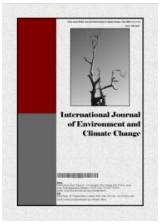

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Social Learning in Integrated Land and Water Resource Management through Indigenous "Zabo System": A Study from India Tribal State

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Social learning has been cited as essential process for sustainable ecosystem management and enhancement of desirable behavioral change. The present study has focused on an integrated land water resource management through locally developed "zabo system" by the collective action of community. Focus discussion, PRA tools and personal interview methods were used to gather the data. The result reflected that farmers were co-acting together which highly enhanced their occupational capacity (53.3%), adaptive capacity (50%) and knowledge level (69.5%). This system provides 133% more yield of paddy than average yield of the Nagaland state under *Jhum* cultivation. The study showed that social learning could be an effective tool for bringing sustainability when ecosystem management is at stake.

Keywords: Social learning; water; land; management; zabo system.

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1. INTRODUCTION

Social learning is an iterative and on-going process that comprises several loops and enhances the flexibility of the socio-ecological system and its ability to respond to change. Because of its ability to respond to change, social learning has been found important in solving problems related to natural resource management [1], rural development [2,3], irrigation [4], urban development [5], environmental conflict [6], transboundary negotiations [7,8] multifunctional land use [9], coastal zone management [10], water and river basin management [11,12]. Social learning results in growing capacities of social entities to perform the common tasks by enhancing the positive attitude, beliefs, skills, capacities and actions in and among the counterparts. Social network is effective in enhancing climate change resilience in agroforestry management [13]. Integrated water and land resource management reflects coordinated development and management of water, land and related resources in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems [14]. This coordinated development and management can be cited as social learning process. This study focused on an indigenous way of integrated water and land resource management among Chakhensang tribe of Phek district. Kirkuruma village of Phek district situated at an elevation of 1270m, at 2 at 25°36'N latitude and 94°10'E longitude. As the village is situated between two streams i.e. Seidzu on southern side and Khuzha on northern side, Kirkruma falls under rain-shadow area. The village being situated above streams, water from the streams cannot be used for drinking and irrigation purpose [15,16]. Only way to mitigate the water scarcity problem is rainfall water but due to surface runoff, rainwater also could not be used in spite of enough rainfall. This situation forced the villagers to come up with an Indigenous way of integrated water and land resource management known as “Zabo system” (Fig. 1). Literal meaning of Zabo is “impounding runoff water” in Chakhesang dialect. The system is a unique combination of forest, agriculture, livestock and fisheries with a water and soil conservation base, which encourages the sustainability of the environment, besides increasing crop productivity [17]. This system is followed in the group of 10-15 farmers through collective action and reflection [18]. Keen [16] defines social learning as ‘the collective action and reflection that takes place amongst both individuals and groups when they work to improve the management of the interrelationships between social and ecological systems. So, study aims at exploring the human dimension of Zabo system by analyzing the social learning pattern and its impact on people’s life.

Fig. 1. Components of zabo on lower altitude

2. MATERIALS AND METHODS

2.1 Local of Study

The study was conducted in Kikruma village of Phek situated at an elevation of 1270 m, at 2 at 25°36'N and 94°10' E. The village has a total of 1805 households (Census, 2011) and is dominated by Chakhesang tribes. It is divided in sub unit known as "Khel". It had 8 Khels namely Seba Khel, Chipi Ruso Khel, Rukho khel, Phutshuba Khel, Chiku Khel, Phulu Khel and R D block Khel (the largest one).

2.2 Research Design and Data Collection

Case study method was used. Mixed combination of data collection methods was used. In the first phase, focus group discussion was done. In second phase, PRA tools, transect walk and resource mapping was done to get better understanding of Zabo system. In third phase, again focus group discussion was conducted to clarify the understanding from 3rd phase. In fourth phase, personal interview was conducted with randomly selected 60 farmers from the village.

Table 1. Variables and their measurement in zabo system

S. No.	Variable	Operational Definition	Measurement
1.	Age	measured as the chronological age of the respondent and measured in number of years	Years
2	Education	measured as the number of years of formal schooling and college attended by the respondent	Years of schooling
3.	Sex	measured as the biological identity of the respondent	Male=1, Female=0
	Social participation	measured as the degree of involvement of a respondent either as a member of any organization or office bearer	No participation=1, member of any organization=2 and office bearer=3.
4	Experience in agriculture	measured as the number for number of year a respondent is engaged in agricultural activity for livelihood generation	Years
	Variable to Pattern of social learning		
1	Pattern of social exchange	measured as the way of communication among the members of village for technical and factual knowledge regarding agricultural practices	exclusively informal=1, exclusively formal=2 and both formal and informal=3.
2	Frequency of contact	measured as the degree to which members of the village contact each other for exchange of the messages related to agricultural purposes	never=0, few times=1, sometimes contact=3, frequent contact=4, very frequent contact=5
3	Ease of contact	measured as the degree to which a respondent feel ease and accessible in contacting with his/her fellow farmer regarding advice for agricultural purposes	very difficult=0, difficult=1, moderate =3, easy=4 and very easy=5

S. No.	Variable	Operational Definition	Measurement
4	Mutual expectation of benefit	measured as the degree to which respondent expect help from his/her fellow farmer in generation of his/her livelihood	very low=0, low=1, medium=3, high=4, and very high =5
	Variables to analyze features of social learning		
1	Facilitation	operationalized as whether villagers perceive need of some external help in terms of technique to conduct their agricultural activities	Required=1, not required=0
2	Small group work	operationalized as whether group activities are present in conducting agricultural activities or not	Present=1, Not present=0
3	Type of thinking	measured as the as freedom in thinking on new innovative models for agricultural, whether the members discus their view with others or think and implement individually	closed=0, Open=1
4	Opportunity to influence others	measured as the acceptance of advice from fellow farmers	Cannot influence=0, Can influence=1
5	Level of participation*	measured as the degree to which members are involved in group activities *i.e.* integrated water conservation in the present case	Coercing=1, Informing=2, Consulting=3, Enticing=4 Co-learning=5,Co-acting=6
	Impact of social learning		
A	Human capital		
1	Knowledge level	A knowledge test on Zabo system was developed based on 9 items on various practices with difficulty index within 0.45 and 0.82 and Cronbach's Alpha of 0.74.	Knowledge test
2	Occupational capacity	measured as the perceived influence of social learning for integrated water conservation to diversify the agricultural occupation	5-point Likert scale
3	Capacity to work	measured as the perceived impact of social learning for integrated water conservation in enhancing ability of an individual to conduct agricultural activities smoothly	5-point Likert scale
4	Capacity to adapt	measured as the perceived degree of impact of social learning for integrated water conservation to reduce the impact of water scarcity on their livelihood	5-point Likert scale

S. No.	Variable	Operational Definition	Measurement
5	Attitude towards community based action	measured as the degree of inclination of an individual for community action	5-point Likert scale
6	Moral development	measured as the degree to which respondent had developed his/her perspective in terms of others and had ability to differentiate between right and wrong	5-point Likert scale
B	Social capital was worked out with sub-indices of cooperativeness, civic culture, solidarity and sociability	measured as the perceived enhancement in cooperativeness, civic culture, solidarity, and sociability while interacting for process of social learning for integrated water conservation management	
1	Cooperativeness	measured as the degree to which individual is oriented towards help others in generation of livelihood	5-point Likert scale
2	Civic culture	measured as the degree of reciprocity and cooperation among the members of the community which facilitates coordinated actions	5-point Likert scale
3	Solidarity shows degree of similarity between the members in terms of liking, attitude, occupation etc.	measured as the degree of interpersonal relationship among the members of society.	5-point Likert scale
4	Sociability	measured as the extent to which integrated water resource management was providing space to the members of the community to build trust, social relationship, belongingness, respect *etc.*	5-point Likert scale
C	Economic capital	Yield of paddy Yield of fish	Ton per ha Kilogram per ha

**Level of participation [19,20,21,22]*

Informing - Information is transferred in a one-way flow; there is no knowledge or sharing of decision making.

Consulting- Information is sought from different groups, but one group (often the government) maintains the power to analyze the information and decide on the best course of action.

Enticing- Different groups share information and jointly consider priority issues, but one group maintains power and entices other groups to act through incentives.

Co-learning- Insiders and outsiders share their knowledge to create new understandings and work together to form action plans, and define roles and responsibilities. Decision making power is negotiated within institutional and social constraints.

Co-Acting- People set their own agenda and mobilize to carry it out in the absence of outside initiators. Knowledge is shared between the groups engaged in the activity, but knowledge flows and learning outside of this community are not assured. Power in decision making remains with the initiators of the action.

3. RESULTS AND DISCUSSION

3.1 Description of Zabo System

The literal meaning of Zabo is "impounding water" in Chakhesang dialogue. The system is combination of conserved forest area at top of the hill, water harvesting tanks down the forest area, then cattle enclosure area, followed by terrace field for paddy cultivation, Rice-cum-paddy fields at the foot of the hill. This system is sustainable way of integrated farming and water conservation which includes Forest, agriculture, livestock and fishery [17]. This system is followed in the group of 10-12 families. The components of the Zabo system had been described below:

3.1.1 The conserved forest area

At the hill top, there is conserved forest area. This area is managed by families of the village. Each family has given a specified area which is managed by that particular family. Also, hilltop serves as catchment for rainwater. Slope in this area is more steep but due to permanent vegetation, soil erosion is not a problem.

3.1.2 Water harvesting system

Water harvesting ponds are constructed below the catchment area with several small silt retention tanks between the forest area and the main water harvesting pond. The size of main harvesting tank/pond depends on catchment area. Runoffs are first stored in the silt retention tanks for few days to in order to retain soil, humus and organic matter and then transferred to main tank. These small soil retention tanks area are desilted annually. The desilted soil containing humus and organic matter are added to paddy field. The inner side of the main tanks are plastered with paddy straw and mud to reduce seepage loose. The water from main tank is passed through cattle enclosure to the main field.

3.1.3 Cattle enclosure

Cattle enclosure is constructed below the main pond. Enclosure is made up with bamboo. A group of 10-12 families keep their cattle on rotation basis for 15days. About 30-35 cattle are kept at one time. Irrigation water passes from these cattle enclosure to the main field in order to carry dung and urine of the cattle.

3.1.4 Agricultural field

The main crop of the village is paddy. It is grown on terraces. Generally, they follow monoculture. After harvesting of the paddy, they left some part of straw in the field only. When field is ploughed during February-March, these straw are mixed in soil. They also add Alder tree leaves and composts made from animal waste to improve soil fertility. They do not use any chemical fertilizer making the system completely organic and environmental friendly.

Rice-cum-fish culture: Below the main crop field (nearly bottom of the hill), the farmers practice fish-cum-rice culture. In wet land terraces, small pit is made. They release fish-lings in the month of July. Paddy harvesting started in month of October, at that time water from main paddy is drawn to these pits and fishes are also collected in these pits. Nearly, 50-60kg/ha fish is harvested every year.

Most of the farmers were in the middle age group (36.7%), while 5% farmers are in 'very old age' group (Table 2). Old age group farmers were purposively interviewed to understand the historical context of the Zabo system. The females of the village were mainly engaged in household chores, collecting wood, and their food from forest area. Village More than half (53.3%) of the people were literate with 20% of them had higher degree, while 41.7%were illiterate. As every household followed Zabo system of farming, so, everyone was a member of some group to carry out the agricultural activities. Most of the respondents had medium (31.7%) to low (30%) experience in agriculture.

Sustainable society emerges from interactions and communication determines the desirable changes in the society [23] showed that 84.4%of the respondents were engaged in both informal and formal modes of communication (Table 3). Here, formal communication pattern was communication through social institution of the village. The village had three social institutions *i.e. v*illage council with 25 members, village development council with 30 members, and governing body for forest conservation. These institutions had very regular meeting as all welfare activities of the village are carried out by them. Contact through informal interaction were frequent (56.7) to very frequent (41.7%) while in formal interactions, 31.75%agreed to have frequent contacts (Table 4).

Table 2. Descriptive statistics of socio-personal variables in Kikruma village

S.N.	Variable & their categories	Frequency	Percentage
A.	**Age (Mean=47.6, S.D=14.89)**		
	17.8- 32.71 (Very young)	14	23.3
	32.7-47.6 (Young)	15	25.0
	47.6-62.49 (Middle age)	22	36.7
	62.49-77.38 (Old)	6	10.0
	>77.38 (Very old)	3	5.0
B.	**Sex**		
	Female	22	36.7
	Male	38	63.3
C.	**Education**		
	Not literate	25	41.7
	Literate (5-8)	8	13.3
	High school (10 year)	7	11.7
	Higher secondary (12 year)	8	13.3
	Highly educated	12	20.0
D.	**Social participation**		
	Participant of some group/organization	46	76.7
	Office bearer in some organization	14	23.3
E.	**Experience in agriculture (Mean-27.1, SD=14.6)**		
	2.3-12.4 (Very low)	14	23.3
	12.4-27.1 (Low)	18	30.0
	27.1-41.8 (Medium)	19	31.7
	41.8-56.5 (High)	6	10.0
	>56.6 (Very high)	3	5.0

Table 3. Communication pattern in Kikruma village

S. No	Pattern of social exchange	Frequency	%
1	Only informal	7	15.6
2	Only formal	0	0
3	Both formal and informal	38	84.4

Table 4. Frequency of contact in Kikruma village

S. No	Class	Informal		Formal	
		frequency	%	frequency	%
	Very frequent	25	41.7	13	21.7
	Frequent	34	56.7	19	31.7
	Sometimes	1	1.7	13	21.7
	Few times	0	0	9	15
	Never	0	0	6	10

Table 5. Ease of contact in Kikruma village

S. No	Class	Informal		Formal	
		f	%	F	%
	Very difficult	0	0	8	13.3
	Difficult	0	0	4	6.7
	Moderate	2	3.3	13	21.7
	Easy	29	48.3	27	45
	Very easy	29	48.3	8	13.3

Table 6. Mutual expectations of benefits in Kikruma village

S. no	Class	F	%
	Very low	0	0
	Low	2	3.3
	Medium	15	25
	High	27	45
	Very high	16	26.7

Kikruma was very close knitted village, so, most of the respondents (48.3%=easy, 48.3%=very easy) found contacting with people easy (48.3) to very easy (48.3) in informal interaction (Table 5), while 45% of them found it easy (45%) in contacting people through formal channels. Villagers do not use inputs for agriculture from outside. They used local varieties preserved from previous harvest. Whosever had good quality of harvest, his/her produce was kept for seed. They exchanged their harvest with community people. There is no culture of using hired labour rather they work in each other's' field with mutual reciprocity. Most of the respondents had high (45%) to very high (26.7%) mutual expectations of benefit from the village members (Table 6).

The features of social learning were revealed from the collective processes (Table 7) in the village. A majority of the farmers (90%) shared that there was facilitation from some active member of village for collective activities. All respondents affirmed that they participated in Zabo method of farming in group mode, while most of them (78.3%) agreed that they were allowed to think openly to introduce new changes. Their thinking and ideas were discussed in general body meeting of the village and if found feasible, it was implemented. Most of the respondent farmers (81.7%) had experienced that they had opportunity to influence other members on welfare ideas, and the village had a great level of participation *i.e.* co-acting. Muro and Jeffrey [24] in their critical review on social learning suggest features of social learning process should include some facilitation from some sources either from the community or outside agency, small group work, open thinking, people should have opportunity to influence each other, and active participation from members. Rist et al. [25] emphasize on co-acting level of participation through creating learning environment for facilitation of social learning instead coercing.

3.1.5 Impact of social learning

Social learning may lead to a number of social outcomes specifically acquisition of knowledge, technical and social skill along with common understanding of the system, social capital and finally collective action for better adaptation [26,27,28,2,29,8,18]. In the present case, there was positive outcomes of social learning in the terms of gain in knowledge and enhancement in human capital components like 'Occupational capacity', 'Capacity to work', 'Adaptive capacity', 'Attitude' and 'Moral development' (Table 9).

The level of technical and factual knowledge on *Zabo* system among the respondent ranged from 45 to 80% (Table 8). Their knowledge level was measured through a knowledge test developed for *Zabo* system with internal consistency of 0.74. Human capital was measured in terms of occupational capacity, capacity to work, capacity to adapt, attitude and moral development. About 53.3% of the respondents perceived that collective action for integrated water conservation enhanced their occupational capacity by diversifying the source for inputs and integrated resource availability (Table 9). Social learning provides facilitative framework for actively building capacity to work on complex environmental problems [30]. In our study, 50 % of the respondent had a high level of capacity to work in complex water scarcity situation through collective active (Table 6). Most of the respondents (58.3%) perceived that working collectively had increased their adaptive capacity. There was highly favorable attitude towards community action among a majority of the respondents (65%). Learning collectively to manage the resources also results in change in attitude, beliefs, skills, capacities and actions in and among the stakeholders [26]. While working together to solve common problem, people develop a sense of self-respect and responsibility to oneself and others also, which help them to make judgment in perspective of whole community [26]. In the present case also, most of the respondent had a medium (35.6%) to high (45.4%) level of sense of responsibility towards

others which has been termed as moral development.

Social learning has key for unlocking the potential of social capital to bring people together for better land use practice [31]. The level of social capital components ranged between medium to high (Table 10). The level of cooperativeness among half of the villagers was high, while 65%of the villagers agreed that Zabo system enabled them to maintain high level of civic culture within the village. Due to high similarity in occupation, attitudes, frequent contacts and beneficent work, most of the respondents (61.6%) also showed high to very high degree of solidarity. Along with cooperativeness and solidarity, most of the farmers agreed that Zabo systems also facilitated medium (30% farmer) to high (31.6% farmer) level of space to villagers to develop trust, social relationship, and respect with each other. Collective resource management helps in creation of social capital which emphasized on better bonding and formation of local groups in a variety of management sectors including watersheds, forests, irrigation channels, pest management, wildlife conservation, farm research, and microfinance [32,33,34].

Table 7. Features of social learning in Kikruma village

S. no	Items	Frequency	Percentage
1.	**Facilitation**		
	a. From external agency	6	10
	b. From internal agency	54	90
2.	Small group work		
	a. Present	60	100
	b. Not present	0	0
3.	**Type of thinking**		
	a. Closed	13	21.7
	b. Open	47	78.3
4.	**Opportunities to influence** others		
	a. Can- not influence	11	18.3
	b. Can influence	49	81.7
5	**Level of participation (coercing=1,informing=2,consulting=3,nticing=4,co-learning=5, co-acting)**		
	Co-acting	60	100

Table 8. Level of knowledge on *Zabo* system of farming

S. No.	Questions	Percentage of framers with correct answer
1	Do you know the meaning of Zabo?	80
2	Do you know about different components of Zabo?	78
3	For how many days water is kept in silt retention tank before transferring to main tank?	73
4	Do you know, how the seepage loss from bunds is prevented?	58
5	Which rice variety is mainly grown in your area?	75
6	What is the seed rate for your local paddy variety “Tanyekemuga”?	65
7	What is the the average capacity of catchment tanks?	45
8	In which month ponds are repaired?	72
9	When the fish-lings are released in the fields?	80
	Average	69.5

Table 9. Perceived enhancement in human capital on *Zabo* system of farming

S.N.	Variables & their categories	Frequency	Percentage
A.	**Occupational capacity**		
	<2.6 (Very low)	5	8.3
	2.6-3.4 (Low)	5	8.3
	3.4-4.2 (Medium)	12	20.0
	4.2-5.0 (High)	32	53.3
	5-5.8 (Very high)	9	15.0
B.	**Capacity to work**		
	<2.8 (Very low)	4	6.7
	2.8-3.5 (Low)	7	11.7
	3.5-4.3 (Medium)	6	10.0
	4.3-5.0 (High)	30	50.0
	5-5.7 (Very high)	10	16.7
C.	**Adaptive capacity**		
	<3.3 (Very low)	3	5.0
	3.3-3.9 (Low)	4	6.7
	3.9-4.3 (Medium)	4	6.7
	4.3-5 (High)	35	58.3
	5-5.6 (Very high)	14	23.3
D.	**Attitude**		
	<3.4 (Very low)	5	8.3
	3.4-3.9 (Low)	0	0.0
	3.9-4.4 (Medium)	9	15.0
	4.4-5.0 (High)	39	65.0
	5-5.5 (Very high)	7	11.7
E.	**Moral development**		
	<3.4 (Very low)	2	3.3
	3.4-3.9 (Low)	3	5.0
	3.9-4.4 (Medium)	22	36.7
	4.4-4.8 (High)	27	45.0
	4.8-5.3 (Very high)	6	10.0

Zabo system of integrated water management has helped the community in improving their quality of life and environment. It helped in producing better yield of paddy and other minor crops by ensuring adequate irrigation water on time. The average yield of paddy under Zabo system was 1.95-2.5 t ha-1 (Table 11) which is nearly 1.33 times than average yield of than Nagaland state (1.7 t ha-1). Sharma [35] reported that the paddy yield through Zabo system was more than double the average yield of the state and three times more than shifting cultivation. The average yield of fish from Fish-cum-paddy cultivation was 40-80 kg/ha. This higher yield enabled community people to meet their daily needs along with requirement in rituals and festivals.

It was evident from the study that community practice based social learning for integrated water conservation through locally developed *Zabo* system had enhanced the economic yield and perceived social capital and human capital. Social learning helpes in management of natural resources through acquisition of new knowledge as well as development of trust, relationship, and collective action [36,24]. The villagers followed co-acting level of participation in social learning process, which is most desirable way of participation for community of practice [36]. When people have freedom to add their ideas in decision making, as in Kikruma village, this provide open thinking platform enhancing their adaptive capacity. Involvement of people in decision making for ecosystem management enhances their adaptive capacity [37,38]. Social learning is important means for adaptive management through stakeholder participation to cope with complexity and resultant uncertainty when they faced [39,40,41]. It is important for our policy makers to emphasize on collective action by locals when ecosystem management is at stake.

Table 10. Perceived enhancement in social capital in Kikruma village

S.N.	Variable & their categories	Frequency	Percentage
A.	**Cooperativeness**		
	<3.5 (Very low)	0	0.0
	3.5-3.9 (Low)	7	11.7
	3.9-4.3 (Medium)	17	28.3
	4.3-4.6(High)	30	50.0
	4.6-5.0 (Very high)	6	10.0
B.	**Civic culture**		
	<3.1 (Very low)	3	5.0
	3.1-3.8 (Low)	6	10.0
	3.8-4.4 (Medium)	12	20.0
	4.4-5.1 (High)	39	65.0
C.	**Solidarity**		
	<3.5 (Very low)	2	3.3
	3.5-4 (Low)	2	3.3
	4.0-4.5 (Medium)	19	31.7
	4.5-5.0 (High)	20	33.3
	5-5.5 (Very High)	17	28.3
D.	**Sociability**		
	<3.3 (Very Low)	1	1.7
	3.3-3.8 (Low)	12	20.0
	3.8-4.3 (Medium)	18	30.0
	4.3-4.8 (High)	19	31.7
	4.8-5.3 (Very High)	10	16.7

Table 11. Financial capital

Variable	Kikruma Village	Average yield of Nagaland under Jhum cultivation
Yield of paddy (t ha^{-1})	1.95-2.5	1.7
Yield of fish (kg ha-1)	40-80	

4. CONCLUSION

The study showed that the social learning through collective action for integrated water conservation had positive impact on human capital, social capital and economic standard of the people. More research on social learning for collective management of resources with local context should be taken up to harness the strength of communities' wisdom and value. Since such traditional techniques like Zabo system, remain confined to a particular area, there is need of concerted efforts towards devising strategies to popularize the importance of such eco-friendly systems through various change agencies for wider adoption among communities of similar ecosystems.

CONSENT

As per international standard or university standard, respondents' written consent has been collected and preserved by the author(s).

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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