.

The study also looks at the relation between sharing an irrigation system and inclination to cooperate. In line with Krishna (2004), this is tested by asking which alternative he/she would prefer between owning 7 ha individually or sharing 18 ha with a friend from the same community. Noteworthy, 7 ha alternative is equal to the average land plot size in the area of study. The results, presented in Table 3, show that 80% of the sample would

choose the first alternative and give up having access to more land under a shared production system. Nevertheless, considering those who would have chosen the alternative "owning 18 ha jointly", higher frequency is found among those who also share an irrigation system. This suggests that preferring cooperative solutions is more likely when individuals have had previous collective experiences.

Table 2. Relation between sharing an irrigation system and trust

Shares an irrigation system	Trust valuation in the community (% responses)		
	Don't trust	Trust	Total
Yes	24	31	55
No	33	12	45
Total	57	43	100

Pearson chi^2 = 7.9 P = 0.005
Source: Own elaboration

Table 3. Relation between sharing an irrigation system and inclination to cooperate

Shares an irrigation system	Preference to own (% responses)		
	7 ha individually	18 ha jointly	Total
Yes	40	15	55
No	40	5	45
Total	80	20	100

Pearson chi^2 = 4.02 P = 0.045
Source: Own elaboration

Regarding our hypothesis 3 on conflict resolution mechanism, we examine conflicts related to water for irrigation and water for drinking. Conflict resolution scales have been assessed by distinguishing to whom they would turn in first and second instance for resolving disputes related to water and river resources.

As reported in Table 4, mean comparison test shows that for conflicts related to irrigation water first and second place dispute resolution mechanisms differ. While in first instance, people would solve conflicts at the community level or turn to local judicial facilitator, in second place most respondents would turn to higher public organizations, as the Ministry of Environment.

Table 4. Mean comparison test for irrigation water conflict resolution mechanisms

Variable	N	Mean	Std. Dev.	SE
Irrigation conflict 1	98	5.64	3.97	0.40
Irrigation conflict 2	98	5.91	3.98	0.40

T-Test mean(diff) = mean (irrigation conflict 1 – irrigation conflict 2) = 0: T= -1.65
H1: mean(diff) <0 P= 0.05 ; H1: mean(diff)$\neq$ 0 P= 0.10; H1: mean(diff)>0 P=0.95

Note: Irrigation conflict 1 and 2 refer to first and second instance resolution mechanisms for conflicts related to water for irrigation.
Source: Own elaboration

In the case of conflicts related to drinking water, test results for first and second conflict resolution scales are nearly identical, as shown in Table 5. In this sense, it is worth noting that drinking water supply in rural communities is in most cases provided by local water committees formed by community inhabitants. The fact that water committees agree on common rules and functioning mechanisms might explain these results and confirm our hypothesis.

Table 5. Mean comparison test for drinking water conflict resolution mechanisms

Variable	N	Mean	Std. Dev.	SE
Drinking conflict 1	98	9.94	4.09	0.41
Drinking conflict 2	98	9.89	4.09	0.41
T-Test mean(diff) = mean (irrigation conflict 1 – irrigation conflict 2) = 0: T= 1.00				
H1: mean(diff) <0 P= 0.84 ; H1: mean(diff)$\neq$ 0 P= 0.32; H1: mean(diff)>0 P=0.16				

Note: Irrigation conflict 1 and 2 refer to first and second instance resolution mechanisms for drinking water conflicts.
Source: Own elaboration

Results reported in Table 6 confirm our hypothesis 4 that the relation between success of previous collective action and valuation of both participation and contribution to the community is significant. So, community engagement and contribution either with time or money are relevant factors for collective action success. Ultimately, both factors seem to be related to the sense of action ownership by the community members. In this sense, it should be noted that collective experiences refer to community development projects requested by community members collectively.

Table 6. Relation between success of previous collective action and both valuation of participation and contribution to the community (% responses)

Success previous collective action	Valuation of participation in community					Contribution to community (time and/or money)	
	Very low	Low	Medium	High	Very high	None	Some
Yes	0	4	15	18	3	48	38
No	1	20	23	16	0	12	2
Total	1	24	38	34	3	60	40
	Pearson chi^2 = 12.45 P =0.014					Pearson chi^2 =4.44 P=0.035	

Source: Own elaboration

3.2. What factors influence the likelihood of cooperation?

The question of whether some communities are more willingness to cooperate and to which extent issues as participation, assets and previous collective experience affect cooperation is tested using a logit regression analysis based on the data for six out of eight communities obtained from the survey developed for this study.

Table 7 summarizes the main results from the model 1 described above in equation 1. As hypothesized earlier, coefficient β_1 is significant and positive which indicates that individuals with previous collective irrigation experiences are more willing to choose the alternative "owning 18ha jointly" instead of "owning 7ha individually". Our model also hypothesized that irrigated land, both in total and per capita terms, can have an impact on the probability of cooperation. However, while total land is positive and per capita negative, both are not significant in the model. In line with previous results, valuation of participation in the community is a positive and significant variable.

As we control for communities in model 2, the results show that geographical controls are very significant. This implies that community characteristics are also powerful explanatory factors of the cooperative behavior of individuals. In addition, in this case total irrigated land becomes significant. This indicates that higher irrigated land endowment increases the probability of preferring a cooperative option, which, in turn might be linked to individual risk perception and participation in cooperatives, as shown in Table 1. So one can conclude that, despite community conditions play an important role in explaining the probability of cooperating, previous collective experience and total irrigation assets endowment are identified as important factors to take into account independently of site-specific settings. Thus, findings reported in Table 7 confirm our previous hypothesis discussed earlier.

Table 7. Results from logit model 1 and 2 for analyzing the probability of electing "owning 18 ha jointly" or "owning 7 ha individually"

	Model 1		Model 2	
	Coef.	Std.Err.	Coef.	Std.Er.
Irrigation sharing (β_1)	1.265*	0.692	1.334*	0.809
Irrigated land (β_2)	0.554	0.389	0.999**	0.509
Irrigated land per capita (β_3)	-0.545	1.034	-1.605	1.351
Valuation participation (β_4)	1.585**	0.503	2.056***	0.623
Namanji (δ_1)	-	-	-3.039*	1.660
Sacacli (δ_2)	-	-	-2.818*	1.694
Santa Rosa (δ_3)	-	-	-5.246**	2.491
S. Coyolito (δ_4)	-	-	-2.981*	1.740
Valerio (δ_5)	-	-	-1.587	1.670
Constant (α)	-8.329***	2.050	-7.824***	2.366
Number of observations	87		87	
$p<0.10$*, $p<0.05$**, $p<0.001$***				
	R^2=0.261 Correctly classified=81.61%		R^2=0.351 Correctly classified=86.21 %	

Source: Own elaboration

4. Conclusions and implications

This paper looks at the incentives of farms for participating in collective irrigation entities. It asks what factors may be more favorable for creating irrigation districts in

Nicaragua. The context in which the study has been carried out involves a hilly landscape with strong seasonal hydrological and rainfall regimes, and groups of small and large farmers, with little or none irrigation infrastructure. The research attempts to provide clues about the communities and individuals more prepared to participate in irrigation districts, which the Nicaraguan Water Law wishes to create in the rural areas.

Our results suggest that households with some capital see benefits in participating in collective entities in which economic gains represent the major incentive. In this line, as establishing irrigation districts will require a common investment farmers must be convinced that by participating they can become more productive by having access to inputs that otherwise would not acquire.

Subjective perceptions of the community and of peers' trustworthiness are also found to be relevant. Trust to borrow from or lend money to community members seems to be larger for those farmers with some experience in sharing irrigation systems. In addition, successful collective experience is positively correlated with higher valuation of participation and contribution (with time and/or money) to the community. The analysis of conflict resolution mechanisms shows that in those cases in which a more clearly defined framework exists for managing resources at community-level, disputes resolution takes place at and within the community. This supports the idea that transfer of resources management to the community requires a minimum institutional set up for putting in place both common and accountability procedures.

Results from the logistic regressions suggest that, as we control for geographical differences, having had collective irrigation experience and larger irrigated land assets increases the probability of electing the alternative of collective ownership instead of the individual option. In line with Meinzen-Dick *et al.* 2004, our findings suggest that examining questions related to the community background, in particularly past experiences with collective action, might be useful before implementing programs with the objective of organizing irrigation into formal districts.

In sum, it is not easy to get irrigation districts off the ground in Nicaragua. For this reason, targeted communities should be carefully selected, based on the previous experience of individuals, observed communal life, and sociological factors. More research about the way communities manage their affairs would certainly add valuable information.

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