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Participatory GIS For Irrigation Management in Periyar Main Canal Command Area - A Case Study of Kumaram Village, Madurai District

R. Manonmani, Dr. R. S. Suja Rose
Department of Environmental Remote Sensing and Cartography Madurai Kamaraj University, Madurai, Tamil Nadu. India

ABSTRACT

Geographical Information System (GIS) has been established as a powerful tool for planning and decision making process. The participation of local farmers at different stages of data input in GIS enables the researcher or a planner to produce a holistic and efficient output in the process of participatory planning. Participatory GIS (PGIS) aims to use the spatial knowledge of people at local level. The spatial representation of local knowledge facilitates participatory decision-making processes. The use of local knowledge and perception of farmers can help in creating an outline for developmental plans. It can contribute to the empowerment of farmers in solving developmental problems. The Periyar main canal command area (PMCC), under the administration of Dindigul, Madurai and Sivaganga districts, is selected for the present study to understand and the problem of the farmers. The aim of the study is to understand the irrigation facilities and to analyse the problems in irrigation management using PGIS in Kumaram village. Participatory maps are prepared by the farmers and are used as input in GIS. Further various methods of participatory rural appraisal (PRA) like transect walk, focus group discussion, participatory mapping and ranking methods are adopted in the study. The problem faced in the study area includes shortage of water for irrigation, inadequate price for agricultural produce, inadequate labour and ineffective water user association. Finally, the study concludes with suggestive measures that can be taken for the improvement of irrigation facilities for better cultivation in the study area.

Keywords: Irrigation Management, Participatory Mapping and PGIS

I. INTRODUCTION

Participatory rural appraisal (PRA) is a specific form of rapid rural appraisal (RRA), a research technique developed by the researchers in the late 1970s and early 1980s as an alternative and compliment to conventional sample survey. PRA is a way of learning from and with community members to investigate, analyze and evaluate constraints and opportunities, and make informed that timely decision regarding development projects.

Participatory GIS (PGIS) is a participatory approach to generate spatial information for spatial planning. PGIS combines Participatory Learning and Action (PLA) methods with geographic information systems (GIS) [Chambers, R. (1992), JoAbbot et.al.,(1998), Giacomo Rambaldi (2010)]. PGIS combines a range of geo-spatial data management tools and techniques such as sketch maps, participatory 3D modeling (P3DM), aerial photography, satellite imagery and Global Positioning System (GPS) data to represent peoples' spatial knowledge in the form of two or three dimensional maps. They are used for spatial learning, discussion, information exchange, analysis and decision making. PGIS implies making geographic technologies available to the disadvantaged groups of the society in order to enhance their capacity in generating, managing, analysing and disseminating spatial information. The PRA studies have been conducted by scholars like Paul Gosselink et al., (1997), John Campbell (2002), Mehretab Tesfai et al (2000), Anwar Alam et al (2012), and Kannan Narayanan (2014). Whereas the scholars like Saha et al., (2012), Soman (2014) and K.Musungu (2015), have used GIS for participatory appraisal.

The recognition of local participation has contributed to evolve a set of techniques designed to increase local participation and knowledge in planning process. The participation of local villagers at different forms of data

collection and using them as input in GIS enables the researcher to produce a comprehensive output for planning. GIS is necessary to ensure local knowledge and participation in a variety of planning projects. This research paper examines the sources of irrigation in Kumaram village in Periyar Main Canal Command (PMCC) area and considers the local knowledge in irrigation management to improve the irrigation facilities by applying the techniques of PGIS.

STUDY AREA

The Kumaram village spatially lies between 10°0'31" to 10°1'47"N latitudes and 78º4'52" to 78º5'46" E longitude, which is located in the head reach command area in the Periyar Main Canal Command (PMCC) area (See figure 1). The study area holds a total population of 858 persons as per 2011 census. The male population is 412 persons and female population is 446 persons. The study area experiences a sub-tropical climate. The predominant agricultural crop is paddy, followed by coconut, banana, sugarcane and dry crops.

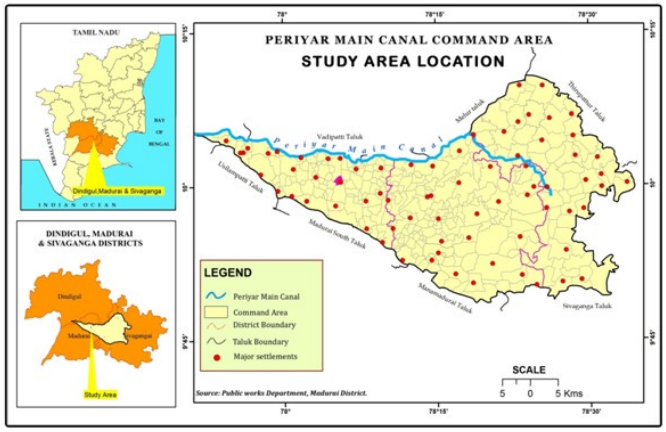

Figure 1.

AIM OF THE PRESENT STUDY

The aim of this study is to analyse the irrigation facilities and its management by applying the PGIS methods in Kumaram village of PMCC area. The aim is achieved by framing the following objectives.

OBJECTIVES

i. To apply PGIS for irrigation management in Kumaram village.

ii. To study the perception of farmers about irrigation related issues.

iii. To suggest measures for improving irrigation facilities.

II. METHODOLOGY

The methodological frame work adopted for the study can be explained in a few steps. Initially, the Survey of India toposheets comprising the numbers 58K/l, 58G/13, 58J/4, 58F/16 at 1:50,000 scale is georeferenced. Subsequently, the cadastral map of Kumaram village was imported and rectified with reference to SOI toposheet in ArcGIS platform. The georeferenced cadastral maps were then digitized and are assigned with the revenue numbers.

The various methods of PRA adopted in the study were transect walk, focus group discussion, participatory mapping and ranking methods, which brought out the problems of farmers in irrigation management. Initially, transect walk was undertaken, involving the local farmers for monitoring the field and identifying the problems. Transect walk method mainly deals with direct observation and incorporates the views of farmers. Informal meetings were held with the local farmers and workers and group discussions were made to bring out the problems related to irrigation and farming activities. Participatory mapping helped in preparing thematic maps on major crops, irrigation sources, facilities and its problems in the study village during 2017. Ranking methods is designed for the factors related to irrigation management. The ranking method was used to extract the preferences and opinions of farmers with regard to irrigation management. The local farmers shared their knowledge and opinions and were appropriately used in the study. They ranked the irrigation management strategies, on the basis of the criteria they have chosen.

The matrix ranking (first, second, third, etc.) gives an indication of relative preferences scoring (placing on a scale of 1–5) which were also used in the present study to improve the irrigation facilities and planning through farmers' participation. All the farmers were allowed to discuss elaborately and freely to express their opinion to rank the issues individually. Finally, a matrix was prepared immediately on the chart paper and displayed to the participants. Farmers felt more comfortable to change their minds from their original point of view.

Plot maps and direct observation data were integrated in GIS environment. Thematic maps of revenue plots within Kumaram village, land use, crop types, sources of irrigation, methods of irrigation and canal flow were mapped. The results are discussed here under.

PGIS FOR IRRIGATION MANAGEMENT

The study on the irrigation management in Kumaram village of Command area is done by using participatory methods. The selected village is located in Madurai district and lies in the head reach of the command area (Figure 1). The irrigation management using PGIS in Kumaram village is discussed under four major headings as irrigation and agricultural practices, problems related to irrigation management, strategies of irrigation management and mitigation practices for irrigation management.

III. IRRIGATION AND AGRICULTURAL PRACTICES

The irrigation and agriculture practices of Kumaram village are discussed under three headings as given below.

i) Sources of Irrigation

Irrigation source is analysed with the help of local farmers using participatory mapping method. Figure 2 shows the resultant participatory map prepared in GIS. The major sources of irrigation in Kumaram village include canal, tank, and well. The irrigation in the village is fully dependent on the PMC water as it lies in the head part of the command area. From the transect walk and group discussions carried out with the local farmers, it has been found out that the infrastructure facilities for canal irrigation is sufficient. Double crop is cultivated, when there is enough supply of water in PMC and the system tanks connected to it. During the time of deficit, well water is used for irrigation. The seasonal availability of these water sources has adversely affected the irrigation. From the study it is found out that seasonal shortages of water from PMC are becoming a regular phenomenon, local farmers and their sub-groups depend on well for their irrigation needs.

ii) Land use / land cover

The land use pattern of the area brings out the actual and specific use of land and it changes from time to time according to human use. Out of the total study area the following land use / land cover is categorized viz. built up area, agricultural land, fallow land, water body category like tank, canal and pond and are mapped by the farmers during the participatory mapping process. Accordingly, built up area occupies 8.39% (11.15 ha), agricultural land occupies 9.98% (13.38 ha) fallow land occupies 66.44 % (81.00 ha). The high percentage of fallow land is due to the shortage of water, labour problems, lack of finance and ineffective WUA. As a result these cultivable fallows lands are converted in to residential plot, commercial activity and other industrial activities. Canal occupies 1.88% (2.53 ha), tank and pond occupies 19.51% (26.15 ha).

Table 1. KUMARAM VILLAGE
AREAL EXTENT OF LAND USE / LAND COVER-2017

Land use/land cover	Area in	
	Hectare	**Percent**
Built up area	11.25	**8.39**
Agriculture land	13.38	**9.98**
Fallow land	81.00	**60.44**
Canal	2.53	**1.88**
Tank/Pond	26.15	**19.51**
Total	134.00	**100.00**

iii) Cropping Pattern

In the present study, transect walk was done and it was found out that paddy, sugarcane, and banana are predominantly cultivated in the rainy season in Kumaram village. In summer, pulses have been cultivated depending on well irrigation. A map on cropping pattern is created with the help of local farmers using participatory mapping method and the map prepared in GIS is depicted in figure 3. Based on the irrigation facilities the agricultural crops including paddy, coconut, banana, sugarcane and mango are cultivated. Out of the total study area, the areal extent of net sown area is 13.38 ha. Of this net sown area paddy occupies 28.40 % (3.80 ha), coconut 27.87% (3.73 ha), banana 26.23% (3.51 ha) and mango 1.04% (0.14 ha).

Table 2. KUMARAM VILLAGE
AREAL EXTENT OF CROPPING PATTERN-2017

Crops	Area in	
	Hectare	Percent
Paddy	3.80	**28.40**
Coconut	3.73	**27.87**
Banana	3.51	**26.23**
Sugarcane	2.20	**16.44**
Mango	0.14	**1.04**
Total net sown area	13.38	**100**

Source: Field data collected by the Investigator

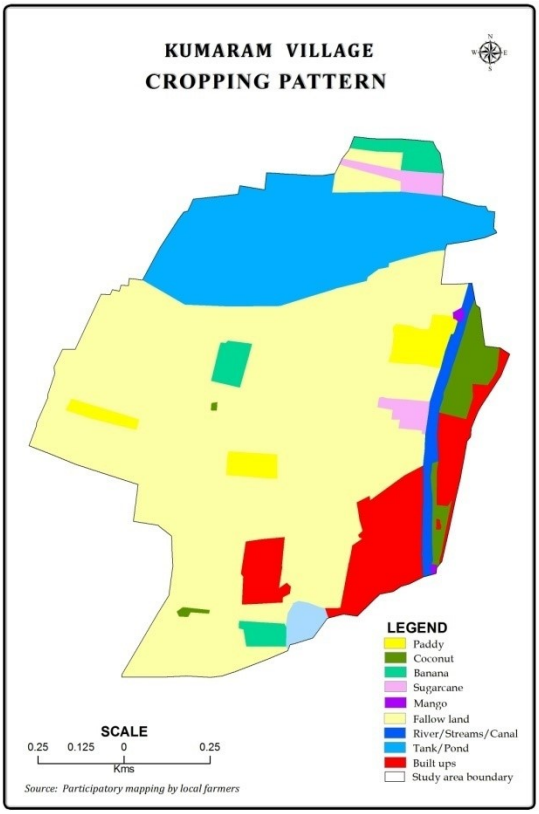

Figure 2 .

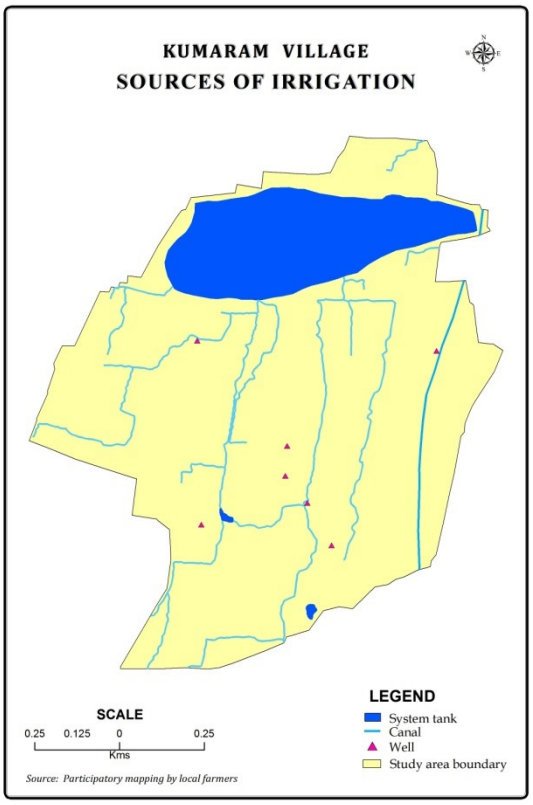

Figure 3.

IV. PROBLEMS RELATED TO IRRIGATION MANAGEMENT

The problems related to irrigation management have been identified and information is collected through focus group discussion. This method was adopted for all farmers and were consolidated and presented in Table 3 and discussed in three subheadings hereunder.

i) Problems identified in irrigation infrastructure

During the series of meeting with local farmers of 19 members it is learnt that they are facing various problems and those are listed and described in Table 3. The problem of insufficient quantity of water supply due to inadequate rain fall is reported by 89 % of the farmers; labour problems during cultivation period is faced by 65 % because labours are shifting to MGNREGS, while theft of irrigation infrastructure

(electricity wire and irrigation motor pump set) is reported by 20 %. As a result these cultivable fallows lands are converted in to residential plot, commercial activity and other industrial activities. These are the reasons identified in the village regarding irrigation infrastructure.

Table 3 .PROBLEMS RELATED TO IRRIGATION MANAGEMENT

Sl.No	Problems	Percentage
1.	**Problems identified in irrigation infrastructure**	
	Insufficient quantity of water supply	89
	Labour problems	65
	Theft of electricity wire and irrigation motor pump set	20
2.	**Water user Association**	
	Ineffective water user association	85
3.	**Problems identified in farming activities**	
	Unprofitable cultivation	63
	Very less selling price for agricultural produce	74
	Lack of finance and loan	79

Source: Multiple responses were reported in field data collecting

ii) Water user Association

The focus group discussion meeting in the present study area has revealed that water user association in the 9th branch channel is established. The water user association effectively functioned before five years, but currently it is inactive due to some internal problems. This is also a major hurdle in irrigation management in this village. Eighty five percent of farmers have suggested that the water user association should be activated to take over the responsibilities of canal maintenance, equal distribution of water and farmers needs.

iii) Problems identified in farming activities

The focus group discussion meeting in the study area has identified problems related to farming activities, which are unprofitable cultivation expressed by 63 %, very less selling price for agricultural produce is 74 %, lack of finance and loan at the time of cultivation for low income group is 79 %.

V. STRATEGIES OF IRRIGATION MANAGEMENT

The criteria related to strategies of irrigation management have been identified through focus group discussion. Further, the criteria have been ranked by the respondents using ranking method. This method was adopted for all the farmers and the ranks were consolidated and presented in Table 4.

Table 4. ISSUES IN STRATEGIES OF IRRIGATION MANAGEMENT

S.No	Criteria	Percentage of Respondents					
		Ranks					
		I	II	III	IV	V	NR
1	**Involvement of farmers in irrigation management**						

	(i) Operation and maintenance of the structures for the distribution of water	95	-	-	-	-	5
	(ii) Suggestion for the distribution of water	-	53	-	-	-	47
	(iii) Design of the irrigation system	-	-	21	-	-	79
	(iv) Construction of the irrigation system	-	-	-	5	-	95
2	**Role of motivator**						
	(i) Trained govt. official	89	-	-	-	-	11
	(ii) Any person who knows farmers and their problems	-	26	-	-	-	74
	(iii) Farm leader	-	-	11	-	-	89
3	**The technologies that can be used in irrigation management**						
	(i) Mobile phone	100	-	-	-	-	-
	(ii) Television	-	95	-	-	-	5
	(iii) Computer	-	-	21	-	-	79
	(iv) Internet	-	-	-	-	5	95
	(v) App	-	-	-	-	5	95
4	**Media to be used for sharing information for irrigation management**						
	(i) Mobile	100	-	-	-	-	-
	(ii) Television	-	74	-	-	-	26
5	**Awareness about Mobile app related to irrigation management**						
	(i) Yes	-	5	-	-	-	95
	(ii) No	95	-	-	-	-	5
6	**Information used from Mobile App**						
	(i) Crop insurance	-	5	-	-	-	95
7	**Farmers requirement related to irrigation management information**						
	(i) Government subsidies	53	-	-	-	-	47
	(ii) Crop insurance and information	-	42	-	-	-	58
	(iii) Market status	-	-	37	-	-	63
	(iv) Soil fertility	-	-	-	26	-	74
	(v) Land characteristics	-	-	-	-	11	89

Source: Field data collected through multiple responses were reported
Note: NR – No response

i) Area which requires involvement of farmers

Kumaram village has good canal infrastructure facilities. As far as the canal water supply is considered 90 % of the local farmers show interest in the maintenance of the canal structure for the distribution of water and they have given first priority. They are interested to work with their neighboring farmers. They never depend on water user association and government officials for the maintenance work. Whereas second priority is given to involve farmers in the distribution of water (53%) because, it depends upon farmers needs and 21 % of the farmers have suggested involving them for the design of irrigation system and five percent of farmers are ready to involve themselves in the construction of the irrigation system and has given third and fourth priority

respectively. They felt water supply to reach every one of the farmers land.

ii) Role of Motivator

The role of catalyst is most important to motivate the farmers to participate. At the time of discussion 89 % of the local farmers feel that during the cultivation period Government officials of the department of agriculture have to train the farmers based on the availability of water about the various cultivation procedures and the list of crops to be cultivated in order to enhance their agricultural produce. Whereas 26 % of the farmers feel that any person who knows farmers and their problems can act as catalyst and have given second priority and eleven percent of the farmers suggested that a farm leader can also motivate participation of farmers for irrigation management because they have to take strong decision regarding farmers problems and convey it to the government authority.

iii) Use of technologies in irrigation management

The recent technologies play a major role in irrigation management. One of the recent technologies namely GIS and Participatory approaches effectively contribute to spatial planning, management and development. During the village meetings, question is asked to the farmers regarding the recent technologies that can be used in guiding their irrigation management. Positively, all the local farmers have given the first priority to mobile phone technology, because all of them use mobile phones (Table 4). The other technologies are in their order of preference is television 95 % because farmers watch the program related to irrigation management directly and is more effective in self understanding. Use of computer is 21%; internet and mobile app is five percent because most of them are not aware about these technologies.

iv) Media to be used for dissemination of information

The media for sharing farm related information is also ranked by the farmers. The local farmers have given the first priority for mobile phone, because all the farmers feel that if information is given through mobile by means of SMS /automated call it can be easily accessed for effective irrigation management (Table 4). All the farmers have mobile phones and they can get the farm related messages immediately and so the farmers feel mobile phone can be very well used for the dissemination of information. The second priority is given to television (74%).

v) Awareness about mobile app

Mobile application is probably used in all fields. It can be of so much use and so convenient to be downloaded. The Agriculture Ministry and Central government have launched a number of mobile apps for farmers. The application aims to provide information about the latest agriculture trends, equipment, technologies and methods being used for agriculture. In the present study the awareness about mobile app related to farming activity is discussed in focus group discussion among the farmers. From the study it is found out that 95% of the farmers don't know about mobile app because most of them farmers do not have smart phone and few of them are illiterates.

vi) Information used from Mobile App

From the study it is evident that few of the farmers know about the information in mobile app that too only five percent of them know about crop insurance information. The remaining farmers are not aware of mobile app, as they seldom use smart phones, which can display the farming related information.

vii) Information to be presented mobile apps

During the series of village meetings, questions are asked to the farmers about the information to be included if a participatory GIS is developed which will be useful for the farmers. The local farmers of 53% addressed that it should be government subsidies, 42% as information related to crop insurance, 37% as market status of agricultural produce, 26% as soil fertility and 11% as land characteristics in the order of priority from first to fifth rank respectively (See Table 4).

VI. MITIGATION PRACTICES FOR IRRIGATION MANAGEMENT

From the farmers' response the solution for insufficient irrigation is in found out an efficient way through participatory tools. The local farmers provided the reliable solution like the effective water user association,

trained govt. official to catalyst participation of farmers in irrigation management, loan facility for cultivation activities, crop insurance during crop failure, government support to labour for agriculture (for example, the labours could be met from MGNREGS) and appropriate information related to farming activity as the solution for mitigation practices for better irrigation management.

VII. SUMMARY AND SUGGESTION

The present study revealed the use of Participatory GIS for irrigation management. A participatory approach helps in gathering data from local farmers by exploring the geographical area through their eyes and experience. Kumaram village is fully dependent on the PMC irrigation and the infrastructure facility for canal irrigation is sufficient.

The local farmers faced major problems like insufficient quantity of water supply, unprofitable cultivation, very less selling price for agricultural produce, labour problems during cultivation period, lack of finance and loan at the time of cultivation, ineffective water user association and theft of agricultural equipments and infrastructure. On analyzing the strategies of efficient irrigation management, they felt that water supply should reach every one of farmers land. The local farmers feel that during the cultivation period government officials belonging to the department of agriculture have to train the farmers based on the availability of water about the various cultivation procedures and the list of crops to be cultivated in order to enhance their agricultural produce. The recent technologies play a major role in irrigation management. The media for sharing farm related information through mobile by means of SMS /automated call can be easily accessed for effective irrigation management. Farmers represent the flexible solution for irrigation management and the information to be provided to farmers through mobile phones are government subsidies, crop insurance and information, market status of agricultural produce, soil fertility and land characteristics. The result of Participatory and GIS for irrigation management concluded that the information provided by the participatory methods like transect walks, focus group discussion, participatory mapping, and ranking method are useful for the development activities with regard to irrigation management in the study area. This methodology can be applied for any study area to assist in better irrigation management. PRA analyses have a good performance for irrigation management.

VIII. REFERENCES

[1]. Anwar Alam et al, (2012) Role of Participatory Rural Appraisal in Community Development- A Case Study of Barani Area Development Project in Agriculture, Live Stock and Forestry Development in Kohat: International Journal of Academic Research in Business and Social Sciences, Vol. 2, No. 8.

[2]. JoAbbot et.al.,(1998), Participatory GIS: opportunity or oxymoron? PLA Notes, October 1998.

[3]. Giacomo Rambaldi (2010) Participatory Three-dimensional Modelling: Guiding Principles and Applications, 2010 edition.

[4]. Chambers, R. (1992). "Rural Appraisal: Rapid, Relaxed, and Participatory", Institute of Development Studies Sussex: HELP, United Kingdom: 3-70.

[5]. John Campbell (2002). A critical appraisal of participatory methods in development research, International Journal of Social Research Methodology, 5:1, 19-29.

[6]. Kannan Narayanan (2014) Impact of Participatory Irrigation Management - Case Study: Cocurirwa Cooperative, Rwamagana Rice Project, Rwanda: Advances in Plants & Agriculture Research, Volume 1 Issue 3 – 2014.

[7]. Mehretab Tesfai et al., (2000) "Participatory rural appraisal of spate irrigation systems in eastern Eritrea," Agriculture and Human Values 17: 359–370.

[8]. Musungu,(2015)" Assessing spatial data quality of participatory GIS studies: a case study in cape town" ISPRS Annals of the Photogrammetry, Remote Sensing and Spatial Information Sciences, Volume II-2/W2

[9]. Saha et al., (2012) "Participatory GIS for judicious water resource management in canal commands of eastern india", 13th Esri India User Conference.
[10]. Soman,(2014)" Participatory GIS in action, a public health initiative from Kerala,India" The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences, Volume XL-8.
[11]. Paul Gosselink and John Thompson (1997) "Application of Participatory rural appraisal methods for action research on water management" IIMI vi, 30p. (Short Report series on locally managed irrigation, no. 18)