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Using participatory GIS to bridge knowledge divides among the Onge of Little Andaman Island, India

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Introduction

The present age of human history is known as the Information Society, or the Age of Knowledge. Interpretation of information acquired formally (through learning, education, reading, writing, etc.) and/ or informally (through thinking, believing, feeling, dreaming, etc.) can be treated as knowledge. As such, every community has some or the other form of indigenous knowledge. The socio-economic impact of knowledge acquired in this manner is huge since sustainable development is unthinkable without a knowledge-based society (Kroó, 2003). Sustainable development can be defined as constant improvement in the quality of life for the current generation, same or better quality of life for subsequent generations, all from the same sources of the earth. And as such, knowledge for sustainable development should incorporate diverse knowledge systems, in terms of geography as well as provenance (formal and indigenous knowledge); even so, it tends to originate primarily from scientific knowledge.

Nonetheless, the importance of local knowledge systems to effectively manage natural resources for sustainable development is increasingly recognized at different national and international levels. Ways to effectively incorporate and use the existing local/ indigenous knowledge are still being researched. This is due to the inability of the local practitioners to package their experiences and knowledge well for the competitive world of formal, scientific knowledge. This creates a knowledge divide between the scientific knowledge and traditional knowledge systems.

This knowledge divide affects sustainable development in many ways. Firstly, it increases the communication gap between communities having scientific knowledge and those with traditional/ tacit knowledge working in grass-roots realities. In terms of ICT-enabled development efforts, there are numerous examples where this has led to the adoption of scientific technologies which do not fit the ground realities at all, and even have negative implications in terms of development and power relations. Secondly, due to the communication gap, development policies based only on scientific knowledge and excluding community knowledge often do not represent or solve the problems faced by the poor in their day-to-day realities. Thus, many such policies fail when it comes to implementation in the field. Thirdly, the divide leads to 'selling' scientific knowledge to communities, rather than 'scientifying' local knowledge. Finally, to achieve sustainable development, effective natural resource management (NRM) is a key step, requiring innovation, fusion of indigenous/ traditional technologies with scientific applicability to adequately cope with new generation problems in NRM.

Effective natural resources management requires proper documentation of existing natural resources, evaluation and monitoring of the current situation and planning of future actions. Further, relevant traditional technologies need to be identified and their usability and replicability researched. And finally, infusion with modern technologies according to field suitability is to be established and communicated.

This paper is part of a broader research project on Indigenous Knowledge Systems towards sustainable development among Andaman Islanders[i]. It addresses the use of participatory GIS as a tool for documentation, evaluation and monitoring in order to achieve more effective natural resource management and planning. Further, it will illustrate how participatory GIS can help in documentation and identification of indigenous/ traditional knowledge with the consent and help of indigenous people. Finally, it explores how indigenous knowledge can be used by policy makers to plan future NRM activities for sustainable development of Andaman islanders.

Research methodology

The main research method used for the study was participant observation, open-end questionnaire and participatory GIS. In exploring the area with the Onge, coordinates and activities performed were recorded using a handheld GPS system. Open-end questionnaire was used to understand the relevance of the activity to the site and to chart the strategy used. Recorded coordinates were plotted on the base map acquired from the Forest Department of Andaman using Remote Sensing and GIS cells, with the help of GIS software, on the basis of ground truthing with GPS. As such, there may be chances of 0.005% error in location of the coordinates with respect to the original remotely sensed image or GIS images of Andaman Government.

Geography of the islands

The Andaman Islands are located in the Bay of Bengal, forming a group of 572 islands only 36 of which islands are inhabited. The two most important groups of islets are Ritchie's Archipelago and Labyrinth Islands. The Nicobar Islands are located south of the Andamans, 121 km from the Little Andaman Island.

The islands have a tropical climate. The monsoon period often brings medium to heavy rains, and these often cause heavy damage. The canopied rain forests of the islands harbour 3,000 species of plants and a wide variety of tropical fruits. Marine fauna is diverse including a wide variety of tropical fish and coral. Considering the diversity and uniqueness of fauna and flora and the fragile nature of the eco-system, 96 sanctuaries and nine National Parks spread have been established on the islands.

The consistent emphasis of the government on progress and its encouragement to the mainlanders to settle there has resulted in the local tribes becoming a minority group in their own land.

Figure 1: Tribes of Andaman [source: www.andaman.org]

The indigenous tribes are distinguished in two group clusters: the Onge, Sentinelese, Jarawa and Andamanese of Negroid descent living on the Andaman Islands, and the Shompen and Nicobarese of Mongoloid descent living on the Nicobar Islands. Most of these tribes are on the verge of extinction. This sad destiny will most likely hit the Andamanese tribe first since their number is as low as thirty. The Sentinelese is the least studied tribe still living in isolation on the North Sentinel Island. Their number is estimated at 250. Outsiders attempting to make contact with them are driven away with bows and arrows. They continue to maintain a unique lifestyle living in harmony with nature just as they have done for thousands of years.

Knowledge divides and sustainable development

The 'knowledge divide' indicates the gap between those with an abundance of knowledge, while others have less. It is acknowledged that this gap is increasing. Even though every community or society has knowledge in some form of indigenous, traditional or tacit knowledge, bridging the divide is a necessity to achieve sustainable development. The knowledge divide is based, after all, on the degree of access to a specific form of knowledge which determines the possibility for sustainable development. This is framed by three paradigms – all of which need to be addressed – namely ecological, economical and social development. Sustainable development as defined is improved quality of life for the current generation and all subsequent generations. Relevant knowledge systems help us to predict likely future developments, illustrating how to ensure sustainable development – the same, or a better quality of life for the future.

All over India but also in many other countries there is a dearth of knowledge and understanding of the phenomena happening in the environment. Not one knowledge system, may it be scientific, indigenous, traditional or tacit, is complete and sufficient enough to manage the present resources effectively. Thus, a blend of all of them is necessary – and as such access is beyond the reach of most, this is a source of knowledge divides. UNESCO (2005) details many social issues in knowledge divides, including gender, race, ethinicity and social classes. This paper broadly classifies causes of the knowledge divide in two types: first, due to the increasing gap between

those who have abundant access to it and those who have very little of it, and second, the huge distance between those who carry scientific knowledge and those who inherit indigenous or traditional knowledge.

In parts of the world where knowledge is abundant, consumer products to a large extent determine the quality of life; however, the processes through which these are developed and obtained are often not sustainable. Where scientific knowledge is less abundant, development is stunted or unsustainable, as in the case for Negrito tribes of Andaman as well as for many rural communities. The Negrito tribes of Andaman islands have an abundance of knowledge, although generally not a scientific form. The ignorance of scientific knowledge of these communities creates inability to package their own knowledge systems and make them available to the world.

Human attitudes and values are also a pre requisite for sustainable development and these are an integral part of local knowledge systems. According to UNESCO (2002), 'the traditional values of science are meant to safeguard objectivity, neutrality, disinterestedness and rationality. These and other values described by the sociologist Merton have come to be seen as the core ethos of science. Taken to the extreme, however, they may seem to justify absence of ethics, empathy and concern for social implications. The search for universal laws and theories with no attempt to relate them to human values and concerns can present science as abstract and insensitive to human needs, with the result that many people perceive science as cold and lacking a human face.'

It is clear that there is a need for tempering the core ethos of science with humaneness so that it becomes ethical and shows empathy and concern for social justice. Through the absence of the 'human face', people look for knowledge systems other than science. Therefore, it becomes necessary to analyze traditional knowledge systems and to verify what they contain for universal applicability and use. However, traditional knowledge systems are often not easily documented and applied for development. Unfortunately, in the development of the process for doing this, scientists often forget to go back and share the learnings and the benefits with the original knowledge 'owners'. This results in the loss of good will – and thus the knowledge divide widens.

In the meantime, the Economic and Social Council (ECOSOC) directed UNDP and other United Nations operational bodies and specialized agencies to respect the rights of indigenous peoples; this has led to the recent establishment of the Permanent Forum on Indigenous Issues with a mandate to discuss issues such as economic and social development, culture, the environment, education, health and human rights of indigenous peoples. The linkage drawn between indigenous people's rights and successful human development was an important step, along with implementation of the goals of the *International Decade of the World's Indigenous People (1995-2004).*

The distinct legal status and rights of indigenous peoples have been recognized at every world conference for more than a past decade and they are considered an important group for achieving sustainable development (the United Nations Conference on Environment and Development (1992)).

Indigenous knowledge system of Andaman Islanders

Indigenous knowledge refers to the unique, traditional local knowledge existing within and developed around specific conditions of woman and men indigenous to a particular geographical area. Knowledge held by indigenous communities uses the information, advice, and wisdom that has evolved over centuries. It is also known as traditional ecological knowledge (TEK), 'accquired by indigeneous and local people over many hundreds of years through direct contact with the environment. It includes an intimate and detailed knowledge of plants, animals, natural phenomena, the development and use of technology for hunting, fishing, traping, agriculture and forestry and holistic knowledge or world view which parallels the scientific diciplines of ecology' (Inglis 1993, VI- cited at Berkes 1999).

Indigenous people hold great significance as they observe the world carefully, share findings, conduct experiments and adjust conclusions on a continuing basis. Their knowledge is often wrapped up in superstition or tradition-instilled ways. Tradition is a social process of learning and sharing knowledge and it has a social meaning and legal character unlike other knowledge. The biggest challenge is to find effective ways of synthesizing the best of traditional knowledge and the best that scientific analysis can bring. Such knowledge is often embedded in cultural and religious systems, which give them strong legitimacy. For example, sacred groves are often protected as homes of ancestors, but also serve an ecological function for watershed, landscape and biodiversity protection. Such knowledge and understanding takes time to build and is rapidly lost.

Among the so-called primitive tribal groups surviving in Andaman Islands are the Onge. They are a tribe of hunter-gatherers and live a nomadic life. The Onge were the sole occupant of little Andaman where they maintained, until as late as the 1950's, a largely undistributed traditional way of life. The state of Onge's dwindling population is a cause for concern today. There are only 97 of them left from thousands 100 years back, due to disease, battles, way of living, contact with outsiders, marriage patterns, changing environment, etc. In 1967 the island of little Andaman was opened up for settlement from outside. After the 2004 Tsunami all Onge abandoned their respective settlement area and moved to safer and higher grounds.

The Onge's use of a traditional knowledge system for effective natural resource management can be illustrated by several examples. Other than the food they buy from outsiders by barter system they mainly consume 3 types of terrestrial resources, wild boar, honey and honey-based products, some birds and 6 types of aquatic resources (fish, turtle and turtle egg, dugong, crabs, shells). The Onge follow certain nature rules for extraction of resources: in the months of April to June, the time for wild boar's reproduction, they don't hunt and survive completely on jackfruit and seafood. Similarly December to April is their honey collection season, as June to November is the breeding season of bees. The study showed that the Onge have identified almost 146 plant varieties used for day to day-to-day purposes such as hut making, medicinal use, making of bows, arrows and instruments, ornaments, making, fishing nets, dresses and apparel, as well as for cultural ceremonies. Different roots and tubers, collected in the forest, are consumed as food.

A major problem caused by insufficient recognition of this use of indigenous knowledge by the Onge is the lack of understanding of the ecosystem among the Andaman Government which has led to natural resource devastation. This in turn affects the pattern of livelihood of Onges. For example, a decision of the government to settle Onge in a biodiversity rich area such as Dugong Creek has led to heavy deforestation. The plan to settle these nomadic forest dwellers in one place has changed their way of living and livelihood, and effectively their population growth. Further, their traditional ways of living is getting eroded. The knowledge divide between the Onge and 'modern society' causes the situation to worsen and puts them at an even bigger disadvantage: they are not able to adapt to modern knowledge, but simultaneously lose their indigenous knowledge system. Such a situation has left them helpless and incompetent to fight against the changing scenario.

Another major problem that is visible is the failure of the tribal policy in Andaman, designed for the development of indigenous tribes. The knowledge divide between the stakeholders is again a major factor for this: the policy doesn't address the critical issues faced by these tribes and hence implementation of the policy also fails.

One of the mandates of the Andaman Tribal Welfare Authority is to protect indigenous tribes and take care of their welfare. Poaching is a serious problem for the tribes as the natural resources on which they depend are devastated. This has resulted in resource depletion and they are forced to adopt the authority's rationing system which has affected their health.

With the help of participatory GIS, tracks of poachers can be mapped and traced out so as to stop their interference and protect natural resources. This will help the Onge revert back to self-sustaining access to food resources instead of being dependent on the rationing system.

Participatory GIS and indigenous knowledge.

Participatory approaches regarding the creation of maps and their interpretation started in late 1980s. Development practitioners at that time were inclined to adopt participatory rural appraisal methods, giving preference to eliciting local knowledge and building on local dynamics to facilitate communication with all stakeholders. Technologies in mapping changed in 90s with the diffusion of modern spatial information technologies including geographic information systems (GIS), Global positioning system (GPS), remote sensing image analysis software and open access to spatial data via Internet. The new environment and drive towards local participation has facilitated the integration of geo-spatial information technologies and systems with community-centred initiatives. This merging for the empowerment of all stakeholders has come to be known as participatory GIS (PGIS).

The complex nature of sustainable natural resource management demands research that uses a systems approach; i.e. research that is interdisciplinary, combining bio-physical and socio-economic dimensions and attempts to understand the interrelatedness of system components (Barr and Dixon,1998). Community-based,

participatory natural resource management is being widely adopted as a possible solution to address such complex problems. Also, participation and knowledge of local groups (e.g. farmers, peasants, and tribes) is understood to be a valuable resource in community-level natural resource management, decision-making and policy-planning processes. From the above discussion of the indigenous knowledge system of the Onge It can be said that indigenous knowledge plays an important role in the sustainable management of natural resources and can also have an impact on issues of global concern. This recognition is directly related to the growing realization that scientific knowledge has contributed very little to the development of communities and societies; in fact it has commonly hastened the depletion of their social and natural resources (Murdoch and Clark, 1994; Norgaard,1992; Ulluwishewa,1993).

The documentation and mapping of indigenous knowledge and traditional knowledge is intended to preserve and honour knowledge held by local indigenous people, people whose ancestors have long inhabited a region, or people who are new to a region and bring their own traditions to a new community. However, the collection of information from diverse indigenous sources is often a laborious, time-consuming and costly process. Proper storage and management must be ensured if the information is to be made available and accessible for quick analysis and interpretation to all those who need it, e.g. planners and decision makers involved in the management of land resources.

Geographic Information Systems (GIS) is capable of performing these functions and is widely used in the management of information for planning and decision making purposes. GIS also makes it possible to create, analyse and process different scenarios, using the information stored in the computer (Jordan and Shrestha,1999). Programmes involving the integration of GIS and IK have for the most part been used within natural resource management projects where increased food or income source choices for local communities and effective participation in benefits sharing are the main goals (Mbile et al.,2003). Due to the spatial nature of Indigenous Knowledge Systems (IKS), GIS technology can facilitate the inclusion of IKS in local decision-making processes.

Participatory GIS models (maps) are appealing, fuelling community-esteem and a sense of intellectual ownership. Further, the knowledge divide will slowly be sealed, as the enormous amount of information gathered from local stakeholders will come back as policies implemented for sustainable development of their own area and resources. The collated information can also be permanently displayed at a local level, where it is readily accessible and understood by the local residents and outsiders. Thus the map becomes part of the local cultural landscape.

Such a spatial decision-making tool utilizes GIS technology in the context of the needs and capabilities of communities that are involved with and affected by development projects and programs (Abbot et al.,1998). For the collection of primary data, a number of different data acquisition techniques are used, such as Rapid Rural Appraisal (RRA), village immersion, the farmer-based interview schedule, field visits and observations, the use of a checklist of questions, analogue maps and aerial photographs. In this study, the GIS tool is used for mapping and understanding the

linkages between the spatial distribution of resources in Little Andaman and the harnessing strategies of Onges.

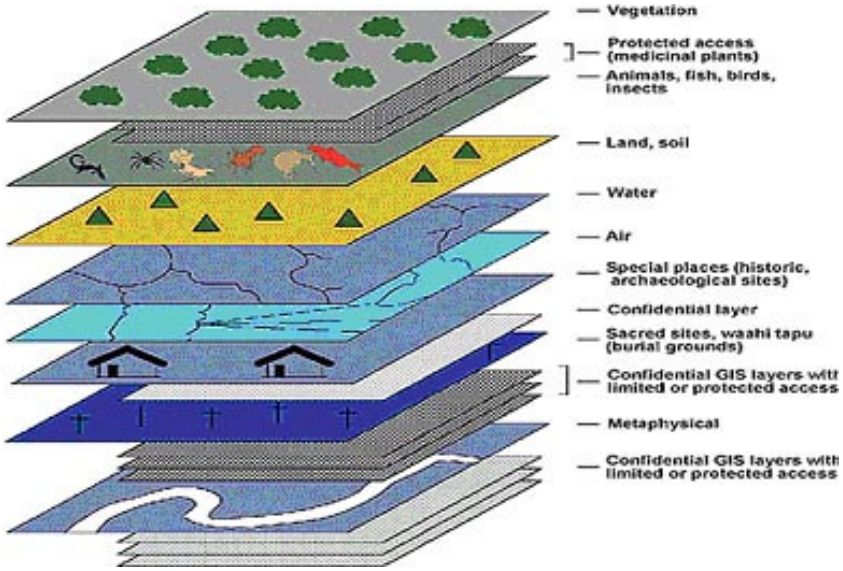

Figure 1: Example of participatory GIS layers and confidential sub-layers (Harmsworth,1998).

Observations and discussion: participatory GIS and Onges

Figure 2 below shows the movement of settlements of the Onge since 1970 within Little Andaman, and illustrates the settlements opened for outsiders by the Indian authorities. In 1970, Onges were also moved to permanent settlements at Dugong Creek and South Bay, declared reserve areas. But Onges continued to move all around Little Andaman. After the tsunami of 2004 (during which the research took place), due to heavy damage the Onges shifted to higher grounds, one of the biodiversity rich areas which was not affected by the waves.

Mapping data

Point A on the map below shows where temporary huts were constructed, immediately after the tsunami. However, this was quite close to Madrasi settlements and thus they faced problems in accessing resources (food, wild boar, fruits, etc.). Accordingly, they shifted to point B and then to point C. This movement was based on the availability of resources and to keep away from the outside settlers. From point B and C access to a population of wild boar was much easier, areas that moreover were less visited by the settlers and the poachers.

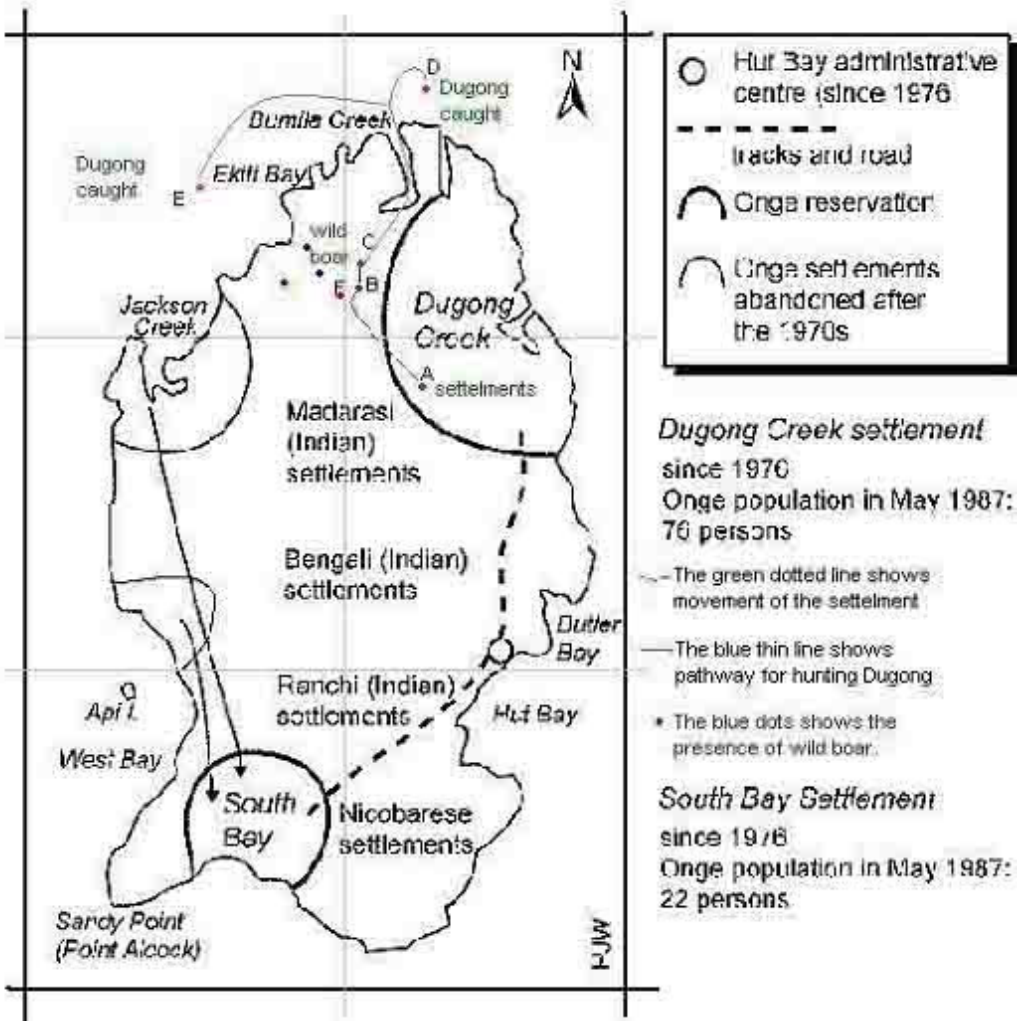

Figure 2: After Little Andaman was 'opened to settlement' the Indian authorities moved the Onge into two reservations where they found themselves subject to rehabilitation Source: www.andaman.org (further geo-referenced by researcher)

The thin line in figure 2 indicates the pathway for hunting dugong, which is one of the relished and important foods of the Onge community and a necessary component for any Onge ceremony. Although the species is said to be locally extinct by the Wildlife Department of the Andaman Government, two dugong were sited during the study period at point D and E.

From the GIS map it was calculated that while the settlements were at point B and C, Onges moved and average of 5 km every day for gathering and hunting resources. While settled at point A, this was an average of 12 km. There exists a clear relation between the availability of resources, time required for hunting and the movement path. With the help of participatory GIS this relation has been recorded and understood with reference to GPS coordinates. From the settlement at point A, resource gathering took a longer time because the pressure on the resources was higher, due to the presence of other settlements; hence they had to travel further. This was not in case when settlements were located at point B and C.

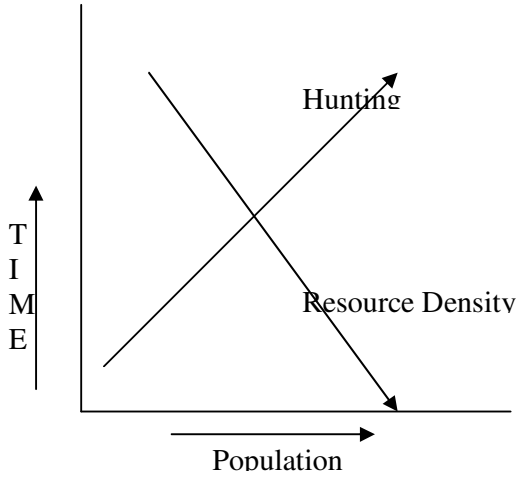

Figure 3: the relationship between hunting time, population and resource density

From figure 3 it is clear that with the increase in population the time required for hunting increases and the resource density decreases. Similarly when the population is less the time required for hunting is less and the resource density is high as found at point B and C in figure 2.

Interpretation of participatory GIS maps

Government Authorities can use the spatial distribution of resources and its usage pattern as acquired by the participatory GIS process for planning the tribal policy and deciding the place for settling the outsiders. The information of dugong presence should be valued by the wildlife department and this area should be protected so that the few remaining dugong (also hunted by poachers) should not go extinct. Further, a thorough knowledge of the movement pattern of Onges shows that living under a constructed roof at one place in Dugong Creek is not a suitable option for them. The information gathered from participatory GIS can help decision makers to a great extent in understanding the linkages between ecology, social and economic issues. By understanding the tribe's ways of living, management tactics and strategies to overcome crisis situations will help authorities to plan well.

There is a specific type of knowledge which can be acquired by scientists through participatory GIS. But are the benefits shared equally? How would the Onge community benefit from all these activities? How could this help bridge knowledge divides?

As said, the Onge are in no dearth of knowledge about their environment and manage their resources in a sustainable manner. This is clear from the fact that forest in Onge area is much denser and richer in terms of biodiversity. The research showed that they are not interested in learning about and using modern technologies. The questionnaire revealed that their primary need is the availability of food. What they do want, is first, that the authorities ensure proper legislation on poaching so that their resources are not illegally depleted. Second, they want money. Initially, the Andaman government provided them with money in exchange for resources like honey and timber but at that

time they did not know to count. As this realization has increased, the Onges have understood that money provides access to consumer products with which they have been familiarized in the process of acculturation. The Andaman Government should help in the process of their natural acculturation, not merely by providing money, but rather through education. Finally, they want access to their rights such as meeting the chief secretary, sharing problems and participating in government.

The authorities can identify and fulfil such needs through the use of participatory GIS in monitoring and evaluating policy planning and implementation. Information gathered can be used for decision-making purposes and planning, ensuring participation of all the stakeholders. Further, the map generated can be shared with the community for their understanding, even where illiteracy is a problem.

Conclusion

The synergy derived from combining participation and GIS results is a powerful communication medium which bridges the gap between indigenous technical knowledge and scientific knowledge, and increases the capacity of local stakeholders and policy makers to interact, locally, with external agencies and with central governments.

Participatory GIS can be considered as a rudimentary community-based geographic information gathering: the use of different coding methods allows for the composition and storage of thematic information layers (as shown in figure 1); this in turn facilitates community-based analysis of spatially-defined information and the display of results. The tool processes existing data and its outputs (for instance the change in policy by decision makers in favour of society welfare), providing the foundations upon which public participation GIS can release its full potential, by displaying multiple realities and conflicting interests through the eyes of all concerned stakeholders.

There are many ways of using the tool. One has to be innovative in generating data. Even a map drawn by the local community in a participatory rural appraisal (PRA) activity can be inserted as a thematic layer after identifying the spots and locating the coordinates with a GPS system. The common output in the interest of all is clear understanding of the area, better resource management, local stakeholder participation at policy level and highly accurate scientific data for monitoring and evaluation, well-displayed and properly stored.

Onges find themselves in a situation where their access to resources is threatened and it is the prime responsibility of the government authorities to safeguard them from these. The participatory GIS tool can help understand the provenance and consequences of these threats, to help protect the resources from being exploited. Participatory GIS can be a tool which can help Andaman authorities to understand the ecosystem in detail with the help of indigenous peoples and their knowledge and ensures their participation at policy level in decision making processes. This way, Onges can be supported in their survival and livelihoods through informed choices,

exchange of knowledge and empowerment, ultimately leading to sustainable development of a threatened indigenous community.

The diversity of social knowledge systems should thus be used as a source of empirical knowledge. In the many parts of the world that are yet to embrace the scientific knowledge system to the full, it is necessary to utilize aspects of culture, beliefs and practices as popular mode of explanation to avoid knowledge divides from hampering development or even survival. Changes needed for sustainable development often derive from culturally-determined indigenous knowledge systems and this can be brought into the realm of science with the help of participatory GIS.

Abstract
This case study explores how participatory GIS techniques are applied among the native community of the Onge in the island of Andaman. GIS techniques can contribute to empirical understanding of indigenous knowledge systems in the natural resources management processes and techniques as applied in this region. Furthermore, GIS techniques also illustrate the apparent knowledge divide and anomalies between indigenous and scientific knowledge systems and the Onge community. The main research method used for the study was participant observation, open end questionnaire and participatory GIS (PGIS). Through this technology, data on natural resource management (NRM) practices amongst the Onge community were collected, interpreted and then extrapolated on participatory GIS modules. The researcher worked with the Onge community using a hand-held GPS system, recording the coordinates and activities performed. These coordinates were plotted on the base map of the Forest Department of Andaman using Remote Sensing and GIS cells, with the help of GIS software.

The method gave a clear picture of the community's resource distribution (land coverage and usage patterns) and resource usage, control and access (hunting, gathering, fishing, grazing, mining and harvesting from the wild). Further, it contributed to the identification and understanding of places of historic, cultural and religious significance, providing insight into the community's metaphysical vision and their hazard perception (e.g. related to the tsunami). The exercise revealed many of the socio-economic, bio-physical and cultural components – and their interlinkages – of Little Andaman. The generated data can be used for better planning, monitoring and evaluation of the existing resources. Further, it can help policy makers develop a more participatory, stakeholder-involved development policy. PGIS for NRM helps improve communication between scientific and indigenous communities, bridging knowledge divides and contributing to sustainable development.

Key words: Sustainable Development, Indigenous Knowledge systems, Participatory GIS, Andaman islanders, Knowledge Divide.

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[i] The paper is a part of M.Phil dissertation work entitled 'Indigenous Knowledge Systems towards sustainable Development among Andaman Islanders' done at the Indian Institute of Forest Management in the year 2004 – 2005 under the guidance of Prof. D. Debnath, IIFM, Bhopal and Prof. Anil Gupta, IIM, Ahmedabad. The main objectives of the research were:

1. To study the habitat structure in the homeland of the indigenous peoples in Andaman Islands;
2. To document the Indigenous Knowledge System as an important source of degree of interaction with the surrounding environment in relation to biodiversity conservation, Ecosystem Management and Livelihood Patterns;
3. To study the variation in the utility pattern of space, environment and bio-resources among the women in comparison to men, and
4. To study the significance of community institutions for the empowerment of the people to achieve sustainable development.