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Water Governance Framework in Sta. Cruz River Watershed, Laguna, Philippines

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ABSTRACT

Since food security relies on sustainable water supply, this study developed an irrigation water governance framework in order to achieve an effective water irrigation supply. It was conducted in Pila and Sta. Cruz, Laguna with 176 members of the 26 Irrigation Associations. Spearman Rho correlation was used to analyzed the relationship between water governance variables and availability of water. Hindering factors include insufficient water supply during the dry season, deforestation and quarrying, and the limited funds for rehabilitation of the irrigation canals. Majority of the respondents positively declared that their rice production is enough for their household consumption. However, they occasionally experience rice shortage due to strong typhoon and dam was damage by strong typhoon but there is still food security at the household level since rice is available in the market.There is a positive strong linear association between management of water resources and regulation of irrigation water and availability of water. Regulation of irrigation water and the availability of irrigation water were found to have a strong linear relationship. The IA is at the core of the water governance model since ownership of the irrigation system was already transferred by the NIA to the IA. With these, the study recommended that the political, social, and economic aspects, and administrative systems should be taken into consideration. However, various institutions play a vital role for the IA to address the different factors. Through this, good water governance can be achieved resulting to water security thereby achieving rice security.

Key words: *water governance model, food security*

INTRODUCTION

Agriculture is the sector with by far the largest water withdrawal and consumptive water use (*Podimata and Yannopoulos 2015*). According to the *Food and Agriculture Organization* (*2011*), it is the sector responsible for approximately 70% of water withdrawals and 90% of the water consumption in the world. In Africa and Asia, agriculture remains as the largest consumer of water (*Rebelo et al. 2014*). This account of water abstraction for satisfying agricultural needs goes up to 95% in developing countries (*Podimata and Yannopoulos 2015*).

In agrarian Southeast Asia, irrigation is always presented as the cornerstone of social and economic development (*Chea et al. 2011*). It plays an essential role in economic development and poverty reduction in the region (*Rebelo et al. 2014*). However, there are many problems associated with irrigation. These include mismanagement or poor irrigation practices (*Walters and Groninger 2014*) and overuse of water in the upstream which leads to drought in downstream areas (*Thomas and Ramzi 2011*). Overgrazing and the poor condition of rangelands also affects irrigation as it reduce upper-watershed buffering capacity, thereby, further contributing to growing-season water shortages in the downstream crop-production areas (*Walters et al. 2012*). In the Philippines, massive degradation of the watersheds and river basins is also likely to result to water scarcity in the irrigation. Furthermore, the mismanagement of the country's forest resources over the last 50 years has already resulted in a cumulative loss of more than 97% of the country's original forest cover which affects water supply (*SEPO 2011*).

At the present level of socio-economic growth, agricultural development is seen as the most effective way to ensure food security. Therefore, improving agriculture serves as a key component for food security in most of the developing countries (*Hussain et al. 2004*). Since the country's major water users is the agricultural sector (*PEM 2004*), the effective way to achieve agricultural development is through water governance.

Water governance was defined by the Global Water Partnership as the “range of political, social, economic and administrative systems that are in place to develop and manage water resources, and the delivery of water services, at different levels of society (*Rogers and Hall 2003*)”. Water governance in the Philippines has become complex with the involvement of many institutions (*SEPO 2011*). With the complexity of water governance in the country’s agriculture sector, there is a need for immediate attention through research and development to ensure food security in the country (*Tortajada 2010*). The concept of food security emerged during the United Nations Food and Agriculture Organization (UN FAO) World Food Conference in 1974. It refers to access by ‘all people at all times to enough food for an active, healthy life’ (*Saad 1999*).

Literatures show that there is a paucity of studies done on water governance in relation to food security (*Pahl-Wostl et al. 2012; Bakker and Cook 2011; Araral and Wang 2014*). Hence, it is imperative to conduct studies along this line since the Asian Development Bank (2016) stressed that in 2016, the water crisis was considered as the most impactful risk over the next 10 years, reinforcing water security as an urgent political matter.

In the Philippines, *Webber and Le-Huu* (*2003*) reported that the availability of water supply per capita is decreasing. This scenario is attributed to a number of factors– two of which is the increased need for water because of economic growth and second, the degradation of watersheds in the country. In a *JICA* (*1998*) study, results showed that by 2025, water supply in Luzon region coming from freshwater sources such as river basins will experience shortages. This information only shows that the state of water in the country pose risks on supply and should be given due attention.

Rice production which is mainly dependent on water will be highly affected. For example, in Sta. Cruz, Laguna, the Santa Cruz River which provides water source for about 2,185 ha of rice fields in five municipalities in Laguna would face serious threats (*LLDA 2011*). The looming situation of water resources in the country and the water deficit that will happen particularly in Laguna needs an urgent reform in water governance. This pressing issue may be economic in nature but can also be related to leadership capabilities (*Tortajada 2010*) that imply urgent need for a research study associating water governance to food security.

*Birongo and L*e (*2005*) stressed that there is no single model of effective water governance. This is also confirmed by *Rogers and Hall* (*2003*). Similar to this is the fact that discussions on good governance of water received less attention (*Tortajada 2010*). Thus, in order for water governance to be not only effective but sustainable requires the present of systems that fit the political, social, economic and cultural particularities of each country. The challenges confronting water governance requires a holistic approach of determining the different factors affecting its achievement.

Hence, in consideration of the requisites needed, this undertaking identified the hindering factors in the sustainability of irrigation water and determined the relationship between the different factors in water governance and availability of water in order to develop a water governance framework for the Sta. Cruz River Watershed. Through this research, the concerns of water scholars and policy makers would be addressed regarding the need for a new generation of research on water governance model since most of the studies conducted are descriptive in nature.

MATERIALS AND METHODS

The study was conducted in 2016 in Sta. Cruz River Watershed particularly in the municipalities of Sta. Cruz and Pila (**Figure 1**). Pila is politically subdivided into 17 barangays. Eleven of these barangays are the residences of the farmer-respondents in this study. Among the 26 barangays in Sta. Cruz, the study covered 11 barangays where the respondents live (*Municipal Profile 2010*).

The area was the appropriate site to study irrigation water governance and rice productivity since Sta. Cruz River Watershed had the highest number of irrigator’s association with various classifications, namely, upstream, midstream, and downstream. Specifically, there was a total of 26 Irrigators’ Association (IA) in the area where 19 are from Sta. Cruz, and seven from Pila (**Table 1**). There was a representative sample population from both municipalities of which the upstream, midstream, and downstream communities served as strata. Slovin’s formula was used to obtain the appropriate sample population from each municipality at 10% margin of error. After determining the sample size from each municipality, stratified sampling was done among all the IAs.

The respondents of the study were all irrigated rice farmers who were members of the different IAs in Sta. Cruz and Pila, Laguna. Respondents were randomly selected to have representative from different IAs.

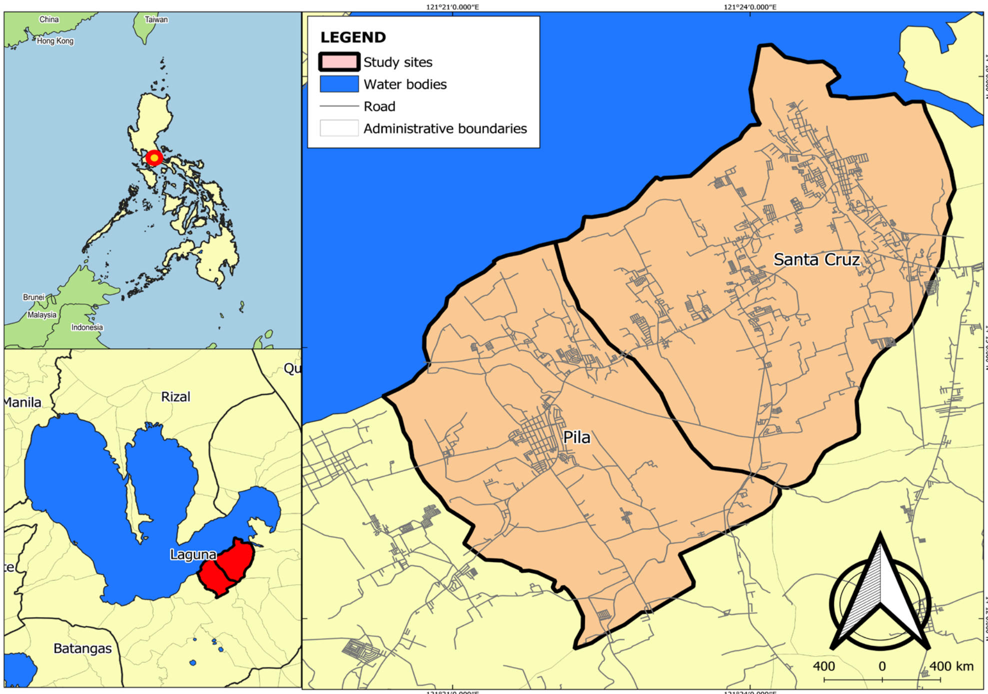

Figure 1. Map showing the site of the study.

Table 1. Sampling frame of the study.

Municipalities	Number of irrigators' association	Numberof farmer-fembers of the irrigators' association	Sample respondents	Classification
Sta. Cruz	19	922	99	Upstream (3), midstream (7), downstream (9) barangays
Pila	7	444	77	Upstream (1), midstream (3), downstream (1); 2 barangays cover upstream, midstream, and downstream
Total	26	1,808	176	

Different data collection methods were used to gather all the necessary information. A combination of quantitative and qualitative methods was used for triangulation purposes. The methods used include household interview, key informant interview, review of documents, and observation. All the IA presidents, the National Irrigation Administration (NIA) key personnel, Municipal Agricultural Officer, and the Municipal Planning and Development Officers in Sta. Cruz and Pila served as key informants. The qualitative data obtained from the key informant interview support the result from the household interview.

The research instrument for the household interview was a semi-structured interview schedule. It underwent content validity and was pre-tested in Bay, Laguna. The IAs in Bay have similar condition with that of the study sites. Content validity was applied in the guide questions used for the key informant interview.

Descriptive statistics such as frequency and percentages were used to describe the data obtained from the interview among farmer-members of the IA. Inferential statistics was used particularly Spearman Rho, to analyze the relationship between water governance and availability of water.

RESULTS AND DISCUSSION

Hindering Factors in the Sustainability of Water

The hindering factors in the sustainability of irrigation water were identified by the NIA, Local Government Units (LGUs), IAs, and the Municipal Agricultural Office (MAO) in the study sites through key informant interview (**Table 2**). One of the identified factors pertains to insufficient water supply particularly during the dry season. Water from Sta. Cruz dam supplies the needs of communities in Laguna province; hence, only a small percentage is allotted for irrigation.

Table 2. Hindering factors in the sustainability of water identified by the key informants.

Hindering factors	Stakeholders involved to address the hindering factors
1. Insufficient water supply	LGU, NIA, IA, DENR, Local Communities
2. Limited rehabilitation fund	LGU, NIA, IA, NGOs, Private Sector, DPWH, DAR, Local Communities
3. Deforestation and Quarrying	LGU, NIA, IA, DENR, DA, Local Communities

This means that there is competition in the water supply among various stakeholders resulting to scarcity during the dry season in which there is less rainfall. *Nguyen et al.* (*2012*) and *Ella et al.* (*2012*) emphasized in their study conducted in Quezon and Bicol, that there is scarcity of irrigation water specifically during the dry season due to increase in water users and less rainfall.

Another hindering factor according to the NIA officials was the shortage of funds for the rehabilitation of the irrigation system (**Table 2**). The NIA is tasked to repair, restore, and rehabilitate the irrigation system; however, the decreasing financial support hinders their institution to immediately repair damaged irrigation canal. The *Asian Development Bank (ADB)* (*2016*) pointed out that irrigation system needs proper operation and maintenance activities to ensure equitable, adequate, and timely distribution of irrigation water. Efficient operation and management of an irrigation system is highly imperative to make irrigated agriculture sustainable (*Mishra et al. 2001*). Hence, water utilities in developing countries need to work earnestly to improve the efficiency of operations that will lead to better services (*Omer 2010*).

Besides fund constraints, NIA officials also pointed out that quarrying and deforestation impedes water supply. This is due to the presence of small mining activities and illegal logging resulting to soil erosion and decrease in water supply (**Table 2**). Accordingly, there are households living in the vicinity of the Sta. Cruz dam whose primary source of income is farming, collection of forest products, and charcoal making. Disturbances in the watershed such as quarrying, illegal logging, and forest denudation affected the supply of irrigation water. The situation in the study sites is the same with the findings of *Ella et al.* (*2012*) that the inadequate water supply during dry season in Quezon and Bicol is partly due to poor watershed cover. *Nguyen et al.* (*2012*) further recommended the rehabilitation and the protection of critical watersheds in Bicol.

Sustainable supply of water is crucial to food security. In fact, the agriculture sector including the farmer respondents of this study requires large quantities of water for irrigation. Besides, various production processes do not only require sufficient amount of water but also of good quality (*UN Water 2014*). It is then essential that the sustainability of water be discussed first as it is indeed the key to food security. With this being said, the next sub-section on food security is better understood as a function of the hindrances identified in this sub-section.

Food Security

When asked whether rice production covers the household needs for rice consumption, majority (77.78% and 90.91%, respectively) of the respondents from Sta. Cruz and Pila answered positively while some (22.22% and 9.09% respectively) declared that rice production was not enough for their household consumption (**Table 3**). For Sta. Cruz, majority (64.94%) of the respondents whose rice production covers the household consumption said that the level of sufficiency was just enough while 14.29% and 20.78% claim that it was 'slightly enough' and 'more than enough', respectively. Similar results were obtained for Pila. In this locality, majority (78.57%) of the respondents also perceived that rice production is only enough to cover the household needs, while 5.71% and 15.71% claim that it was 'slightly enough' and 'more than enough', respectively.

Among the reasons for rice insufficiency were occurrence of typhoon (34.48%), debt to pay from the harvest (37.93%), big household size (20.69%), and limited size of farm (10.34%). This revealed that the sufficiency of rice does not only depend on the availability of water but likewise on good weather. This corroborates the findings of *Trilla* (*2009*) that climate affects food prices and availability. Less food is caused by weather disturbances that destroy harvests. This further showed that the level of sufficiency of rice production would not only be enough if the households have no debts and their rice farms are not damaged by natural calamities.

Despite these factors, food security was still achieved at the household level through the management of water resources, regulation of water for irrigation, and equitable water allocation and distribution. This only implied that the income of the farmer-respondents is adversely affected since it was intended for other household expenditures but not the household food security.

Moreover, the respondents were asked regarding the number of meals taken by their household daily

Table 3. Perceived sufficiency of rice production for household needs.

Particulars	Sta. Cruz (n=99)		Pila (n=77)		Total (n=176)	
	F	%	F	%	F	%
Rice Production for Household						
Rice Needs	77	77.78	70	90.91	147	83.52
Yes	22	22.22	7	9.09	29	16.48
No	99	100	77	100	176	100
Total						
Reasons for Insufficiency						
Harvest intended to pay debts	9	40.91	2	28.57	11	37.93
Low production due to typhoon	8	36.36	2	28.57	10	34.48
Big household size	4	18.18	2	28.57	6	20.69
Small farm size	2	9.09	1	14.29	3	10.34
No response	1	4.55	0	0	1	3.45
Total	22	100	7	100	29	100
Level of Sufficiency						
More than enough	16	20.78	11	15.71	27	18.37
Slightly enough	11	14.29	4	5.71	15	10.20
Enough	50	64.94	55	78.57	105	71.43
Total	77	100	70	100	147	100

during the first and second rice cropping seasons (**Table 4**). In the southern parts of Luzon which include the study sites, wet cropping season last from October-November to March-April (1st cropping season) while dry cropping season is from May-June to November (2nd cropping season) (*FAO 2004*). There was no difference on the frequency of household meal per cropping season between the two sites and between the two cropping seasons i.e., majority of the respondents eat thrice a day during the first and second cropping season at 66.48 and 65.91%, respectively. In the Philippines, the National Food Authority's (NFA) buying price for palay was at PhP 17 kg^{-1} over the past 10 years (*Gomez 2019*) but on the average, prices received by farmers for their produce in 2015 were lower by 5.96% from the 2014 records (*PSA 2016*). Perhaps these were some of the reasons as to why there are no observed differences in the number of meals the farming family experiences throughout the year and why there were still respondents who won't be able to eat three meals per day. It was only in October of 2018 when the NFA Council launched its buffer stocking incentive (*Gomez 2019*) which offered a PhP 3.00 incentive in addition to the PhP17.00 kg^{-1} price for clean and dry paddy rice (*Lena 2018*). Production of rice in 2015 is 18,149.8 MT with registered output losses of 4.31% (*PSA 2016*).

Table 4. Frequency of household meals/cropping season.

Particulars	Sta. Cruz (n=99)		Pila (n=77)		Total (n=176)	
	F	%	F	%	F	%
First Cropping Season						
2 times a day	3	3.03	2	2.60	5	2.84
3 times a day	69	69.70	48	62.34	117	66.48
4 times a day	13	13.13	11	14.29	24	13.64
5 times a day	14	14.14	16	20.78	30	17.05
Total	99	100	77	100	176	100
Second Cropping Season						
2 times a day	3	3.03	2	2.60	5	2.84
3 times a day	70	70.71	46	59.74	116	65.91
4 times a day	12	12.12	12	15.58	24	13.64
5 times a day	14	14.14	17	22.08	31	17.61
Total	99	100	77	100	176	100

The study also investigated the monthly consumption of rice of the respondents. The most common mode of rice consumption in both sites is at 26-50 kg (Sta Cruz, 39.39%; Pila, 42.86%) (**Table 5**). In the country, a family belonging to the bottom 30 percent income group consumes around 390 kg of ordinary rice in a year or 7.5 kg weekly, on the average (*PSA 2010*). This corresponds to the mode of the result on rice consumption (**Table 5**). Rice is considered as the most essential food item in terms of calorie intake, providing over 20 % of the human dietary energy. The per capita rice consumption (PCRC) in the Philippines increased by 13% from 106 kg yr^{-1} in 1999/2000 to 119 kg yr^{-1} wherein Central Visayas obtained the highest at 41% and CALABARZON ranked the least at four percent (*PhilRice 2011*). Meanwhile, the rest of the monthly rice consumption of the respondents' households for the two sites combined are as follows: 26-50 kg (40.91%), 51-75 kg (24.43%), 76 -100 kg (18.18%) and 0–25 kg (10.80 %) which depends on their household size. In terms of rice shortage, it is significant to note that majority (61.62%) of the farmer-respondents in Sta. Cruz and many (48.05%) in Pila experience rice shortage. Only 44.32% in both sites declared to have enough rice supply (**Table 6**). This information was alarming since the staple food in the country is rice. In fact, due to insufficient rice production, some regions divert to corn consumption as an alternative to rice. Using the self-sufficiency ratio (the extent to which a country relies on its own production resources), it can be said that production is not enough to cope with the demand of the population (*BAS 2012*).

Table 5. Monthly household consumption of rice (in kg).

Particulars	Sta. Cruz (n=99)		Pila (n=77)		Total (n=176)	
	F	%	F	%	F	%
0 – 25	10	10.10	9	11.69	19	10.80
26 – 50	39	39.39	33	42.86	72	40.91
51 – 75	28	28.28	15	19.48	43	24.43
76 – 100	19	19.19	13	16.88	32	18.18
101 – 125	2	2.02	1	1.30	3	1.70
126 – 150	1	1.01	4	5.19	5	2.84
151 – 175	0	0	0	0	0	0
176 – 200	0	0	2	2.60	2	1.14
Total	99	100	77	100	176	100

Among the 98 respondents who answered yes, 34.43% in Sta. Cruz and 27.03% in Pila shared that the rice farms were damaged by calamities. An almost equal number of respondents in both sites attributed rice shortage to damage of the dam due to calamities and to low production at 15.31 and 13.27%, respectively. Although the farmer-respondents occasionally experience rice shortage, there was still food security at the household level since rice is available in the market. In times of rice

Table 6. Rice shortage experience by the farmer-respondents.

Particulars	Sta. Cruz (n=99)		Pila (n=77)		Total (n=176)	
	F	%	F	%	F	%
Experienced Rice Shortage						
Yes	61	61.62	37	48.05	98	55.68
No	38	38.38	40	51.95	78	44.32
Total	99	100	77	100	176	100
Reasons for Food Shortage						
Damage by calamities	21	34.43	10	27.03	31	31.63
Damage dam due to calamities	8	13.11	7	18.92	15	15.31
Low production	5	8.20	8	21.62	13	13.27
Harvest intended to pay debts	5	8.20	1	2.70	6	6.12
No capital for planting	5	8.20	0	0	5	5.10
Low income	2	3.28	3	8.11	5	5.10
Pest infestation	2	3.28	3	8.11	5	5.10
Low harvest	2	3.28	0	0	2	2.04
No water during dry season	2	3.28	0	0	2	2.04
Damaged irrigation canal	1	1.64	0	0	1	1.02
Drought	0	0	1	2.70	1	1.02
No response	8	13.11	4	10.81	12	12.44
Total	61	100	37	100	98	100
Measures of Rice Shortage*						
Buy rice in the market	30		33		63	
Borrow money	7		2		9	
Decrease number of meals	5		2		7	
Borrow rice	4		1		5	
Replace rice with root crops	2		1		3	
Ask help from relatives	2		1		3	
Replace rice with banana	1		0		1	
Total	51		40		91	

*multiple response

shortage, majority (64.29%) of the 98 respondents buy rice in the market. Only very few (7.14%) resorted to other means like borrowing money from relatives and friends and some (7.14%) decide to reduce the number of daily meal intake. Other measures cited include asking help from relatives and replacing the rice with either root crops or bananas.

Social capital is evident in the study sites when rice shortage occurs. One of the essential aspects of social capital is social support. Social support refers to "social interactions providing assistance to individuals with a web of social relationships perceived to be loving, caring, and always available in times of need (*Barrera 1986*)". Studies on social support vary on the pattern of help utilization (*Kaniasty and Norris 2000*). The pattern of help utilization starts with the family, followed by other support groups such as friends, neighbors, and co-workers (*Hogan et al. 2002; Maton1988; Rook 1992*). Social capital is not only evident when there is rice shortage but likewise when there is blockage of wastes in the irrigation canal. The IA officers shared during the key informant interview that their members voluntarily help in cleaning the irrigation system.

Relationship between Water Governance and Availability of Water

There was a strong positive linear association between management of water resources and availability of water based from the coefficient value of r = 0.628 at 0.05 level of significance (**Table 7**). This highlighted the importance of proper management of water resources to ensure availability and sustainability of water for irrigation. Proper management of water resources should be prioritized if the IA wants to have regular water supply in their farms. Regulation of irrigation water and the availability of irrigation water were found to have a strong linear relationship obtaining a value of r = 0.604 at 0.05 level of significance. This implies that the water regulations are highly related to the availability of water; thus, emphasizing the vital role of IA in implementation and regulation to ensure water availability.

With regard to the correlation of the management of IA and availability of water, there was a positive linear relationship between these variables. The relationship was found to be moderate based on the obtained value of r = 0.493 at 0.05 level of significance. This implied that availability of irrigation was also dependent on how the IA managed the irrigation water. Well-managed irrigation water by the IA officials means higher probability that water will always be available to the rice farms.

Table 7. Relationship between water governance and availability of water.

Water governance variables	Availability of water (*r*=value)
Management of water resources	0.628***
Regulation of irrigation water	0.604***
Equitable water allocation	0.561**
Water distribution	0.530**
Management of Irrigators' Association	0.561**
Proper use of irrigation water	0.349*
Responsibilities of in-charge of Irrigators' Association	0.339*

Note:
* Weak significant at P< 0.05
** Moderately significant at P<0.05
*** Strongly significant P<0.05

Moreover, there was a positive moderate linear relationship between water distribution and availability of irrigation water based from the obtained coefficient value of r = 0.530 at 0.05 level of significance. This implied that the distribution of water also played a significant role in the availability of water. If the water is well distributed by the IA among the farmer-members, there will always be available water to irrigate the farms.

Furthermore, the relationship between Management of Irrigators' Association and water availability was also investigated. At r = 0.561 at 0.05 level of significance, there is a moderate positive linear relationship between the management of IA with water availability. For instance, there is an agreement that water distribution should be based on the cropping calendar prepared by NIA in coordination with the IA officials. The cropping calendar should be followed in order to distribute the water among all the farmer-members in accordance with the schedule. However, other farmers, particularly those in the upstream, do not follow the schedule assigned because these farmers think that they can plant anytime within the cropping calendar since they have regular source of water in the upstream areas. Thus, water scarcity was experienced in other lower areas. In other words, failure of the IA to execute the water usage regulations in all areas would result to water scarcity.

There was a positive moderate linear association between equitable allocation of irrigation water and availability of water based from the obtained coefficient value which is r = 0.561 at 0.05 level of significance. Equitable allocation of water ensures farmers that they will have water supply to irrigate the rice farms. However, there were some farmers who over-appropriate and divert water to irrigate their farms even if it is not yet their schedule. This leads to unequal allocation of water thereby resulting to problems and conflicts among members and officials. This was also revealed in the study of *Rola et al.* (*2016*) wherein water conflicts were found to be evident between the uplands, rural, and urban as well as in upstream and downstream. The conflicts were pointed out in the absence of formal agreements and unclear property rights.

There was also a positive linear association on the availability of water and the character of the IA in-charge of the irrigation system based from the obtained value of r=0.339 at 0.05 level of significance. However, the relationship was found to be weak. Furthermore, the proper use of irrigation water and the availability of water was found to have a positive but weak linear association based from the coefficient value of $r = 0.349$ at 0.05 level of significance. This implied that the proper use of water among the farmer-members does not ensure that there was always available water to irrigate the farms.

Water Governance Framework

A policy is a deliberate system of principles to guide decisions and achieve rational outcomes. It is generally adopted by a governance body within an organization. In the framework and methodology done by *Saleth and Dinar* (*2004*), water policy is necessary in water governance. It is indeed needed since it serves as an indicator which is grounded in both theory and practice to avoid conflict and help ensure equitable allocation of water. The indicators of water governance include political, social, and economic and administrative system (**Figure 2**). The IA is at the center of the proposed water governance framework since the ownership of the irrigation system was already transferred to them by the NIA. Among the key factors in the management of the irrigation system are leadership, capacity building, participation, and formulation of water policies of the IA.

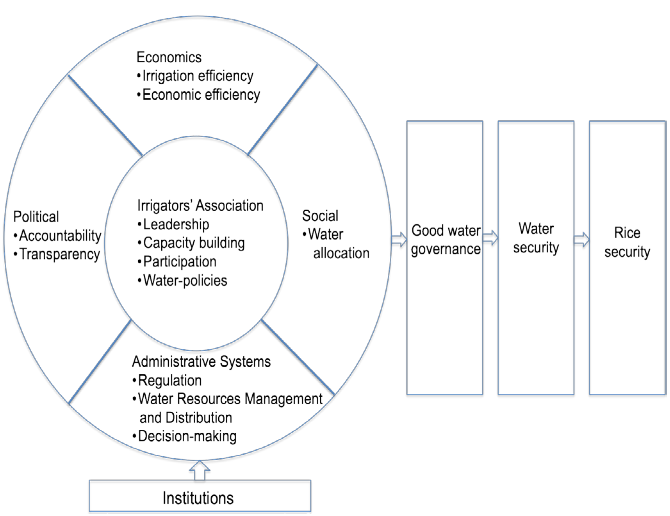

Figure 2. Water governance framework for irrigation.

Leadership exists in all organizations and it is imperative for them to function accordingly (*Ardichvili and Kuchinke 2002*). Leaders can influence the organization and the society in general (*Jandaghi et al. 2008*) to result to economic development (*Kolzow 2009*). The study of *Rola et al.* (*2015*) has recommended for the review of the legal and institutional framework for water because of the lack of the inadequate water data for planning.

Aside from leadership, capacity building is another important factor in irrigation water management. It refers to the process of changing attitudes and behaviors as well as imparting knowledge and developing skills while maximizing the benefits of participation, knowledge exchange, and ownership (*UNDP 2009*). Capacity building to enhance the knowledge of the IA officers and members can be obtained from trainings sponsored by NIA, PhilRice, and the MAO.

Further, the participation of IA officers and members is deemed necessary in initiating, deciding, planning, and implementing activities in relation to irrigation water management (*Samah and Aref 2000*). It is a process of social development in which people find ways to meet collective needs and overcome common problems to attain efficiency, effectiveness, self-reliance, coverage and sustainability (*Schneider 1995*). Participation is thus important in addressing the hindering factors to attain sustainability of irrigation water that the respondents identified (**Table 1**).

The political aspect in the water governance model focuses on accountability and transparency (**Figure 2**). Accountability pertains to being answerable for actions and decisions made. This also requires the ability of citizens and community-based organizations to examine institutions and hold them to account. In water services, it refers to power relationships shaped by actors in the water sector. In this particular study, the NIA, LGU, IA, and MAO are the key actors in the governance of irrigation water. With the transfer of the management of the irrigation system from NIA to the IAs, the latter holds full accountability in the equitable distribution of irrigation water to the farming communities. Accountability for water service delivery requires understanding of the objectives and processes for improved accountability as well as showing of respect to others to account excess water service delivery, and displaying confidence, trust and skills to fulfill the role (*DFID 2007*) that will lead to good water governance. In the study of *Brillo* (*2017*) in San Pablo, Laguna, Philippines, the water governance was found to be weak due to evident lack of long-term commitment and accountability among the stakeholders concerned. Aside from accountability, transparency is another dimension of governance. Transparency occurs when the constituencies of an institution are ensured of timely, accurate, and necessary information on its effect to them and to the community. Transparency creates the knowledge that, in turn, creates public confidence (*Malayang 2003*).

For the economic aspect, irrigation efficiency is necessary in water governance. Irrigation efficiency pertains to the ratio of water volume used by plants to the volume of water delivered through an irrigation system, adjusted for effective rainfall and changes in the water storage in the root zone (*Burt et al. 1997*). Irrigation efficiency is subdivided into distribution efficiency referring to the water distribution in the main canal, conveyance efficiency which pertains to the water distribution in secondary canals, and field application efficiency which refers to water distribution in the crop fields (*Wallace and Batchelor 1997*).

Inefficient water use in irrigation is commonly brought about by poor management (*Jensen et al. 1990*). There are categories to improve physical and economic efficiency of the irrigation system. These include agronomic improvements such as use of cropping strategies; technical improvements like advanced irrigation system; managerial improvements like adoption of demand-based irrigation scheduling systems and improved maintenance of equipment; and institutional improvements (*Wallace and Batchelor 1997*).

Through regular monitoring of irrigation efficiency, there is an assurance that water will be delivered in the main and secondary canal and will also be distributed to the rice fields. This is important since there are reports that there are some farmers who over-appropriate and divert water to irrigate their farms, thereby resulting to problems and conflicts among IA members and officers. Availability of water for improved rice productivity will be achieved when water distribution is closely monitored. Another problem related to irrigation system is the inefficient allocation of resources. According to the report of the World Water Vision 2000, the root cause of the problem in irrigation system is the inefficient allocation of resources (*Cosgrove and Rijsberman 2000*). To address this, *Prabhu* (*2009*) stressed that water allocation in an irrigation system should be done with equity and social justice. It requires concerted efforts to ensure that the potential of irrigation is maximized. Hence, it is suggested that the command area development approach should be adopted in irrigation.

Meanwhile, statistical results of this study revealed that water resource management and distribution are two major factors in the availability of water supply. This implies that to distribute water in the farms for rice irrigation, management of water resources is deemed necessary. Availability of water supply was also found to have a strong relationship with regulation of water. This implies the importance of water regulation in achieving good water governance. There should be coordination among IA officials together with the ditch tender and members who have schedule to plant and harvest rice, and farmers who are in the stage of growing rice to ensure that water will be regulated based on the needs of the farmer-members. Water regulation not only satisfies the users of the irrigation water but also ensures that water is equally distributed to all levels. The results imply the importance of formal institutions to carry out mandates that are related to water management (*Hall et al. 2015*).

Management of the water resources should also include a participatory approach by involving the users in an effective and decisive manner, in various aspects of planning, designing, development and management of water resource schemes. Necessary legal and institutional changes should be made at various levels for this purpose (*Prabhu 2009*).

Water governance is shaped by the decisions exercised in fields that extend beyond water (*Gomez and Ravnbor 2011*). Effective decision-making requires power-sharing and consultation (*Ribot 2000*). Thus, involving the users in the decision-making process is indispensable (*O'Brien et al. 2002 and FCM 2003*). To achieve good water governance, regular meetings should be conducted for the participatory decision-making on problems encountered in the irrigation system.

Institutions, as one of the factors in the proposed model corroborate with the findings of World Water Vision. Based on the report of the *World Water Vision* (*2000*), institutions are blamed as the causes of the problem in water governance (*Cosgrove and Rijsberman 2000*). Institutional arrangements can contribute in attaining success in the formulation and implementation of good water governance practices. Institutions which are governed, planned, and financed are vital in providing reliable water services (*Tortajada 2010*). Various institutions also play a significant role in the capacitation of the IA officials to achieve good leadership and ensure active participation among the members. Results implied that capability building activities should be regularly provided considering that leadership changes based on the result of elections. In this way, good leadership and capability building will both be sustained.

Other government institutions can also aid the IAs not only on the capability building and leadership formation of the members but also on provision of the technical aspect such as the selection of rice seeds that are resistant to climate change and addressing water scarcity. Other information relevant in rice farming should also be imparted in consideration of the IA as an institution that contributes to the rice security at the household and community level.

To achieve water and rice security, good governance is imperative. It is essential in the effective performance of organizations particularly in enforcing and adopting rules, resolving conflicts, building trust and legitimacy, and ensuring accountability. Good governance can lead to efficient and cost-effective service provision, suitable services to the users' preferences, and increased responsiveness to the changing conditions and people's needs (*Bakker and Cameron 2002*).

Water scholars, policy makers, and donors agree that water governance is the key to address water insecurity in developing countries (*Saleth and Dinar 2004; Asian Development Bank 2004; OECD 2011*). Water security refers to the sustainable access, on a watershed basis, of adequate quantities of water in acceptable quality that can ensure human and ecosystem health (*Norman et al. 2010*).

To achieve water security, results of the survey conducted among water managers and end users (*Norman et al. 2010*) showed that coordination of data sets, funding for local and regional level stewardship projects, coordination of water management between political jurisdictions, holistic approach to water governance, adoption of a watershed approach, monitoring of ecological systems, communication among academic research, policy decisions, and community; and involvement of government officials are all necessary. Rice security which refers to the available, affordable, accessible, and safe rice for all at all times can only be achieved through good water governance also (*Balisacan et al. 2006*).

CONCLUSIONS AND RECOMMENDATIONS

Deforestation due to illegal logging, charcoal making, and destructive farming practices of the households living in the vicinity of the Sta. Cruz dam as well as quarrying and the presence of small mining activities resulted to insufficient water supply during the dry season and inefficient water resource management. All these factors impeded rice productivity and sustainability in the area. These hindering problems can be attributed to the low priority being given by the DPWH for the construction, repair and restoration of the irrigation canal as well as the decreasing financial support and low income of the NIA.

Food insecurity is experienced when the rice fields and dams are damaged by a strong typhoon and other calamities. These instances compel households to buy their supply of rice in the market. Amidst constraints in sustainable and quality water supply, the rice productivity of the households is generally enough with monthly rice consumption amounting to 26 to 50 kg.

In order to address the factors impeding rice productivity and sustainability, this study recommends NIA and IA to improve the management, distribution, and regulation of water resources. With this, water will always be made available and equitably allocated in the rice farms whenever needed.

With regard to deforestation, this study recommended the coordination with the DENR concerning the quarrying in the area and presence of human settlements coupled with cutting of trees for charcoal and other farming practices that are destructive and resulting to deforestation of the watersheds.

In terms of food insecurity, Local Government Units must provide alternative livelihood programs to the IA members. Livelihood trainings should be conducted and linkages with other government institutions/business enterprises/non-government organizations/foundation should be improved to equip the IAs with alternative skills. These will enable them to create a ready market once they are able to come up with products/services from such trainings. Doing such would sustain food security at the household and community level regardless of the adverse impacts of strong typhoons and farm and household size.

Overall, the water governance framework proposed by this study can guarantee sustainability of irrigation water to achieve rice security at the household and community level since significant factors based from the results of the study were taken into consideration, although it takes time to determine the effectiveness of the proposed model.

For an improved water governance endeavor, this study recommended using its developed irrigation water governance model which is grounded on empirical research and theory. Since the improvement of water governance at the different levels is crucial in attaining equitable access to water resources, application of the newly designed model is needed to determine its efficacy in achieving sustainability of irrigation water. However, this can only be addressed with regional cooperation in research and development (*Lapong and Fujihara 2008*).

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