CHAPTER 1

INTRODUCTION

1.1 Statement of the problem

Our environment provides us with a variety of useful things which are needed as a basic entity and we sometime called it as resource. Resources are source of supply from which benefits have been produced and it is very essential for survival of human. Without resource people cannot think of development and resource help in development of an area.

Resources are available in nature as renewable and non-renewable. Non-renewable resources are limited everywhere in the globe. If people use non-renewable resources without proper management then it will be difficult for future generation to withstand growing demand of resources. In present days context resource management is a challenge. Proper management of resources is necessary to achieve sustainable development.

In 18^{th} century many parts of the world unexplored. At that time resource availability was also very high. As population starts to grow in 20^{th} century the development took place at its fastest point. People start to explore natural resources for the development of countries. As the time passed, now non-renewable resource is reducing very fast. Population density is getting higher and higher as land resource is limited and population is growing very fast. People are clearing forest area for agriculture land to feed the growing population.

Over time there are many changes took place on the earth. These changes are the imprint of resource use by human. To reduce the pressure on the earth and to conserve resource for future generation, resource management is very important. In India, resource management is a challenge with large growing population. The relationship between population growth and resource use generated a research interest for researcher in India. For a better future we need to plane a wise utilization of natural resources. Resource management in local level is very important because local people care about their area more than others. GIS (Geographical Information System) is a useful tool for data representation in 21^{st} century. Participatory spatial planning and decision making requires a combination of software tools for group decision support, individual decision support and geographic analysis and presentation (Voss, 2004).

Participatory GIS (P-GIS) is a useful method under GIS which is based on people's perceptions and ideas of local areas where they live. "Participant observation, for many years, has been a hallmark of both anthropological and sociological studies. In recent years, the field of education has seen an increase in the number of qualitative studies that include participant observation as a way to collect information" (Kawulich, 2005). People use simple and effective method based on their knowledge to manage the resource utilization. "The traditional view of GIS as an useful technology that is only useful for high level management planning and understandable to the technology-trained has changed" (Follosco, 2005).

Conservation and preservation are very important as local people understand the value of their resource. Sometime lack of proper knowledge led to the misuse or overuse of natural resources available in a particular area or nearby areas. This overuse creates an unbalance situation which destructs the natural settings. The destruction of ecosystems, species, and landscapes relates closely to the overuse of renewable resources but focuses more on species and ecosystems that are not or cannot (yet) be used as factors of production. Important aspects include aesthetic and ethical questions with regard to the extinction of species and the destruction of ecosystems and landscapes (Rogall 2008).

The works based on ideas and knowledge of people has brought wide range of management planning in the region. Participatory GIS (P-GIS) helps in developing maps and diagrams for the management planning in which local people take part not only as data producer but also as a surveyor or investigator. In other words, "P-GIS is the practice of gathering data using traditional methods such as interviews, questions, focus groups, all using some form of paper maps to allow participants to record spatial details. This information is then digitized so that it can be analyzed and interrogated using the power of the computer GIS software, and also so that any outputs can then be communicated using computer-drawn map outputs" (Forrester and Cinderby, 2014).

The recognition that local participation is a critical goal of development has contributed to the popularity in a set of techniques designed to increase local participation and knowledge in planning processes. Identified as participatory rural appraisal (PRA), this trend is marked by the use of a variety of high-end technologies, including geographic information systems (King, 2013). The local people have adopted many different methods for managing their areas. Before it was very difficult to convince local people for participation but now a days due to awareness among peoples, they are very much interested in this field. "Concomitantly P-mapping and P-GIS are considered to have superior effects in terms of relevance,

usefulness, sustainability, empowerment, and meeting good governance objectives, due to their eponymous stress on participation and on utilizing local knowledge" (McCall, 2004).

The study area in this research has many parameters that can be explored during the study. Physical features influencing the people activities in both the villages. As people of both the villages adjusted to natural setting they utilize the natural resources available in the area. The people has adopted methods for the use of resource especially land. Starting from land use to water utilization everything working systematically as things is adjusted with local people's ideas. Two villages having diverse physiographic as well as cultural characteristics have been chosen for the study. One village have hilly terrain feature situated within Arunachal Pradesh whereas the other village situated in rather downstream plain surface in Assam. The study is mainly on the management of the resources in these two district villages located in Assam and Arunachal Pradesh. The comparison is based on their utilization of resources like soil, water and forest products etc. The village people mainly depend on primary activities. The village Lokampur (Lakhimpur District, Assam) is mainly depends on primary activity like agriculture and tea plantation and the fuel for domestic use are collected from their own planted bamboo trees. The 2nd village Banderdewa (Papum-Pare District, Arunachal Pradesh) depends on primary activity like agriculture i.e. jhum cultivation and the fuel for domestic use is collected from the forest. The people consider the resources available for their use is a gift from God and they protect it.

Both the villages act differently in resource management and also their method and ideas are different in changing nature of landscape. Keeping this point in view, the present study titled "Participatory GIS (P-GIS) in resource management: A comparative study of two selected villages in Assam and Arunachal Pradesh" has been undertaken for investigation.

1.2 Objectives:-

Main objectives of the study are as follows:

I. To analyze how the physical parameters determine the resource utilization processes within the community.

II. To identify the sustainability of the resource utilization process and make a comparison between the villages.

III. To develop a participatory GIS model to be used in rural communities.

1.3 Research Questions

There are some research questions based on the situation of both the villages.

I. What are the crucial physical parameters determine that determine the nature of recourse utilization processes within the communities ?

II. What are the inherent resource utilization process of the villages in the study area ?

III. Whether P-GIS can be used in documentation of management of local resources ?

1.4 Data Base and Methodology

Two villages are selected for the study of resource management using P-GIS. The study is based on both primary and secondary data. In this data gathering process local people act as an active agent. The primary data are collected by survey with the help of schedule and questionnaire and also use of GPS (Global Positioning System) and the secondary data are collected from the Census of India, journals, books internet etc.

The study is about the resource management and the maps prepared by people based on their experience are converted to digital format in the end of the survey. The other methods are GIS and P-GIS (as P-GIS helps in managing resources in different and effective way). The other original maps are used to compare the differences in the objects located in

the villages. Some cartographic methods, GPS for locating different points in the villages etc. are also used in this study.

Survey and mapping:

Both the villages have been thoroughly surveyed to get detailed information about the physiography and the land use pattern of both the villages. The Cadastral map of Lokampur village has been collected from Office of the Directorate of Surveys, Assam. In this cadastral map fragmented land are marked and with the help of GIS the digitization is done. After digitization the image is verified for ground truth and the information are plotted on the maps based on GPS reading points. The village which is located in Arunachal Pradesh has no cadastral map and with the help of Village Head (*Gaon Burha*) Tana Yaga and local people maps are prepared. With the help of field survey a detailed land use classification map is done. In both the land use classification maps each and every micro component of the villages like settlement, water bodies, schools, kutcha road, pucca road, railway track, agricultural land, tea garden, forest patches, current fallow land, barren land, vegetables, traditional home garden etc are portrayed to design the land use map.

Plate 1.1: Collection of GPS data, resource utilization mapping and household survey

Different types of cropping lands are identified in both the villages in consultation with the experienced and old persons. Based on their knowledge maps are prepared for 1980 and 2017. The deforestation areas are highlighted in both the land use classification maps.

Household survey:

The survey is carried out throughout both the villages through well designed questionnaire to get the relevant information and data on demography, occupation, literacy, household amenities, income etc. In both the villages, total households were surveyed i.e. 331 households in Lokampur village and 58 households in Dolicoto village.

Other method:

The information about the resource collection, utilization and management were collected from the interview carried out throughout the village. The method of Participatory Rural Appraisal (PRA) and Rapid Rural Appraisal (RRA), focus group discussion were applied for the problem and prospects of different component of the villages.

Some meaningful quantitative techniques and soft-wares like ArcGIS10.2.1, MS Excel etc were applied for the processing and representing the maps and diagrams based of survey and data collected from field.

1.5 Organization of the work

The whole work is organized into three parts: introduction, analysis and synthesis. The first part is an introductory one consisting of an introduction of the problem (Chapter 1) and the geographical background to the study area (Chapter 2).

The second part includes the formal introduction to Participatory-GIS and its advantages and disadvantages (Chapter 3). Also include the analysis of the resource availability (Land, Water, Forest etc.) and utilization in both the villages (Chapter 4) and traditional technology and sustainability (Chapter 5), Capturing people decision through GIS (Chapter 6).

Last part is the synthesis of the work (Chapter 7). It includes summary and conclusion and some suggestions for making the people aware about resource use and sustainability in both the villages.

1.6 Literature review

The study topic is well known globally as resource management is very important in all over the world. This type of study is going on in international, national and regional levels. Many literatures are available on this burning topic of resource management. A large number of works have been done on Participatory-GIS by different geographers in different parts of the world.

Participatory-Geographical Information System (P-GIS) "term was first coined in 1996 at the meetings of the National Center for Geographic Information and Analysis (NCGIA)". Here NCGIA introduced "three potential implications of P-GIS: i.e. (1) enhance capacity in generating, managing, and communicating spatial information; (2) stimulate innovation; and ultimately; (3) encourage positive social change (Corbett, et al. 2006). This reflects on the rather nebulous "definition of PGIS as referenced in the *Encyclopedia of GIS*" (Tulloch, 2008) which describes PGIS as having a definition problem".

McCall (2004), in his work titled "Can Participatory-GIS Strengthen Local-level Spatial Planning? Suggestions for Better Practice" explored the questions related to P-GIS and P-Mapping (Participatory Mapping) i.e. "what are the ramifications of employing a participatory approach in applying geo-information to spatial planning? What should the principles of PSP (participatory spatial planning) imply? How to operationalise the principles

and concepts of the participatory approach? How much difference will it make in the end to the planning decision and activities?" (McCall, 2004). With these questions McCall fulfilled his objectives. McCall put forwarded an idea about how to use P-GIS in urban and rural appraisal.

Tripathi and Bhattarya (2004), in their paper title "Integrating Indigenous Knowledge and GIS for Participatory Natural Resource Management: State-of-the-Practice" clearly stated about indigenous knowledge i.e. "development efforts that ignore indigenous knowledge (IK), local systems of knowledge, and the local environment generally fail to achieve their desired objectives and also highlighted about indigenous knowledge systems that are becoming extinct because of rapidly changing natural and social environments."

Kienbergerand and Steinbruch (2005), in their published paper "P-GIS and disaster risk management: Assessing vulnerability with P-GIS methods – Experiences from Búzi, Mozambique", they presented "the case study of Búzi, Mozambique where P-GIS methods were applied to assess the vulnerability of communities to hazards (focus on cyclones, floods and droughts) and the role of local people in managing the risk in the area."

Kawulich (2005), contributed in the study of P-GIS in collecting data and some definition of P-GIS. He stated that "Qualitative methods of data collection, such as interviewing, observation, and document analysis, have been included under the umbrella term of "ethnographic methods" in recent years." He discussed that "observation, particularly participant observation, as a tool for collecting data in qualitative research studies."

Elwood (2008), in his paper entitled "Volunteered geographic information: future research directions motivated by critical, participatory, and feminist GIS" developed a concept on "Volunteered Geographic Information (VGI)" in which local people play very important role as a data collection agent. He examined "the early literature on this phenomenon, illustrating its shared propositions that these new technologies are part of shifts in the social and technological processes through which digital spatial data are produced, with accompanying implications for the content and characteristics of geospatial data, and the social and political practices promoted through their use."

Kyem (2008), published a paper entitled “Of Intractable Conflicts and Participatory GIS Applications: The Search for Consensus amidst Competing Claims and Institutional Demands” in which he clearly stated that “discourse about geographic information system's (GIS) potential as a tool for intervening in disputes over access to natural resources.” He also discussed that “GIS is a planning tool with striking analytical capabilities and a great public appeal that can be utilized for explicitly reasoned discussions to facilitate conflict resolution.”

King (2002), published work on Participatory Rural Appraisal and GIS and the study is focusing on “participation of people in creating maps based on knowledge and it will be transformed to GIS maps.” He also discussed that “the explosion of interest in GIS (Geographical Information System) and GIT (Geographical Information Technology) has suggested a variety of new direction for expanding participation within research and policy development circles.”

McCall and Dunn (2011), in their work “Geo-information tools for participatory spatial planning: Fulfilling the criteria for ‘good’ governance?” they explore “the potential contributions of participatory geo-information tools towards participatory spatial planning, in terms of the principles and criteria of good governance. They also discuss five fundamental principles of ‘good’ governance: accountability, legitimacy, respect, equity, and competence, and the potential of geo-information tools to contribute to, and detract from, such principles; although they focus especially on participation and the recognition and validation of local knowledge.”

Forrester and Cinderby (2014), in their work “A Guide to using Community Mapping and Participatory-GIS” mentioned about the some “basics on participation, Methods for carrying out community mapping, Methods for carrying out GIS and Validation and using P-GIS outputs.” They show “the way, how to start and from where to start the P-GIS work.”

Reichel and Fromming (2014), in their paper entitled “Participatory Mapping of Local Disaster Risk Reduction Knowledge: An Example from Switzerland” discussed about “the natural hazard which is based on based on comparative anthropological fieldwork conducted in the Alpine region of Switzerland on sustainable environmental knowledge about natural hazards related to climate change. In this work Reichel and Fromming developed some ideas how to cope with natural hazard and developed mitigation with the help of local people.”

They examined “the way to complement the normative and technological practices of risk management by using local knowledge to improve the resilience of affected communities against climate-related risks and also studied how agricultural practices and knowledge may contribute to sustainable behavior towards nature and the environment.”

Wolf et al. (2015), in their work “The use of public participation GIS (PGIS) for park visitor management: A case study of mountain biking” they used “Public Participation Geographic Information Systems (PGIS) mapping and Global Positioning System (GPS) tracking to monitor mountain bikers frequenting national parks for tourism and recreation in Northern Sydney, Australia.” They also “addressed two fundamental questions for park planning: (1) What is the spatial distribution of visitor activities and location-specific reasons for riding; and (2) What location-specific actions are needed to improve riding experiences? They also discussed how PPGIS mapping provides a cost-effective approach to facilitate spatial decision making, allowing park agencies to prioritise future visitor management actions.”

Lubis and Langston (2015), in their work “Understanding landscape change using participatory mapping and geographic information systems: case study in North Sulawesi, Indonesia” they used “a landscape approach to understand the connections between human livelihoods and environment. They studied five villages using Participatory Rural Assessments (PRA) tools, consolidated questionnaires, formal and informal interviews of various stakeholders, GIS-based participatory mapping and in-the-field observations as well as secondary sources” (Lubis and Langston, 2015). They found “that natural hazards, climate variability, accessibility, extractive industries, food security and water scarcity were interlinked as big drivers of change in the landscape” (Lubis and Langston, 2015).

Mehra et al. (2016), in their paper “A GIS-based methodological framework to characterize the Resource Management Domain (RMD): A case study of Mewat district, Haryana, India” developed that “Resource Management Domains (RMD) represent a way to characterize land units, based on biophysical and socioeconomic characteristics. This concept has been applied to delineate and characterize sustain-able land units for agricultural use in the Mewat District of Haryana, India.” Also they stated “that A GIS-based framework was conceptualized to characterize RMD and appropriate biophysical and socioeconomic parameters were identified based on local conditions and expert opinion.”

Rich et al. (2016), in their published work "Participatory systems approaches for urban and peri-urban agriculture planning: The role of system dynamics and spatial group model building" discussed that "for urban agriculture to be sustainable as a livelihoods and resilience strategy will require decision-support tools that allow planners and participants alike to jointly develop strategies and assess potential leverage points within urban food value chains." They also "argued that system dynamics (SD) models combined with participatory approaches have important roles in bridging this gap, though these will need to be adapted to the spatial influences that exist in urban settings."

Usón et al. (2016), in their work "Using participatory geographic approaches for urban flood risk in Santiago de Chile: Insights from a governance analysis" they focused on "analysing the governance possibilities of using participative geographic information like volunteered and public participatory geographic information for flood risk reduction in the case of Santiago de Chile, a city which regularly experiences urban floods during rainy seasons." They also "indicated that a relevant part of the current information used for flood risk reduction efforts is provided to local and regional authorities by the affected population."

Young and Gilmore (2017), in their published paper entitled "Participatory Uses of Geospatial Technologies to Leverage Multiple Knowledge Systems within Development Contexts: A Case Study from the Peruvian Amazon" argued that "practitioners of participatory methods must extend their thinking to the ways in which their projects foster engagement across multiple social and epistemological perspectives." They also discussed "that the Participatory geographic information systems (PGIS) methodologies are particularly effective at enabling these cross-perspectival engagements-geospatial technologies have unique capabilities for storing and visualizing knowledge from different types of knowledge systems."

Rehn et al. (2017) in their paper "Stabilizing risk using public participatory GIS: A case study on mitigating marine debris in the Bay of Fundy, Southwest New Brunswick, Canada" discussed about "how marine debris originates from the interaction of multiple industries within a small area, including aquaculture and inshore fisheries in Canada's Southwest New Brunswick, Bay of Fundy." They also "highlighted how conflict between these two stakeholders contributes to both debris production and failure to mitigate. They used Public Participation Geographic Information Systems (PPGIS) mapping to assemble and stabilize a common view of what constituted debris, debris locations and threats."

Hedelin et al. (2017), in their work "Participatory modeling for sustainable development: Key issues derived from five cases of natural resource and disaster risk management" studied about "the Participatory Modelling (PM), Sustainable Development (SD) and evaluate five PM research projects against criteria for the procedural dimension of SD. This provides a basis for identifying key issues and needs for further research into PM for SD."

Hendricks et al. (2017), in their paper "The development of a participatory assessment technique for infrastructure: Neighborhood-level monitoring towards sustainable infrastructure systems" attempted to study "how climate change and increasing natural disasters coupled with years of deferred maintenance have added pressure to infrastructure in urban areas." They also explained "the development of the participatory assessment technique for infrastructure that can provide empirical data about the condition of infrastructure at the neighborhood-level, using storm-water systems in a vulnerable neighborhood in Houston, Texas as a case study."

1.7 Significance of the study

It is quite interesting to use GIS application in regional level. GIS can compact the large data and area into small data set. This Participatory-GIS study is mainly focused on the problems and their relative solutions in local level. It is very difficult to manage resources with growing population. Local people's participation is very important in management as they have better ideas regarding the area. Introduction of Participatory GIS (P-GIS) to the local people show a platform to discuss problems faced by the people. The study also provided an opportunity for focus group discussion. This study will bring a change in peoples' perception for managing resource. P-GIS are very effective method in developing a sustainable environment in regional and local level.

1.8 Limitation of the study

The study based on the resource found in both the villages and its uses and management. The study is carried out in both the villages and interaction with local people is the very important part of this study. While carrying out the survey there is some limitation which is very difficult to cope with. The second village i.e. Dolicoto located in

Arunachal Pradesh does not have cadastral map. The map is prepared on the basis of local people's idea and with the help of *Gaon Burha* Tana Yaga. In both the villages the language for communication is very difficult because both the village do not use common language for communication. During the survey many people were absent and have to visit again and again to record their view. For the maps of the villages, based on local people ideas was difficult to gather all the people at the same time. The ideas gather here represents a scenario of the people.

1.9 Acronyms

NCGIA - National Center for Geographic Information and Analysis

PRA - Participatory Rural Appraisal

RRA - Rapid Rural Appraisal

PGIS - Participatory Geographic Information System

PPGIS - Public Participatory Geographic Information System

PNRM - Participatory Natural Resource Management

RMD - Resource Management Domains

P3DM - Participatory 3-Dimensional Modelling

PLA - Participatory Learning and Action

VGI - Volunteered Geographic Information

GIS - Geographic Information System

GIT - Geographic Information Technology

GPS - Global Positioning System

PM - Participatory Modelling

SD - Sustainable Development

SD - System Dynamics

IK - Indigenous Knowledge

GE - Goggle Earth

MSL - Mean Sea Level

GMS - Genetically Modified Seeds

HYV - High Yielding Variety

HH – Household

1.10 Local terms and terminologies

Chang Ghar = A type of house which is build 4-5 feet above the ground with the help of posts.

Mon = Traditional measurement unit used for Rice. 1 *mon* = 40 kg.

Guhali = A house where people keep animals

Pun = Traditional measurement unit used for counting of betel nut.

1 Pun = 80 Betel nuts.

Guchchi = Traditional measurement unit used for counting of betel leaf.

1 *Guchchi* = 20 Betel Leaves

Do-mati = Low land

Bam mati = High land

Pua = Traditional measurement unit used for counting Land. 4 *Pua* = 1 *Lesa*

Lesa = Traditional measurement unit used for counting Land. 20 *Lesa* = 1 *Katha*

Katha = Traditional measurement unit used for counting Land. 1 *Katha* = 0.0268 Hectare.

Bigha = Traditional measurement unit used for counting Land. 1 *Bigha* = 0.134 Hectare.

Pura = Traditional measurement unit used for counting Land. 1 *Pura* = 0.536 Hectare.

Darmaha Sapta = Salary Week (15 Days)

Bazar = Market

Kothia = Seedling

Nala = Stream.

Mithun = A domesticated animal used in South Asia called Gayal.

Pukhuri = Pond

Da = Tool used for cutting forest product like shrubs or bushes.

Kuthar = Axe

Kur = Hoe