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MAPPING AND SITUATION ANALYSIS OF DRINKING WATER RESOURCES IN INDIA – A PARTICIPATORY APPROACH

Kartering och situationsanalys av dricksvattentillgång i Indien ur ett lokalt perspektiv

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Abstract

Geographical space is a vital factor over a broad range of decision making problems. Participatory Resource Mapping (PRM) can be a vital tool for collection and assimilation of data on broader spatial scale with ease and accuracy. In this paper we seek to determine the connections between PRM and its linkages with the grassroots knowledge possessed by the local communities. We have presented a case study of PRM in seven villages of Guna district, Madhya Pradesh, India. The results of the study are presented in form of resource maps. This study focuses on problems faced by villagers in accessing drinking water which may be based on social or economic structure of the society. Mapping of resources is carried out to study in depth the problems existing and with perception that public participation research efforts largely adhere to the more positive first view and seek to develop approaches, technologies and mechanisms that aid self-determination. Problems faced includes shortage of drinking water, social discrimination based on sex and income, depleting of groundwater resources, exploitation of water resources, deteriorating water quality among many others. Finally we conclude with suggestive measures that can be taken for improvement of adverse conditions in these villages.

Key words – Participatory Resource Mapping (PRM), Water Resources, Drinking water, Social Exclusion/Disparity, India

Sammanfattning

Det geografiska läget är en viktig faktor i beslutsprocessen. Participatory Resource Mapping (PRM) kan vara ett viktigt verktyg för insamlande och tolkning av data med hjälp av lokalbefolkning, lokala myndigheter och organisationer. I denna artikel undersöker vi hur PRM för att undersöka tillgången av dricksvattenresurser i sju byar i Guna distriktet, Madhya Pradesh, Indien. Resultaten beskrivs i form av resurskartor. Studien fokuserar på sociala och ekonomiska faktorers inverkan på bybornas tillgång till vattenresurser. Problem som identifierades var brist på rent dricksvatten, diskriminering på grund av kön och inkomst, överutnyttjande av grundvatten, försämrad vattenkvalité mm. Vi föreslår också olika förbättrade lösningar för byarna.

1 Introduction

An individual's ability to map out, in a geographical sense, as to what they view the future to be, is a pre-requisite in any sustainable planning. Resource distribution, tenure and access are crucial factors in natural resource management. They can also be spatially defined within broader social, economic and environmental contexts. The public is an enormous data resource that can be of tremendous benefit to decision makers. Traditional knowledge is information which encompasses the experiences of a particular culture or society. They comprise a formidable tool set for use in cultural preservation, land rights dispute, natural resource management,

ecosystem development etc. The complex nature of sustainable natural resource management requires a sort of research which uses a systems approach – research that is interdisciplinary, combining both physical and socio economic dimensions. Community based natural resource management is being adopted widely as a possible solution to all such problems. GIS as a tool along with indigenous knowledge and combination of ordinary statistics with geographic location to create meaningful, clear and attractive maps that can be applied to development needs (USAID, 2002).

Participatory GIS is an emergent form of practice; in its own domain; developing from participatory approaches to planning, spatial information and communication management. It is result of efficient merging of participatory learning and action (PLA) methods with geographical information technology and systems. PGIS encompasses a range of geo-spatial information management tools and methods such as sketch maps. This practice integrates several tools and methods combining expert skills with socially differentiated local knowledge. It helps to analyze the linkages, patterns and inter-relationships of land use. It can be used as a powerful tool for communities (Jordan and Shreshta, 1999) and also civil society groups working in collaboration with it. Its objective is to enable villagers to carry out the interpretation of the aspects of their land resources, which are of vital importance to them. In this context (Hamilton, 2002) explains while participating in the planning process if group interaction is encouraged, consensus on causes of action can be arrived at. They identify the learning theory to the context of participation planning with four levels as follows, access, comprehension, interaction and finally learning. Sharing information about common problems of a resource can be managed and it facilitates generation of views, which are not seen before (Gonzalez, 2002). There are now innumerable examples of mapping for NRM, covering forestry, watersheds, irrigation, coastal management, fishing, pastoralism, traditional territories, parks and conservation, biodiversity, distribution of species and so on. Such maps range from comprehensive resource mapping to mapping of just one resource like for example livestock forage (Conroy, 2005) or the distribution of a species. Uses include land use and resource planning and management, wildlife conservation, identifying tenure and rights, negotiating boundaries and resource uses, resolving conflicts, and participatory monitoring and evaluation (PM and E). Participatory resource mapping has been used for a whole range of other purpose for NRM including water and sanitation, for example in rural villages in India (Joseph, 1994). Mapping areas of open defecation is a key element in the spreading movement for Community-Led Total Sanitation in Bangladesh, Cambodia, India, Indonesia, Mongolia, and Nepal (Kar, 2005).

Participatory Resource Mapping (PRM) is a method for collating and plotting information on the occurrence, distribution, access and use of resources within the economic and cultural domain of a specific community (Primer on Coastal Resource Management). As it is very often used as the 'entry' tool into the use of participatory methods and approaches by practitioners in a village, especially where spatial analysis of land use is envisaged, it permits more villagers to participate. It also facilitates the identification of resource persons in the village as well as the identification of the more reluctant participants. It is used as a way to identify rights, a way to make customary tenure relations and rights apparent for outsiders and a way to facilitate the official administrative recognition of these rights.

Water is the key to development and sustenance of all communities. Under conditions of increasing stress on this essential renewable but scarce natural resource, effective and efficient management of water is emerging as an urgent contemporary issue. The realization of its limited availability in space and time has necessitated the designing of new globally viable water management regimes aiming at striking a balance between the use of water as a basis for livelihood and its protection to help ensure its sustainability through present to future generations (Aggarwal et al., 2000). In the rural localities, irrespective of the existing social diversities, water is regarded as a gift of nature made available to mankind for fulfilling the basic needs for survival. Most of these needs are believed to be common to all and therefore water is seen as a common resource over which universality of rights basic for life should prevail and every user must have access to water for fulfilling all relevant needs. Water is seen as a renewable yet scarce resource to be handled with care so that quality and quantity are not degenerated. The underlying quantity-related principle in utilizing water resources in the village lies in exploiting nature for serving human interests but not to the extent of depleting them forever. Water is probably the only natural resource to touch upon all aspects of human civilization – from agricultural to individual development to the cultural and religious values embedded in society (Matsuura, 2002 cited in Castelein and Otte, 2002). Due to its fundamental role in society's life, water may also be said to imply strong cultural dimension also (WWC, 2003). The centrality of water in human life has made it arguable that the ways in which it is conceived and valued, understood and managed, used or abused, worshipped or desecrated, are influenced by the cultures (WWC, 2003).

In India, water is today perceived by the rural public as a social right, to be provided free by the Government,

rather than as a scarce resource which must be managed locally as a socio-economic good in order to ensure its effective use. This perception has been grown out of the fact that the present rural water supply systems are designed and executed by the Department/Boards and, imposed on end-users. Demand preferences of the people are not taken into account while executing the schemes. In other words, rural water supply program till now has been adopting a supply driven approach. Experience has shown that the present approach has led to the failure of a large number of water supply systems/ schemes due to poor operation and maintenance. Therefore there is urgent need of understanding social aspects of water and local communities must be involved in planning and management of it.

2 Study objectives

In this paper, we have investigated water resources facilities in seven villages of Guna district, Madhya Pradesh, India. We have prepared PRM of the facilities of water for ease of understanding the present status of resources in these villages. The main objectives of this study includes assess the demand for and supply of water in communities and strategies adopted by them using participatory approach to map resources and their perception, enhancing the information about the available water resources of villages through resource maps, sectorial distribution of water for domestic consumption and sanitation related to personal hygiene, solid and liquid waste generated by households, and finally, inquiry in selected aspects related to availability, accessibility, quality, stress in collection, health impacts, social and sanitation related issues. Along with above said objectives, the present study has few limitations which include: quality of water that has been used in the analysis is based only on the observations by field visits or by the information provided by the community. The study did not undertake a quality of testing of water of the villages studied. The analysis is based on the information provided by the community and on their notions of quality.

3 Study area

Guna is a district in north-eastern Madhya Pradesh, India and is the gateway of Malwa & Chambal. It is located on the north-eastern part of Malwa Plateau, on the bank of river Parfaits. The western boundary of the district is well defined by the river Parbati. Guna is located at 24.65°N 77.32°E. It has an average elevation of 474 meters. The total area of District is 6484.63 km^2 with a total of 115 inhabited villages, 1260 habitated villages, with 1 forest village and total habitations of 1375. Population of Guna district is 976 596. Males constitute 53 % of the population and females 47 %. Guna has an average literacy rate of 67 %, higher than the national average of 59.5 %, male literacy is 75 %, and female literacy is 57 %. In Guna, 15 % of the population is under 6 years of age (Census of India, 2011).

4 Methodology

The present study is primary level study that has adopted the methodology of purposive sampling to initiate detailed enquiry into the issues that have been identified in objectives of study and to address the concerns of communities and individuals in water and sanitation at village level. The data in the study has been procured through intensive residential fieldwork in these villages. Fieldwork techniques such as participant observation, key informant interviews, both unstructured and structured, with open-ended questions and closed ended questions were used for procuring the primary data. A number of secondary sources were also referred for procuring information. Seven villages of Guna were selected. The sample size for collection of data was taken as 10 % of total population in village along with survey of the local self-governments (Gram Panchayats) through questionnaires. The information at the community level was collected from a wide array of stakeholders that included elected representatives of Gram Panchayat, village opinion makers, members belonging to different caste groups, women etc. The villages covered under were: Bageri, Khutyari and Nonera of Bageri Gram Panchayat; Ukawadkalan and Dongar Khedi of Ukawadkalan Gram Panchayat; Shampur and Dhanoriya of Shampur Gram Panchayat.

The concept involved here for mapping is that a group of participants most commonly, the members of the local community draw out the map of their village (or a specified decided area), depicting important resources and places, how the area is represented is interesting in itself as generally aspects of greater importance are portrayed more prominently. Maps are thus not drawn to scale. Steps in PRM included Organizing group of participants from the village concerned – ideally the group should compromise men and women from all age groups, Selecting large ground /area for the map to be made. Then it is usually done using local material of sticks, stones, rangoli powder, chalk, seeds etc. Participants were then elaborated with basic purpose of making these maps, on the basis of which, they were asked to mark certain features such as sources of water, sanitation and natural water resources. The participants were facilitated to ensure equal participation, without a few

dominating. Finally we discussed the issues emerging from the map for further intervention. Data collection tools included individual interviews with persons identified with specific characteristics. The interview was conducted through semi-structured format, group discussions with identified groups in the village to conserve and discuss issues based on the identified issues, observation by authors through field visits and resource mapping to locate water resources and social services in the village by participatory methods.

5 Results

5.1 Resource mapping of villages

Community resource maps were created with help of different stakeholders which are depicted in figure 1. It represents the location based information of different water resources available to community for their use. Data on all the above resources is also compiled in table 1, which shows the exact number and present status of these resources in villages there. With the financial assistance provided to the States under ARWSP, a huge number of hand pumps and piped water supply schemes have been taken up by the state. Due to poor maintenance of the infrastructure created, many of these have become non – functional resulting into fully covered habitations becoming NC/ PC habitations and valuable public resources going to waste. More than 80 % of the drinking water sources in the rural areas are based on ground water. Ground water level is going down drastically which is also a serious concern for the communities. The dominant caste generally leads in regulating water management affairs; little is left for poor and deprived. The social mapping of villages is generally such that the highest castes tend to reside in the heart of the village settlement, while others are arranged towards the periphery in decreasing order of their position, so that those placed lowest generally reside on the village outskirts.

Fulfillment of water needs is accomplished through harnessing of the naturally available water resources. Ordinarily, the water resources available within the physical boundaries of the village are regarded as village resources, the village itself being largely visualized as a micro-watershed. The resources are further classified into categories such as surface water, ground water, and rain water etc., further identified via their sources such as river water, lake/pond water, well water, handpump, tubewell and others with participatory mapping approach (Figure 1). The local villagers have a storehouse of water-related knowledge about their area, which can used in identifying sites and other ground features before creating new water source but government is reluctant to do so.

5.2 Sources of water

The historical water sources used by the community/villagers that were perennial in nature have become seasonal at present due to overexploitation of water for livelihood purpose. The seasonality of these water resources has adversely affected the availability of water for domestic purposes for the households. The sources of water have gone dry due to lowering of the ground water table (main reason being many tubewells/borewells for supplying water to agricultural fields) and increase in population resulting in lower per capita availability. The authors were told by one of the villagers that there are around 70 tubewells in every village, which is very striking, as the total number of households out there are also around 70. This means that each household has a tubewell installed for irrigating their fields. The community fulfils its water requirements through a source-mix depending upon the seasonal availability of water in each of the sources. In most cases all such sources do not form part of the water resources developed by the formal system responsible for supplying water to communities. With shortage of water becoming a regular phenomenon, community and their sub-groups have not been

Table 1. *Status of drinking water facilities in 7 villages.*

S.No.	Village	Dry handpump	Functional handpump	Tubewell	Pond	Well
1	Bageri	5	1	9	3	1
2	Nonera	0	10	12	1	0
3	Khutyari	1	4	5	0	0
4	Dhanoriya	4	4	6	1	2
5	Shampur	0	4	4	0	2
6	Dongar Khedi	3	3	2	0	1
7	Ukawadkalan	2	4	5	0	2

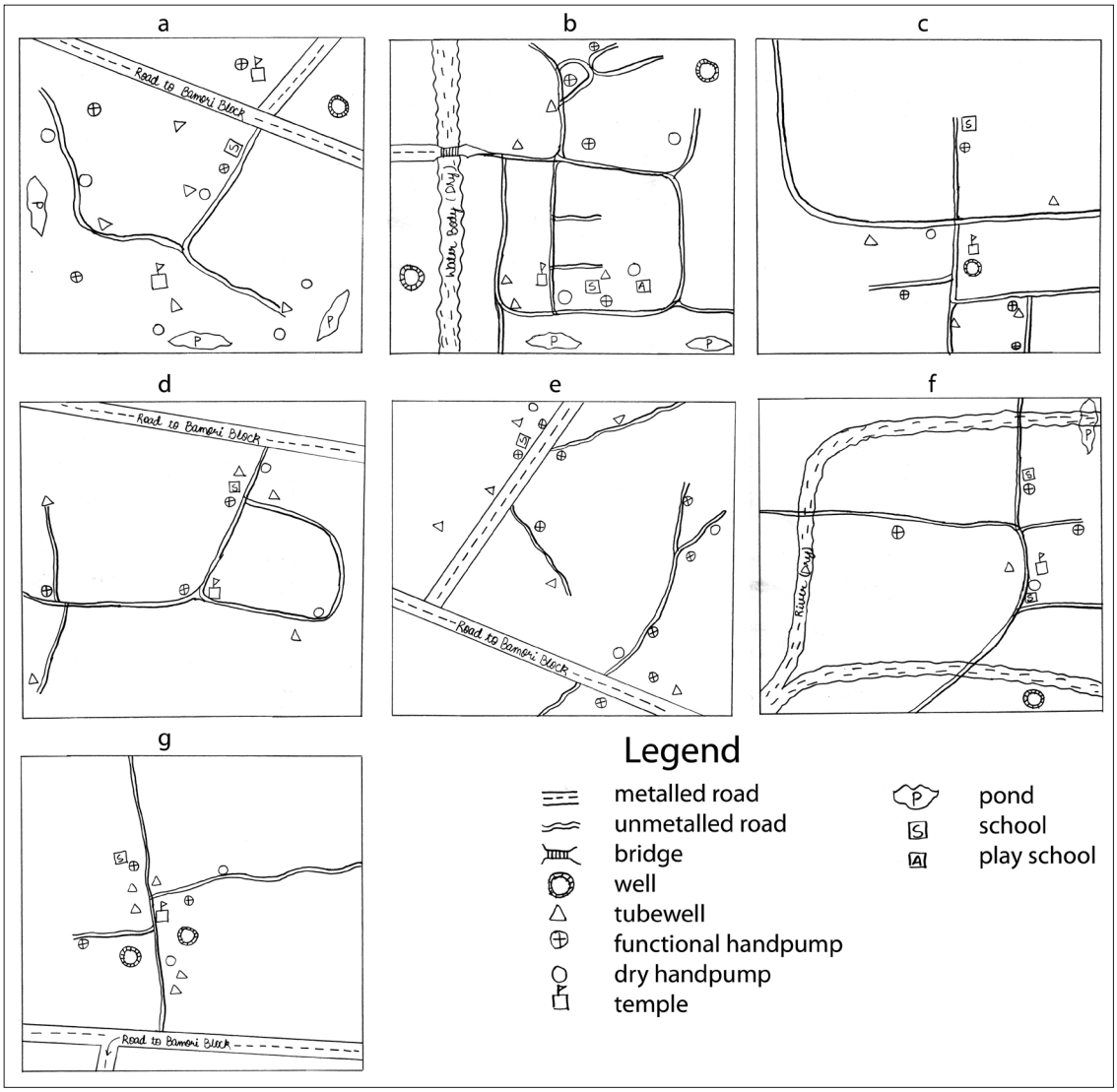

Figure 1. *Participatory resource maps of seven villages where a = Bageri, b = Dhanoriya, c = Dongar Khedi, d = Khutyari, e = Nonera, f = Shampur, g = Ukawadkalan.*

able to develop effective coping strategies to deal with these shortages. Their choice is to go farther leading to loss of wages or to pay for water leading to loss of wages or to pay for water leading to higher cost for procuring water or to tap seasonal sources of water that have variable consistency in terms of portability.

As a collective the communities have not been able to identify the core issues leading to water shortages nor their respective role in perpetuating these shortages. The formal system does not lay emphasis on recharging of water drawn from ground water sources as a result of which the numbers of such sources becoming dry are increasing. They go deeper and tap more into ground water sources and on the contrary increasing the problem. The current policy for the implementation of interventions for provisioning of domestic water is habitation centric. It does not take to account the social and economic dimension of such provisioning, which in fact they should be the only governing factors that should govern the drinking water policy. People from lower castes of society are sometimes not allowed to get water from the hand pumps. Thus they demand a separate

Figure 2. *Main source of drinking water for poor and socially deprived.*

hand pump to be installed for their community (Figure 2). Electricity supply is also important for fulfillment of water needs of community as tubewells/borewells are dependent on electricity supply. According to locals the supply of electricity is very bad thus affecting water availability. Caste and social dominance principles influence the various non-human elements in a complex manner (Figure 3 – based on data collected by surveys and questionnaires). These generally govern the beliefs and practices about rights and responsibilities, powers and privileges with respect to the different water management activities and availability of water.

5.3 Demand of water

The demand from the community's perspective is for households as a unit that comprise of demand of water for animals and occasional cleaning of house/animal. The tendency to view drinking water needs of humans and animals differently does not work out in an economy where animals have a definite role to play. The dangers of not including the needs of animals have implications where the access to poor and the marginalized for the safe drinking water sources is adversely affecting at the cost of providing safe drinking water to animals. The consumption data reveals that people have developed their own mechanisms to change the location of water consumption depending on the availability of water in each water source. The policy needs to recognize this and set delivery standards that state the entitled quantity and quality of water for domestic purpose will be made available at the house or at the water source. Moreover women and children are particularly involved in collection of water for poor and marginalized people (Figure 4).

5.4 Quality of water

Testing of water quality is solely dependent on the PHED. The community or any of the institutions of local self governance are not involved in testing of water or as consumers of the test reports. The process and procedures of water quality testing are based on random sampling methods and on expressed complaints by the

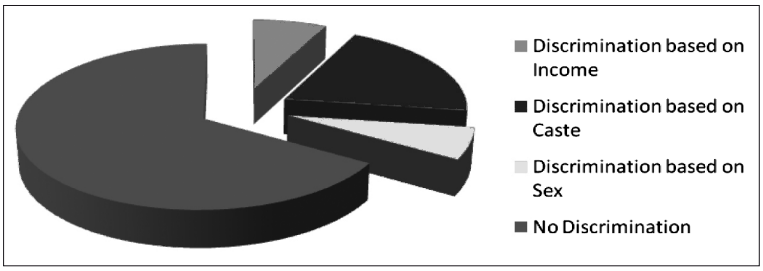

Figure 3. *A pie chart explaining the discrimination on bases of income, caste and sex for drinking water.*

Figure 4. *Involvement of children and women in collection of water.*

villagers. As such there is no regular monitoring system for testing quality of water. As a result not all water sources are tested at regular intervals and neither a profile of water quality is developed for the villages/Panchayats. The use of water sources have the factor of seasonality attached to them. Some of these sources fall within the private domain. There is no water quality surveillance system set up for each of them. The health implications of consumption of contaminated water have serious economic consequences for the poor. Apart from the loss of wages on account of diseases, there are additional expenditures on fuel and on soap/cleaning agents. Figure 5 elaborates on unhygienic conditions at source of water and deteriorating quality of water for consumption during rainy period.

5.5 Status of present day sources of drinking water

Some of the dry hand pumps become functional during rains but the quality of water is very bad. Even the quality of these functional hand pumps deteriorates in rains.

Figure 5. *Unhygienic environment due to poor handling and management of wastewater and deterioration of water quality.*

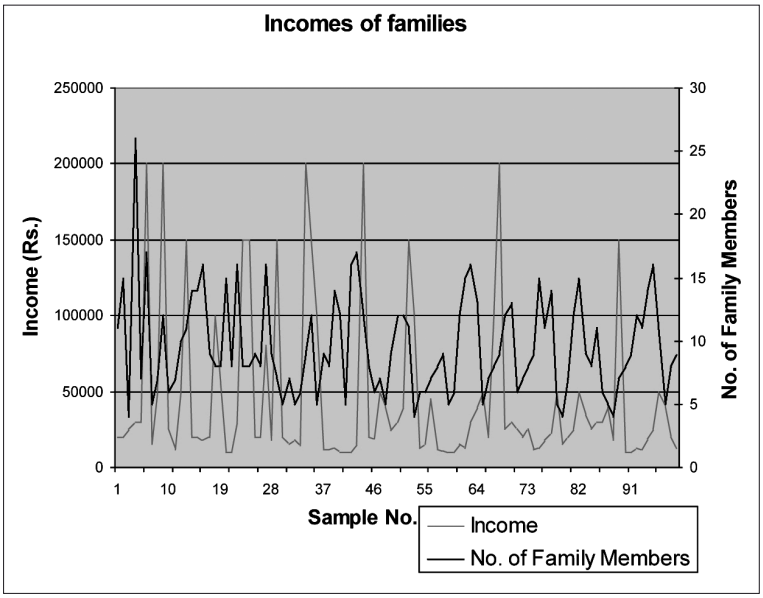

Figure 6. *Graph depicting the number of family members and their incomes (1€ ≈ 70Rs).*

Tube wells shown in the table 1 are privately owned and sometimes others are not allowed to use these tube wells. Most of the families in these villages are poor and consists of many members in single family, this puts an additional pressure in securing resources for all the family members (Figure 6). All the ponds are dry and now used for throwing waste by the villagers. Some the wells are dry and others are not used for the purpose of drinking water, only recreational use. Especially, in Shampur village it was told that they have very many wells but far away in their fields. They only use them to take bath occasionally. There is fast depletion of ground water, which is also increasing incidence of quality problems of Arsenic and Fluoride. There is heavy emphasis on new construction and poor attention to maintenance and traditional water management practices/systems are totally neglected.

5.6 Attitude of villagers and communities

Villagers are not ready to repair the hand pumps that are not functional and those which have gone dry, the main reason being lack of funds as most of the villagers have seasonal occupation and thus earn very little, many of them are below poverty line (figure 6). The proportion of dry hand pumps is going to increase in near future as many tube well/bore well are being installed by the villagers for agricultural fields. Water level is constantly going down due to this practice. Conditions under which people would be willing to maintain and operate water supply schemes include: If they own the assets, if they have themselves installed the hand pump, or being actively involved throughout, if they know the government will not maintain the asset, if they have sufficient funds for maintenance, and if they have to pay for operation and maintenance. It is possible to institutionalize community based rural drinking water supply program only if the Panchayati Raj Institutions/local communities are empowered to generate resources and are trained and equipped to plan, implement, use, maintain and replace water supply schemes themselves in coordination with the government agencies/private sector/ NGOs. There should be emphasis on both the hardware and software activities (awareness creation, capacity building of different stakeholders, startup activity like conducting baseline survey, administrative expenses etc.) for improving conditions of poor and marginalized people there.

6 Discussion and conclusion

It can be effectively concluded from the study that participatory resource mapping can be used as a useful tool for exploring community member's spatial conception of their natural resources, land boundaries, etc and is a widely applied tool in PRM. However, there was indeed a need for its integrated use with other tools to put into context and understand local spatial perceptions. Today, increasing number of people is realizing the importance of local knowledge in promoting sustainable development. Here we have seen that how, using GIS in a par-

ticipatory context contributes to the maximization of local information for development in relatively less time and with ease. It has the potential to empower local groups and communities , and at the same time, providing a platform that can be used by a wide range of users, which includes natural resource managers, decision makers, development planners, project designers and the communities itself.

Community participation and success of management programs is basically dependent on adoption of a demand-driven approach based on empowerment of villagers to ensure their full participation in the project through a decision making role in the choice of scheme design and management arrangement. Focus should be shifted to village level capacity building (village water and sanitation committees) to ensure an integrated service delivery mechanism by streamlining the functions of the agencies involved in project implementation. Conservation measures for sustained supply of water through rainwater harvesting and ground water recharge structures should be emphasized and mass awareness should be spread to people. On the other hand issues related to drinking water must be considered for ensuring sustainability of rural drinking water sources which include: water budgeting, demand, supply, conservation, costing, pricing, sub-surface storage of water specific to drinking water sources (water conservation), and roof-water harvesting, either individual or community based, to provide adequacy of drinking water sources during rainy season and rest the ground water aquifers for recharge as well as dilution of contaminants.

Moreover government should also focus on appropriate media campaigns for clean and safe water, promotion of new and renewable energy sources of water, participation of financial institutions including microfinance and NGOs in ensuring sustainable rural drinking water supply systems, adoption of dynamic norms which can continuously encourage water security, development of models of drinking water supply based on cost of production of water, encourage affordability of water using differentiated tariff mechanisms sensitive to gender, equity and vulnerability issues, control on over-extraction of groundwater, allocation of more funds for repairs and rehabilitation, finally lot of emphasis should be laid on increasing people's participation.

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