Department of Environment and Natural Resources

European Union

Association of Southeast Asian Nations

PARTICIPATORY 3-DIMENSIONAL MODELLING

GUIDING PRINCIPLES AND APPLICATIONS

ASEAN Regional Centre for Biodiversity Conservation

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**BY GIACOMO RAMBALDI AND
JASMIN CALLOSA-TARR**

JULY 2002

ASEAN Regional Centre for Biodiversity Conservation
A joint cooperation project between ASEAN and the European Union

Participatory 3-Dimensional Modelling: Guiding Principles and Applications

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Published by: **ASEAN Regional Centre for Biodiversity Conservation (ARCBC)**

Citation: Rambaldi, Giacomo and Callosa-Tarr, Jasmin. 2002. **Participatory 3-Dimensional Modelling: Guiding Principles and Applications**, ASEAN Regional Centre for Biodiversity Conservation (ARCBC), Los Baños, Philippines

ISBN: 971-8986-47-2

Editors: Mike Appleton, Sahlee Bugna and Bridget Botengan

Design: Nanie S. Gonzales

Pictures: Giacomo Rambaldi unless otherwise specified.

Printed by: WordShop Specialists Network, Inc. in the Philippines

Funding partners: **European Commission**
Department of Environment and Natural Resources

Available from: **ASEAN Regional Centre for Biodiversity Conservation (ARCBC)**
P.O. Box 35015
University of the Philippines Los Baños (UPLB)
Los Baños, Laguna 4031, Philippines

Note: This resource book has been published and is distributed together with a Companion CD containing selected reference documents and an educational movie on Participatory 3-D Modelling with the title “Giving Voice to the Unspoken”.

Web-based reference sites: http://www.arcbc.org.ph
http://www.iapad.org

FOREWORDS

The 2000-2005 ASEAN Environmental Education Action plan is a landmark effort of ASEAN member-countries towards achieving a more secure, equitable and sustainable development of the region through education and public-private partnerships.

The Action Plan proposes strategies that translate local and regional issues into environmental education materials, and encourages greater participation in undertaking environmental programs with governments.

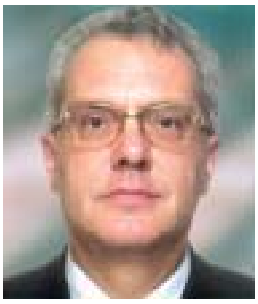
This resource book describes in detail an innovative community-based communication, research and planning tool as it employs new technologies to address environmental and social concerns.

Spatial tools can help reinforce bottom-up development and collective decision- making. Like a universal language based on colour, shapes and dimensions, Participatory 3-Dimensional Modelling helps in bridging language, education and cultural barriers, involving different stakeholders, particularly the younger generations, through a collegial learning process.

Congratulations to the ASEAN Regional Centre for Biodiversity Conservation (ARCBC) for updating the earlier version and for translating it into Vietnamese, Bahasa and Thai.

This document represents a concrete contribution to the successful implementation of the ASEAN Environmental Education Action Plan.

HEHERSON T. ALVAREZ
Secretary
Department of Environment and Natural Resources
Philippines
ASEAN Representative to ARCBC



The Sixth Environment Action Programme of the European Community 2001-2010 known as "*Environment 2010: Our Future, Our Choice*" has four priority areas, namely Climate Change, Nature and Biodiversity, Environment and Health, and Natural Resources and Waste.

The Programme calls for the active involvement and accountability of all sectors of society in the search for innovative, workable and sustainable solutions to environmental problems and sets out approaches, which emphasize the need for more effective implementation and more innovative solutions. The Commission recognizes that a wider constituency must be addressed.

The Action Programme seeks new and innovative instruments for meeting complex environmental challenges. Legislation is not abandoned, but its more effective use is sought together with a more participatory approach to policy-making.

Well-produced information generated through a collaborative effort by scientists and members of the community facilitates communication between stakeholders and implementing agencies and has great potential to support sound policy and decision-making processes. In this respect, Participatory 3-D Modelling may play a substantial role in institutionalizing "participation" in conservation and development.

I would like to congratulate the ASEAN Regional Centre for Biodiversity Conservation for disseminating the method in the region.

JAN DE KOK
Ambassador
Head of Delegation
Delegation of the European Commission
in the Philippines

PREFACE

The importance of integrated approaches to participatory development and management of natural resources has been emphasized in many international fora on sustainable development. In Rio de Janeiro, the 1992 United Nations Conference on Environment and Development (UNCED) devoted Chapter 10 of Agenda 21 to this topic, and noted:

"Expanding human requirements and economic activities are placing ever-increasing pressures on land resources, creating competition and conflicts and resulting in sub-optimal use of both land and land resources. If, in the future, human requirements are to be met in a sustainable manner, it is now essential to resolve these conflicts and move towards more effective and efficient use of land and its natural resources. Integrated physical and land use planning and management are an eminently practical way to achieve this. By examining all uses of land in an integrated manner, it makes it possible to minimize conflicts, to make the most efficient tradeoffs and to link social and economic development with environmental protection and enhancement, thus helping to achieve the objectives of sustainable development. The essence of the integrated approach finds expression in the coordination of sectoral planning and management activities concerned with the various aspects of land use and land resources."

Chapter 26 of Agenda 21 further addresses the need for *"Recognizing and Strengthening the Role of Indigenous People and their Communities through the provision of mechanisms providing them with the know-how they need to manage their environment and resources sustainably, applying traditional and indigenous knowledge and approaches."*

This manual is intended as a small but significant contribution to the desired directions.

The ASEAN Regional Centre for Biodiversity Conservation (ARCBC) has been established jointly by the Association of Southeast Asian Nations (ASEAN) and the European Union (EU). The overall objective of the Centre is to intensify biodiversity conservation through improved co-operation in a comprehensive regional context, by assisting in setting up a network of institutional links among ASEAN countries and between ASEAN and EU partner organizations.

During a regional Training Needs Assessment Workshop held in Bangkok in April 2001, Participatory 3D Modelling (P3DM) was identified as a way forward for enhancing collaborative protected area management and facilitating conflict resolution. Recommendations were made for its region-wide adoption through the conduct of training exercises and the updating and translation of this document in a number of Southeast Asian languages.

Credits for the fine-tuning of the technique and the preparation of the "*Manual on Participatory 3-D Modelling for Natural Resources Management*" have to be ascribed to the National Integrated Protected Areas Programme (NIPAP), a special project (1995-2001) of the Philippine Department of Environment and Natural Resources (DENR), supported by financial and technical assistance from the European Commission. The manual has been published in October 2000 as Volume 7 of the series known as *"Essentials of Protected Area Management in the Philippines"*.

This document has been elaborated and tailored to a wider context. It builds on experiences gained in the Philippines, Vietnam and Thailand and contains new chapters including insights on adult learning and spatial cognition and the analysis of experiences gained in different countries and contexts.

The enclosed companion CD provides access to selected bibliographic references and contains a 21-minute movie with the title "Giving Voice to the Unspoken". The video illustrates the hands-on aspects of 3-D modelling. It has been jointly produced by the ASEAN Regional Centre for Biodiversity Conservation (ARCBC), the Social Forestry Conservation Project in Nghe An Province - Vietnam, and the Environmental Broadcast Circle (EBC) – Philippines, affiliated with the International Television Trust for the Environment (TVE).

ACKNOWLEDGEMENTS

Publications like this are based on knowledge acquired from direct field experience and supporting research. This document embodies inputs from local mapmakers and facilitators during field activities involving Participatory 3-D Modelling. It reflects whatever mistakes happened to be noted and the successes achieved in tailoring a method to the interests and skills of people in contexts where lack of communication poses serious obstacles and is frequently a source of conflict and disempowerment.

Everyone involved in this process, from national and local government agencies, community elders, students, Indigenous Peoples, non-government organizations, and the private sector, has shown immense enthusiasm and dedication to what they could see, touch, understand and shape.

We wish we could list all individuals, whose knowledge, dedication and skills carried the process forward from conceptualization to final "commissioning". Special mention goes to all local governments that supported these initiatives and to Indigenous Peoples in the Philippines, and hill tribes in Vietnam and Thailand who shared their valuable knowledge of remote areas; to the fishers who revealed the hidden features of the seabed; to the farmers who depicted and described the facets of agricultural lands; to the rural health workers, women in particular, who best unveiled details on health, education and demography.

There are researchers and practitioners who deserve special mention for the effort they provided in contributing to, commenting on or revising selected sections of this document. They are listed in alphabetical order: Mike Appleton, Training Adviser at the ASEAN Regional Centre for Biodiversity Conservation, Philippines; Prof. Robert Chambers, Research Associate at the Institute of Development Studies, Sussex University, UK; Dave de Vera, Executive Director of the Philippine Association for Inter-Cultural Development (PAFID), Philippines; Prof. Cees Leeuwis, Professor in Communication and Innovation Studies at the Department of Social Sciences, University of Wageningen, Netherlands; Mr. Chira Prangkio, Head of the Department of Geography, Faculty of Social Science, Chiang Mai University, Thailand; Dr. Uraivan Tan-Kim-Yong, retired Director of the Resource Management and Development Centre, Faculty of Social Sciences Chiang Mai University, Thailand; Dr. Barbara Tversky, Cognitive Psychologist, Professor of Psychology at the Stanford University, USA; Dr. Monina T. Uriarte, Head, Training and Extension Branch, ARCBC, Philippines; Prof. Daniel Weiner, Professor of Geography and Director of International Programs at West Virginia University, USA.

We must make special mention of Dr. Reynaldo C. Bayabos, Director of the Protected Areas and Wildlife Bureau (PAWB), who successfully brought about the institutionalization of 3-D modelling in the Philippines through Memorandum Circular No. 2001-01 issued by the Department of Environment and Natural Resources (DENR) on January 4, 2001.

Last but not least, we thank the NIPAP Co-Directors, Dr. Antonio C. Manila and Nick Ashton-Jones, for providing us with the means and moral support to initiate this challenging and innovative task, and ARCBC Co-Directors, Mr. Gregorio I. Texon and Dr. John R. MacKinnon who, together with the ASEAN National Biodiversity Reference Units (NBRUs), ARCBC staff and ARCBC Editorial Board, valued the potential of P3DM, supported the updating of this document and promoted its dissemination in Southeast Asia. ●

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ABBREVIATIONS

3-D	Three-dimensional
ARCBC	ASEAN Regional Centre for Biodiversity Conservation
ASEAN	Association of Southeast Asian Nations
CADC	Certificate of Ancestral Domain Claim
CALC	Certificate of Ancestral Land Claim
CADT	Certificate of Ancestral Domain Title
CiGIS	Community-integrated Geographic Information Systems
CMU	Chiang Mai University
CNRM	Collaborative Natural Resources Management
DANIDA	Danish Agency for Development Assistance
DENR	Department of Environment and Natural Resources
EC	European Commission
ENTMRPA	El Nido-Taytay Managed Resource Protected Area
GIS	Geographic Information System(s)
GIT	Geographic Information Technologies
GPS	Global Positioning System(s)
ICRAF	International Centre for Research in Agroforestry
INRCP	Integrated Natural Resources Conservation Project
IPR	Intellectual Property Rights
IPRA	Indigenous Peoples Rights Act
LGU	Local Government Unit
MIGIS	Mobile, Interactive Geographic Information System
MMNP	Mount Malindang Natural Park
MPNP	Mount Pulag National Park
NAMRIA	National Mapping and Resource Information Authority
NBRU	National Biodiversity Reference Unit
NCIP	National Commission on Indigenous Peoples
NEA	National Environment Agency (Vietnam)
NGO	Non-Government Organization
NIPAP	National Integrated Protected Areas Programme
NIPAS	National Integrated Protected Areas System
NTFP	Non-Timber Forest Products
P3DM	Participatory 3-Dimensional Modelling
PA	Protected Area
PAMB	Protected Area Management Board
PAWB	Protected Areas and Wildlife Bureau
PLA	Participatory Learning and Action
PLUP	Participatory Land Use Planning
P-GIS	Participatory Geographic Information System
PPGIS	Public Participation Geographic Information System
RFD	Royal Forest Department
SFDP	Social Forestry Development Project
SFNC	Social Forestry and Nature Conservation Project
SM-HDP	Sam-Mun Highland Development Project
TG-HDP	Thai-German Highland Development Programme
TUSFP	Thailand Upland Social Forestry Project
TVE	Television Environment Trust
VNPPA	Vietnam National Parks and Protected Areas Association
WIPO	World Intellectual Property Organization

DEALING WITH SPATIAL INFORMATION AT COMMUNITY LEVEL

GEOGRAPHIC INFORMATION TECHNOLOGIES

"Rapid growth of Geographic Information Technologies (GIT) is transforming how earth and environment are visualized, represented and understood. As a result, GIT applications can alter how people view, exploit and manage the physical resource base. Geographic Information Systems (GIS) produce representations of nature that privilege conventional forms of scientific spatial information, including data on the local environment. As a result, the politics of landscape and the social production of nature are frequently ignored and valuable local knowledge marginalized" (Weiner *et al.,* 1999:18).

In recent years there has been a strong drive towards integrating GIS into community-centred initiatives particularly to deal with spatial information- gathering and decision-making. Researchers around the world have been working on different approaches known under a variety of abbreviations including, among others, PPGIS, P-GIS, CiGIS and MIGIS.

PPGIS: Public Participation GIS
CiGIS: Community-integrated GIS
P-GIS: Participatory GIS
MIGIS: Mobile, Interactive GIS

All share the assumption that the system would place ordinary people in the position to generate and analyse geo-referenced spatial data, integrate multiple realities and diverse forms of information. This would in turn enable broader public participation in environmental and public policy decision-making.

Nonetheless, it has become apparent that, due to its heavy technological component, the community use of GIS cannot be divorced from the resource issues necessary to undertake and maintain it. Therefore, lacking external support, GIS would be outside the capacity of most marginalised or less-favoured communities (Weiner *et al.* 2001; Carver, 2001; Abbot *et al.*, 1998; Dunn *et al.,* 1997)

At the onset of the PPGIS concept, Poiker (1995) expressed the concern that the nature of and access to GIS would simultaneously marginalize or empower different groups in society having opposing interests. Abbot *et al.* (1998) raised the issue on whether participation and GIS would even be a contradiction in terms.

Community-integrated GIS (CiGIS):

- is likely to be agency-driven, but it is not top-down nor privileged toward traditional scientific knowledge;
- addresses questions that participant communities feel are important;
- assumes that local knowledge is valuable and expert;
- broadens the access base to digital spatial information technology and data;
- incorporates communities in the production of GIS;
- assumes socially differentiated multiple realities of landscape;
- integrates GIS and multi-media;
- assumes the potential for more democratic spatial decision-making through greater community participation;
- assumes that spatial decision-making is conflict-ridden, embedded in local politics, and is issue-driven.

Quoted from Weiner D. and Harris T, 1999:8. *Community-Integrated GIS for Land Reform in South Africa.* Research Paper 9907, West Virginia University.

Within a multi-faceted debate on the role of GIS in society, PPGIS evolved along different lines and among diverse interest groups. Currently, the concept embraces a number of applications ranging "from internet-dependent spatial multimedia used in metropolitan areas, to field-based participatory research methods with a modest GIS component" (Weiner *et al.,* 2001:10).

Participatory 3-Dimensional Modelling (P3DM) has been conceived as a method for bringing GIS potentials closer to rural communities and for bridging the gap existing between geographic information technologies and capacities found among marginalised, isolated, and frequently natural resource-dependent communities. P3DM as such fits best into what is considered as Community-integrated GIS (CiGIS) as defined by Weiner and Harris (1999).

This resource book is intended to assist researchers, Participatory Learning and Action (PLA) and GIS practitioners in bringing the power of GIS to the grassroots level through the use of P3DM.

PARTICIPATORY 3-D MODELLING: A MEANS, NOT AN END

Participatory 3-D Modelling integrates people's knowledge and spatial information (contour lines) to produce stand-alone scale relief models (**Figure 1**) that have proved to be user-friendly and relatively accurate data storage and analysis devices and at the same time excellent communication media. Relief models may also contain additional geo-referenced information obtained from field surveys, Global Positioning Systems (GPS) readings and secondary sources. The latter generally applies to virtual features like administrative boundaries, watershed classifications based on scientifically defined parameters, and others.

Figure 1. The model: a focus for learning and negotiation

P3DM is a relatively new communicative facilitation method used in innovation processes related mainly to resource use and tenure. The method has been conceived to support collaborative initiatives aimed at increasing public participation in problem analysis and decision-making. The process within which P3DM is used may unfold at different levels involving a variety of stakeholders and diverse strategies.

The method is generally used within projects or initiatives designed to address issues bound to the territory. The process leading to the construction of the models requires local and external inputs and skilled support. Once the models are done, their maintenance and use rest normally within local capacities. Considering that P3DM is a technology, which is fundamentally proposed to specific interest groups to address a particular problem, the proponents should thus have a thorough understanding of the environmental and socio-economic setting of the area; they should also have the ability to support the participating communities in implementing strategies, plans and actions, and in addressing new realities, which may emerge from the conduct of P3DM activities.

In a practical context, the intervention phase wherein a 3-D model is manufactured, leads participants through a collective learning process to the visualization of their economic and cultural domains in the form of a scaled and geo-referenced relief model, which can be used subsequently for different purposes as discussed on pages 3 to 11.

One major constraint of 3-D models is their limited mobility as elaborated on page 6. Their use is therefore confined to those convening around them. To upscale their utilisation, P3DM should be integrated with GPS and GIS to make their content portable and shareable. This allows adding precisely geo-referenced data, conducting additional analysis and producing cartographic outputs. The synergies resulting from the combinations of the three systems add veracity and authority to community knowledge, paving the way for more balanced power-sharing in collaborative processes leading to change and innovation.

SPATIAL LEARNING AND THE VERTICAL DIMENSION

"Human cognition includes sensation and perception, thinking, imagery, reasoning and problem solving, memory, learning and language. Location, size, distance, direction, shape, pattern, movement and inter-object relations are part of the spatial world as we know and conceive it" (Montello, 1997).

Cognitive maps are internal representations of the world and its spatial properties stored in memory. Frequently referred to as mental maps, they allow us to know 'what is out there, what its attributes are, where it is and how to get there'. Cognitive maps are distinctive to individuals. They are not inclusive like cartographic maps with a constant scale, but consist of discrete, hierarchically organized pieces determined by physical, perceptual or conceptual boundaries (Montello, 1997).

Spatial knowledge develops in humans through three progressive stages: landmark, route and survey knowledge. The first refers to the capacity of memorizing places in relation to an event, and the second, to developing the sense of ordered sequences of landmarks. The last and more progressed stage (**Figure 2**) is where the knowledge simultaneously embraces more locations, their interrelations and allows for detouring, shortcutting and creative navigation (Montello, 1997).

This is the learning itinerary undertaken by informants confronted with a blank relief model. At first, they would look for landmarks to establish their

Figure 2. Assembling the cognitive patchwork

physical location *vis-à-vis* the model. In a few minutes, they could locate themselves and/or their households, and establish spatial relationships between different landmarks. Once this is done, informants could link the model to the real world and would now be in the position to precisely depict their mental landscape.

Practitioners using physical 3-D models at the community level have experienced that when informants are provided with a blank relief model instead of a blank contour map or a blank sheet of paper, they can easily depict their spatial knowledge in a scaled, georeferenced manner and add a lot of precise details.

The fact that 3-D models augment the power of mind (see **Box**) and facilitate scaling, allows for filling in information more fully and accurately on a given area.

Generally this is not the case with sketch mapping, which has been widely used to represent spatial knowledge in the context of participatory action research.

The difference between a blank contour map and the corresponding relief model is the physical vertical dimension that provides essential cues for stimulating memory and for establishing spatial associations.

Among the different visualising methods[1] used to spatially reproduce people's knowledge, Participatory 3-D Modelling (P3DM) is the one which - by adding the vertical dimension and using simple communication means like colours, shapes and dimensions - offers substantial advantages for depicting cognitive maps.

> "The usefulness of a visual representation of the landscape [e.g. map, 3-D models, illustrations, paintings, etc.] originates from the interaction of its physical format with the way humans process information in their mind.
>
> Whereas the information humans can mentally process is limited, both in number of items (memory) and in number of operations (processing), external visual representations are virtually unlimited. Whereas mental information processing is fleeting, external representations are permanent. Whereas human information processing is a private, internal event, external representations are public, transportable, and shareable. External representations enlarge human memory and enhance processing by offloading those burdens from the mind to inspectible, rearrangeable space. People are limited in the amount of information and mental operations that they can keep track of, but people are excellent at pattern recognition.
>
> Turning internal information and operations into external patterns augments the powers of mind." (adapted from Tversky and Lee, 1999:1)

CROSS-CUTTING FUNCTIONALITIES OF PARTICIPATORY 3-D MODELLING

Experience gained over a period of 15 years in Southeast Asia has shown that 3-D models used independently or integrated with GIS and GPS and made part of a wider process contribute to a number of basic functionalities in terms of human development and interaction.

Discovery Learning

For the past century, relief models have played an important role in displaying geographic information for educational purposes. Starting in 1987, 3-D models have been used in an interactive mode as instruments through which people could learn by doing. Considering the fact that the act of *learning* causes a relatively permanent change in cognition or behaviour (Montello, 1997), the *process* of manufacturing a relief model represents an important individual and collective learning experience. By providing a "*bird's eye view*", a relief model widens the participants' evaluative frame of reference on spatially defined issues like watersheds, linked ecosystems, resource tenure and access, and others, thus stimulating active learning and analysis. In other words, it helps the individual to understand the ecological and social dynamics that go beyond his cognitive boundaries.

This method is tailored for areas where poverty, isolation, marginalization, low literacy and language barriers frequently shape society. The tendency for most people residing in these areas is to learn via concrete sensorial experiences, rather than abstract concepts. In this respect, practice has shown that villagers – when properly oriented – could manage the

[1] e.g. sketch mapping, transect diagramming, participatory aerial photo-interpretation, relief modelling, mapping, etc.

Figure 3. Bird's eye view on the Pamitinan Protected Landscape, Rizal, Philippines, 2000.

Figure 4. Information is made tangible

P3DM process with ease and great enthusiasm, walking through the various stages of learning. In fact, the physical nature of the method enhances discovery learning through verbal, visual and tactile experiences, stimulates confrontational feedback, promotes debate and negotiation and generates shared information in visible and tangible (**Figures 3** and **4**) formats.

Thanks to the use of differentiated coding means, 3-D models, like a GIS, accommodate overlapping information layers, and thus facilitate community-based analysis and decision-making.

Being important repositories of local knowledge, relief models are frequently used as displays of the local landscape and as educational instruments for teaching local geography and for enhancing people's interest in conserving and restoring natural resources.

> Concluding remarks of an Elder after the conduct of a series of PLA exercises:
>
> *"At the beginning we thought we were playing. Later on we realised that we were analysing our lives. We knew that we knew, but we were not aware of how much we knew and how important our knowledge is to us".*
>
> Captain George, 1997, Barangay Tawangan, Kabayan, Philippines

Visualizing Knowledge

"Knowledge can be considered as the sum of interconnected rules of interpretation through which we understand, give meaning, perceive or interpret the world around us" (Leeuwis, 2001). Knowledge is what we store in our mind and what leads us to take decisions, act and react to stimuli received from the external world. Knowledge is very subjective and builds up in everybody's mind through a continuous learning process involving, among others, concrete experiences, observations and reflections, formation of concepts and their testing.

At one end of the spectrum we find what is considered as our "*unconscious knowledge*", which is characterized by perceptions and motives that we are not aware of and which is "sealed off" by psychological conditioning. This means that we have to overcome emotional barriers in order to gain access to it.

Our *unconscious* fades into what is frequently referred to as *tacit knowledge,* which corresponds to knowledge that we are not immediately aware of (see **Box**), on which we base our day-to-day actions, but which is somehow difficult to articulate. This type of knowledge can be elicited through in-depth discussions and interactive exercises (e.g. PRA/PLA tools) including visualizing methods like P3DM. The third category is known as *explicit*. This is knowledge that we are aware of, have reflected upon and can easily capture in verbal, textual, physical or visual formats (Leeuwis, 2001), and that transforms into *information*.

It is important to appreciate these differentiations because this book revolves around a method that facilitates the visualization of mainly *tacit* (spatial) knowledge, and increases through an intensive learning process the amount of knowledge we are fully aware of. This enhances our capacities to analyse, communicate and interact on specific issues, which got "much clearer in our mind"

As discussed in detail on pages 2 and 3, cognitive maps (also known as mental maps) are internal representations of the world and its spatial properties stored in memory. They frequently represent portions of our tacit and explicit knowledge and are visualized with the use of sketch maps, transect diagrams, scale maps, drawings and physical or virtual 3-dimensional models.

Compared to technology-dependent Geographic Information Technologies, Participatory 3-D Modelling is a proven method that can be handled in rural areas within locally available technical capacities, and can visualize spatial knowledge particularly among communities characterised by low literacy, language barriers and lack of basic utilities (e.g. electric power) (Tan-Kim-Yong, 1992 and 1994; Rambaldi *et al*. 2000; Hoare *et al*., 2002). Different from other visualizing tools (i.e. sketch mapping) characterised by variable levels of accuracy, 3-D modelling offers the opportunity to produce relatively precise geo-referenced and scaled qualitative and quantitative data, adding substantial value and communication power to existing local knowledge.

Community Cohesion, Self-actualization and Self-determination

Experience gained in the Philippines over almost a decade has shown that 3-D modelling exercises conducted entirely at the community level and as a response to local needs versus external threats have yielded positive effects in terms of community-cohesion and identity building (PAFID, 2001) (**Figure 5**).

The power of maps resulting from the integration of community mapping, 3-D modelling (**Figure 6** and **Figure 7**), GPS and GIS, combined with strong advocacy and an existing legal framework accommodating the results of such actions, has led the way towards legal recognition of ancestral rights claimed by Indigenous Peoples as discussed on page 17 and 18.

Manufacturing a relief model has positive effects in stimulating community cohesion because it gathers people to share information and concerns and frequently reinforces community self-actualisation through the revival of local knowledge. Old people share history with young people, passing on legends and religious beliefs, sacred rites and places so essential to conserving tradition (Alcorn, 2000:1-2).

A well-displayed 3-D model is appealing, fuels community esteem and sense of intellectual ownership, and becomes part of the local cultural landscape. Villagers frequently use these models to introduce visitors to the area. This simple act signifies peer-to-peer information sharing and calls for silent acknowledgment of the existence of local knowledge: *"We are on the map. We do exist! We know where we are, and what surrounds us!"*

Figure 5. Indigenous Peoples working on the 1:10,000-scale model of the Mt. Pulag National Park, Benguet, Ifugao and Nueva Vizcaya, Philippines; 1999

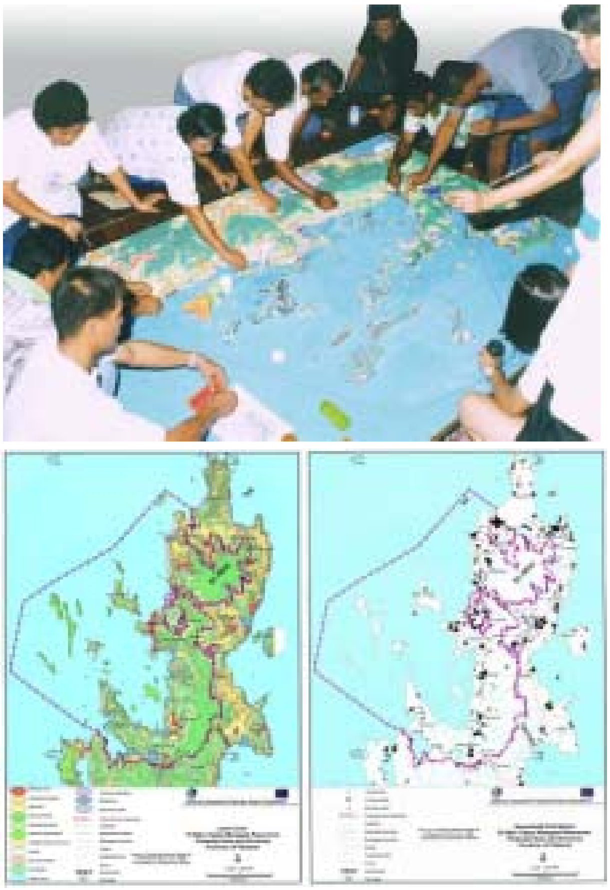


Figure 6. El Nido-Taytay Managed Resource Protected Area, Philippines, 1999; 1:20,000-scale model and derived maps.

Improving Communication

Relief models provide local stakeholders with a powerful medium for easing communication and overcoming language barriers.

In providing open access to information, 3-D models add transparency and create common grounds for discussion. They limit the distortion[2] of messages between communicating parties, by offering a shared language of colours, shapes and dimensions, and broaden individual perspectives. In doing this, 3-dimensional models bridge language barriers and ease communi-

> The information shown on a relief model is easily understood because multiple stakeholders have played an active role in compiling it and in defining its legend, which is the actual key for decoding what is on display.

[2] The presence of the vertical dimension in representing a landscape reduces distortion while transmitting a message because it removes one layer of interpretation.

cation on issues bound to the territory and its resources. This is particularly relevant for people having different education levels, cultural backgrounds and eventually diverse or conflicting interests.

Reproducing geo-referenced people's knowledge in cartographic format thus fitting a *"receiver-oriented"* communication model[3] has generated information that could place informal (community) and formal (scientists, government officials, consultants, etc.) knowledge at comparable levels, thus facilitating interaction, reciprocal learning and negotiation (Alcorn, 2000, 2001; Poole, 1995, 1998; Rambaldi *et al.,* 2002).

Bridging Isolation and Supporting Change and Innovation

Bringing about change requires the organisation of an innovation process in which communication is used primarily to facilitate learning and negotiation (Leeuwis, 2000). Nonetheless innovation has to rely on the concurrence of both technical and social-organisational elements. This implies - among others - the building of networks of co-ordinated action supporting the desired change at different institutional levels and the involvement of decision makers. This exchange process can be facilitated through the use of communicative strategies. In this context, community mapping has gained importance since increased access to modern geographic information technologies has begun to make the power that comes from recording and controlling space available to those who were traditionally disenfranchised by maps. Hence, *maps* have been the most commonly used reference medium when dealing with geographically defined issues in a community-led negotiation process.

[3] In other words, packaging a message to meet the frame of mind of the receiver (scientists, engineers, government officials, politicians, etc.).

Map courtesy of the Tagbanua Foundation and PAFID

Figure 7. Map of the Ancestral Domain of the Tagbanua Peoples, Coron Island, Philippines, 1998
(Source of information: 3-D Model)

While the 3-D model itself (in its making or display) is an interpersonal communication tool that facilitates learning and negotiation, its greatest constraint lies in its limited mobility. Therefore to interact - using the model as a channel - insiders and outsiders have to gather around it (e.g. in the village, protected area or local administration offices, etc.). This is a severe limitation when considering that central, regional and provincial governments are generally the locus of decision making in terms of institutionalising change in resource access and tenure. The limited mobility of a relief model hampers its outreach and mediation function beyond village boundaries. To reach central institutions, information displayed on relief models has to be made *portable* and *widely shareable*. This is made possible by fully integrating P3DM with a GIS. The latter allows for the conversion of the data depicted on 3-D models into a cartographic format, which is mobile and reproducible. A GIS can in turn generate data sets, which can be fed onto the 3-D Model (see page 36) to enrich the learning and negotiation process. Provided adequate linkages and networks are established, and depending on the existing regulatory framework, innovations supported by P3DM outputs (model, maps, plans, etc.) can reach higher institutional levels (bureaucrats and politicians), and go as far as influencing national policy making as exemplified in the case of the Philippines and discussed in more detail on page 17 and 18 (e.g. land tenure rights for ethnic minorities, establishment of protected areas and watersheds).

Models and maps can be used as part of a larger communication strategy to foster legal and policy reform at the national level. Consensus surrounding a map gives legitimacy in political debates in an open society (Alcorn, 2000). The combination of P3DM, GPS and GIS has proven to be quite efficient in increasing the capacity of local stakeholders to interact with national and international institutions. The P3DM process and its outputs appear to be the foundations upon which Public Participation GIS can release its full potential.

Figure 8. 1:5,000-scale model of the Kankanaey Ancestral Domain, Palina, Kibungan, Benguet, Philippines; 1998

Collaborative Planning

The physical 3-dimensional representation of space offers users a so-called bird's eye view and a common perspective from which to acquire a holistic view of the landscape wherein landmarks and salient features are *visible* to everyone (**Figure 9**). The process of making a 3-D Model or of using it as a reference for discussion and planning facilitates the mental handling of spatial data. Imagine discussing the outlining of a 20-km long road sitting around a desk with no reference at all, using a topographic map or a scaled relief model. The last scenario is likely to be the most productive as discussed in detail at page 2.

This is supported also by transparency in data display. In fact all features shown on a model and on its legend are the result of collaborative efforts of various stakeholders. Having a common understanding of the landscape greatly enhances the capacity of individuals to analyze the territory from a comprehensive planning point of view and to interact on a peer-to-peer basis. The concurrence of all these factors makes 3-D models excellent tools for collaborative planning and helps stakeholders in dealing with issues and conflicts associated with the territory and the use of its resources (**Figure 10**).

As discussed on page 27, the use of a coding system based on a rich assortment of materials and colours, allows a 3-D model to function like a rudimentary community-based GIS, accommodating overlapping layers of information. This is extremely useful in any planning exercise because users can establish visual relations between resources, tenure, their use and jurisdiction.

SPECIFIC APPLICATIONS OF PARTICIPATORY 3-D MODELLING

Supporting Traditional Knowledge Intellectual Property Rights

With the development of modern biotechnology, genetic resources have gained increasing economic, scientific and commercial value for a wide range of stakeholders. In this respect, the associated traditional knowledge has attracted widespread attention from a growing audience considering genetic resources and traditional knowledge to be governed by the laws and practices covering intellectual property use and protection. An "Intergovernmental Committee on Intellectual Property and Genetic Resources, Traditional Knowledge and Folklore" has been established in September 2000 by the World Intellectual Property Organization (WIPO) Member States to address intellectual property questions raised in terms of access to genetic resources and benefit-sharing; and protection of traditional knowledge, whether or not associated with those resources (WIPO Web site, 2002).

The Philippines (PAFID, 2001, Rambaldi *et al.,* 2001) has experienced how Indigenous Peoples could provide evidence of using resources and occupying certain areas since time immemorial and to obtain Ancestral Domain/Land certificates with the use of geographic information technologies including 3D models, GPS and GIS facilities (**Figures 7** and **8**). Based on these experiences, one could figure out how useful the integration of these systems could be in documenting traditional knowledge Intellectual Property Rights (IPR).

Figure 9. There we are!

Photo by Dave de Vera, PAFID

Figure 10. Indigenous Peoples in Kalinga working on a 1:5,000-scale model, Philippines; 2001

Figure 11. Informants working on the model of the Pu Mat National Park, Nghe An, Vietnam; 2001

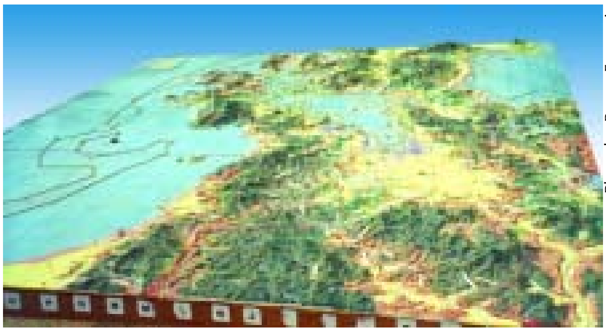


Photo by Royce Eustaquio

Figure 12. 1:20,000-scale model of Malampaya Sound Protected Land and Seascape, Palawan, Philippines; 2000

So far, Participatory 3-D models have been successfully used in preparing land and resource use plans (Tan-Kim-Yong, 1992; Tan-Kim-Yong *et al.*, 1994; GTZ-HDP, 1998; Jantacad *et al.*, 1998), watershed management plans (GTZ-HDP, 1998; Hoare *et al.*, 2002), community-based fire management plans (Hoare *et al.*, 2002), protected area (Rambaldi *et al.*, 2002) and ancestral domain management plans (PAFID, 2001), the last two including both terrestrial and marine components.

Collaborative Research

Participatory 3-D models made at scales equal or larger than 1:10,000, facilitate selective pinpointing of resources, households and other features and can be used as a valid support for the conduct of on-field research in various domains including biological diversity, socio-economics, demography, health and others. What substantially differentiates the method from other modern geographic information technologies like aerial photography and satellite imagery is that it can visualize invisible features like values, tenure, resource use domains, sacred areas, spatially defined rights, cultural boundaries, and others (**Figure 11**).

If the method is applied in a genuinely participatory manner, it generates relatively accurate qualitative and quantitative geo-referenced data (Chambers, 2002) that are intellectually owned and understood by those who have compiled them as discussed in detail on page 32 and 33.

Exploring Water Bodies

The possibility of using 3-D modelling for mapping out water bodies deserves special mention, due to the partially hidden nature of these environments and the value of human cognition in its description and depiction.

Mapping out wetlands and coastal areas characterised by shallow waters is difficult, because of their instability and frequent change (e.g. river deltas). Nonetheless, in cases where the topography has been stable for a long period and reliable contour and bathymetric lines are available, the production of a participatory 3-D model could lead to generating an extremely rich information base on existing ecosystems and their interaction with wetland-dependent communities.

The reproduction of the seabed also depends on the availability of bathymetric lines. Exercises carried out in northern Palawan in the Philippines (**Figure 12**) have demonstrated how well fishermen could map out the details of their fishing grounds including the detailed description of coastal and marine ecosystems.

Collaborative Protected Area Management

The use of Participatory 3-D Models in the context of protected area management (**Figure 13**) has been initiated in the Philippines, as discussed on pages 18 and 19). So far, almost 8% of the 209 (PAWB, 2002) initial components of the National Integrated Protected Area System (NIPAS) has its own models. Recorded uses include the following:

- Generating spatial geo-referenced data based on a community perspective on land use, veg-

etation cover, resource distribution, tenure, etc.
- Storing and displaying such data at protected area/community level;
- Conducting a preliminary census of protected area occupants;
- Planning out field activities at the Protected Area Office level;
- Involving communities in developing resource use and management plans including zoning and boundary delineation;
- Conducting preliminary collaborative research on distribution of species;
- Monitoring jointly with the concerned communities changes in land use, vegetation cover, human settlement, infrastructure development and other features;
- Substantiating public hearings and planning workshops;
- Serving as reference during Protected Area Management Board meetings;
- Supporting the learning of local geography and resource use by students;

> Most protected areas in Southeast Asia do not have demarcated boundaries. Relief models can give stakeholders a clear first time factual understanding of their perimeter. This facilitates a bottom-up approach to boundary delineation and zoning, activities which otherwise tend to be characterized by bureaucratic logistics, frequent confrontation (based on insufficient access to information) and lengthy

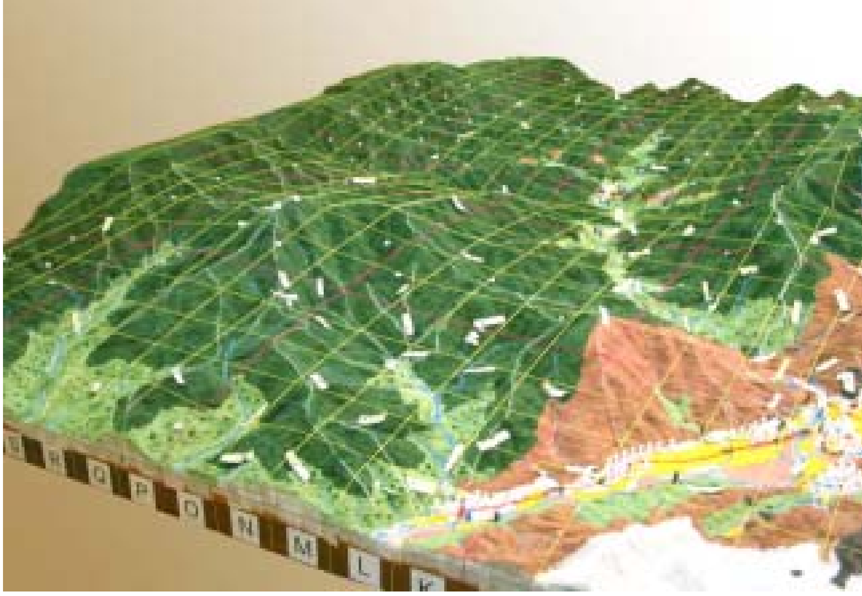


Figure 13. 1:10,000-horizontal and 1:7,500 vertical scale model of the South-western portion of Pu Mat National Park, Nghe An, Vietnam; 2001

- Raising awareness on e.g. the hydraulics of watersheds (upstream-erosion /downstream – sedimentation effects); and
- Introducing visitors to the area.

Participatory Monitoring and Evaluation

Frequently in monitoring spatially defined issues through a process involving community members, sketch maps, transect diagrams or other spatial tools, produced at different times are compared. Their uses carry an inherent weakness because the outputs generally lack geo-referencing and may be inconsistent in terms of coding. P3DM overcomes this weakness because the relief model is a constant with its legend embedded.

A working Participatory 3-D model is never completed. Like in any dynamic system, change is a constant. A relief model, like a GIS, can accommodate regular updating, but – if revised - it cannot store past scenarios (**Figure 14**).

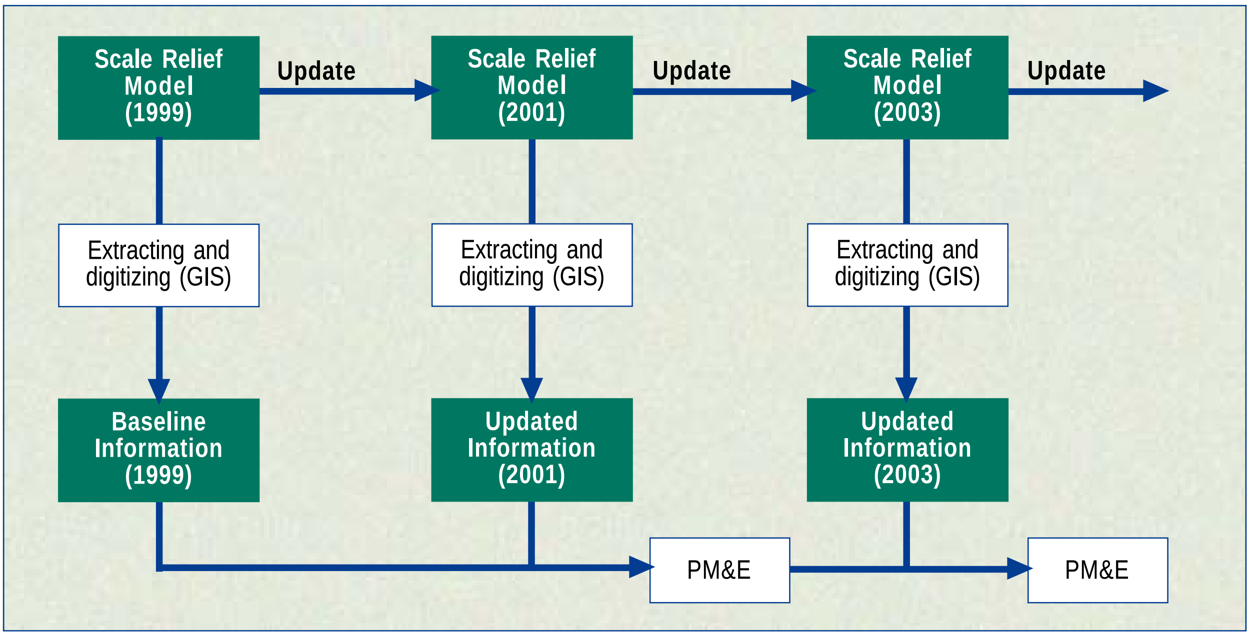


Figure 14. The function of P3DM in a participatory M&E context

Reconciling conflicts through a common perspective

Different opinions are frequently based on different perspectives and the means of expressions used to communicate. A case in point is a long-lasting conflict between tribal communities in the northern part of the Philippines. The origin of the conflict is territorial and relates specifically to boundaries of tribal domains, which were agreed upon by elders a century ago and formalized as written Peace Pacts, passed on from generation to generation. A number of factors have led to diverging interpretations of the scripts and triggered violent confrontations.

In 1998, the Office of the Presidential Advisor for the Peace Process (OPAPP) stepped in to facilitate a negotiation process aimed at reconciling the conflicts. The turning point of the process has been the establishment of a common ground for understanding the territory.

Through the use of relief model embracing the entire area of conflict, it became apparent that diverse ethno-linguistic groups were using different names for natural landmarks, like creeks and peaks. Residents of different locations would construe "the boundary running along the highest mountain" depending on their own viewpoint. Different denominations and interpretations of natural features were ineluctably sources of disagreement.

The model is geo-referenced, represents at 1:5,000-scale, a total area of approximately 700 sq. km. and has been constructed with the active participation of all parties concerned. At planned intervals, the confronting groups have gathered around the model, learned on a common ground and negotiated. In one year and a half, almost all conflicts have been settled and new peace pacts signed.

In such a context, there is no doubt that the third dimension and the holistic view offered by the relief model have been key factors in facilitating the consolidation of the negotiation process: there were only one highest mountain and one creek so-and-so to be named, seen, felt and touched by all concerned.

During the construction of the model and follow-up negotiations, data have been extracted and digitized and fed into a GIS. In support of the data displayed on the 3-D model, the voluminous process documentation includes the description of the boundary corners and the names of the individuals who will be responsible for their identification during the forthcoming ground survey.

This final act, which will conclude the peace process, will be conducted with the assistance of a licensed geodetic engineer. The fact that the elders and the barangay captains have already defined a survey plan represents a reasonable guarantee for the respect of the right to self-delineation (Rambaldi *et al*., 2002).

This is where GIS "adds value" and becomes a vital ingredient for monitoring change, provided the data on the 3-D model are updated at given intervals, periodically extracted, digitized, plotted as thematic maps and finally returned to the community for assessing change, and identifying its causes and effects.

This process adds to the learning aspects discussed on page 3.

Management of Conflicts Bound to the Territory and its Resources

Conflict resolution involves area-based mechanisms to prevent, mediate and resolve local disputes and to strengthen communities in dealing with their management. Disagreements over boundaries, resource use and tenure are often root causes of conflicts.

Photo by Dave de Vera, PAFID

Figure 15. Elders warming up "Peace Pacts" in Balbalan Municipality, Kalinga, Cordillera Administrative Region, Philippines, 2000

The strategies and processes leading to conflict resolution are complex and articulated and need the backing of appropriate institutional, legal and – where applicable - traditional mechanisms.

At grassroots level, 3-D models can help in dealing with conflicts bound to the territory (e.g. boundary disputes) through the visualization of the landscape, and the provision of vantage points shared by the conflicting parties. In addition, a 3-D model provides contenders with equitable access to information (**Figure 15**), adding transparency and reducing the space for subjective interpretations (Rambaldi *et al*., 2002).

The use of 3-D models for conflict resolution has been widespread in Northern Thailand (Tan-Kim-Yong, 1992; Tan-Kim-Yong *et al*., 1994; Srimongkontip, 2000; Hoare *et al.,* 2002) and is currently ongoing in the Philippines under the auspices of the Office of the Presidential Adviser on the Peace Process (OPAPP) (PAFID, 2001; Rambaldi *et al.*, 2002).

It is worth recalling that an interactive process involving 3-D modelling may set the basis for constructive action but that it may also be instrumental in making latent conflicts explicit.

Therefore, it is important that the process be carefully prepared, well managed and embedded in a long-lasting, articulated (multi-actor) intervention, which could eventually deal with follow-up arrangements to accommodate new realities emerging from the process (Leeuwis, 2001).

INHERENT RISKS AND MITIGATING MEASURES

Because of their accuracy, relief models may also have negative implications.

Alone or combined with GIS, Participatory 3-D models "turn local knowledge into public knowledge and conceivably out of local control. This can be used by outsiders to locate resources and meet development needs, or merely, to extract more resources, or to increase control from the outside" (Abbot *et al.*, 1999:29).

Researchers, planners and practitioners should be aware of these possible drawbacks and be careful in the application of the method.

Being on a map, on one hand, means *to exist* vis-à-vis the external world, thus to be in the position to get or claim services and assistance. On the other hand, it may carry undesired implications such as being subject to undesired development pressures, particularly for communities wanting to maintain their cultural identity and traditions.

> Some groups have expressed concern that the mapping process enables outsiders to be in command of information previously controlled by local communities (Poole, P. 1995).

From a biodiversity point of view, depicting habitats of endangered species, or rare resources in demand on the black market, may lead to their further depletion.

Therefore, exercises dealing with sensitive issues should be done with caution and behind closed doors in the course of focus group discussions. Data that are at risk of abuse or culturally sensitive, should be removed from the model and eventually stored as confidential GIS layers with limited or protected access (Harmsworth, 1998).

SCALED RELIEF MODELS IN HISTORY

STRATEGIC PLANNING INSTRUMENTS

Physical three-dimensional models have a special place in the history of urban representation, because of their essentially strategic function. Italian engineers probably invented the technique in the XV century in order to study means of protecting Levantine cities from the Turkish armies (Faucherre, 1986).

The period of glory of 3-D models came with the reign of Louis XIV (1661 to 1715), who ordered the manufacture of 140 1:600-scale models[4] (**Figure 16**) depicting cities that had been incorporated into the Kingdom of France (Faucherre, 1986; Polonovski, 1998).

The relief models were instruments of exclusive knowledge management. The gallery in Paris (**Figure 17**), where these were stored, was kept secret from the eyes of the public (Siestrunck, 1980; Pernot, 1986). Like a hidden vault, accessible only to a selected elite, it contained spatially defined, visualized knowledge enshrining the entire power of the Kingdom. Interestingly enough, this may be considered as a first example of large-scale geographic information storage and management.

[4] A total of 64 relief models have been preserved and are on permanent display at the Lille and at the Hôtel National des Invalides in Paris, France.

Photo by Philippe Caetano/©Centre des Monuments Nationaux, Paris

Figure 16. Three century-old scaled relief model of the city of Perpignan, France (year of manufacturing: 1686).

Because of the strategic function of relief models, engineers manufacturing these took great care in providing an exact representation of the settlements in relation to their surrounding landscape. This was extremely important for engineers who would want to know whether or not a city could be targeted from a particular hill, in order to take the necessary protective measures (Perrin, 1999).

After the reign of Louis XIV, other scale relief models were manufactured both for *defensive engineering* and for *commemorative* purposes (Polonovski, 1998). The former application fell into disuse at the end of the IX century (Faucherre, 1986).

The use of physical topographic models for *strategic* purposes persisted throughout the First and Second World Wars until the present time.

The use of scaled 3-D models for *urban planning* has been maintained among many public administrations. Today, large-scale urban or rural development projects are frequently reproduced as scale models for communication purposes.

From Warfare to Welfare

In the United States - at the end of the IX century - dramatic increases in the quantity of geographic information stimulated a flurry of innovation in terms of visualization and communication methods. Techniques for producing three-dimensional models were developed and their production increased dramatically during the last two decades of the century. The models became a popular medium for communicating the state of geographic knowledge in schools, museums and major public exhibitions. Displays at the World's Columbian Exposition of 1893 in Chicago included some one hundred relief models (Mindeleff, 1889 and 1900; Baker, 1892-94).

Over the past six centuries, the use of 3D models has undergone

Figure 17. The Sun King and his advisors consulting 1:600 scale relief models in the "Galerie du Bord de l'Eau" at the Louvre in Paris; miniature by Nicolas van Blarenberghe [French, 1716-1794] decorating a tobacco box

substantial changes. Conceived essentially for defensive purposes, they represented an efficient means for military engineers to interact with the monarch and highly placed government officials, thus with a selected and restricted power-holding elite.

At the end of the XIX century, their use was opened to the public for educational and communication purposes.

Nowadays scaled relief models are seen mainly as a communication device to exchange information between planners and government institutions and between these and the public.

> **Consultative Participation:** the public participates by being "consulted" and planners and/or institutions may listen to their views. Nonetheless the latter defines both problems and solutions, and may modify these in the light of people's responses.
>
> Such a consultative process does not concede any share in decision-making and professionals are under no obligation to take on board people's views.
>
> (Adapted from Pretty, 1995)

Nonetheless, all these six hundred years of history share a common trait: engineers and artisans have fabricated relief models behind closed doors.

Only in modern history has the public been called in, mainly as a spectator or commentator in a process of consultative participation, but by no means as an actor tasked with inputting data, generating, displaying and *owning* the resulting information.

ADDING "PARTICIPATION" TO 3-D MAPMAKING

The Paradigm Shift

Over the past two decades, the development and conservation sectors have experienced a dramatic shift from an earlier prevailing top-down, to an advocated bottom-up planning approach in the attempt at putting ordinary or disadvantaged people first (Chambers, 1983). Participatory technologies have fast developed becoming almost a requirement for development, land redistribution and biodiversity conservation initiatives. This has led to an array of approaches ranging from ornamental to genuine participation.

At the community level, spatial analytical tools, including sketch mapping, participatory aerial photo-interpretation and participatory 3-D modelling have gained a progressively more important role since increased attention has been paid to the spatial relationships between the territory and its inhabitants, the resources and their users and/or customary custodians. Indeed these tools acquired additional relevance with the diffusion of Global Positioning Systems (GPS), the onset of Geographic Information Systems (GIS) and the associated efforts made by many researchers, practitioners and facilitators, to assimilate these into participatory research, negotiation and planning processes.

In order to translate people's knowledge (i.e. cognitive maps) into high quality geo-referenced information, several methods have been developed, some of which brought about visualizing it in a cartographic, reproducible format accepted at the institutional level as part of a negotiation process.

In a recent publication, Janis Alcorn (2000:12) highlighted the power of maps, "which communicate information immediately and convey a sense of authority. As a consequence, community-based maps empower grassroots efforts to hold governments accountable. This mapping is not action research; it's political action."

LEARNING FROM PRACTICE

It is important to recall that a number of external factors and conditions determine the contribution of 3-D models to innovation processes as exemplified by the analysis of different contexts in which the method has been applied in Thailand, Vietnam and the Philippines.

Thailand, the Frontrunner

In Thailand since the early 1960's, significant areas of the highlands were declared as national reserved forests, parks, and wildlife sanctuaries. A national watershed classification system was introduced in 1986 that imposed additional land use restrictions and gave the Royal Forest Department (RFD) a great deal of control over people living in the uplands of Northern Thailand (SM-HDP, 1998). As a result, many settlements became illegal regardless of how long they had existed. This was in conflict with the national policy for social integration of the hill tribe population (Aguettant, 1996).

Commercial logging concessions in national forestlands were all revoked in 1989 (event commonly known as the 'logging ban') to protect the remaining forests. As restrictions grew over human activities within government forestland, conflict increased over access and control of natural resources and over the geographical extent of users' rights at village and sub-district levels. Villagers had no legal authority to control the harvest of timber products by outsiders, or to establish community-accepted by-laws governing local use and trade of such resources. Moreover, no forum existed to allow village leaders to exchange opinions and experiences concerning these problems (Jantakad *et al.,* 1998).

The use of relief models surfaced in this conflict situation primarily as a facilitating tool for establishing a dialogue on resource use and tenure among outsiders (government officials) and insiders (hill tribe people).

Scaled three-dimensional models had been used by various government agencies, including the Royal Forest Department, for a number of years, but their use was usually limited to project management level. Generally, such models were manufactured at a small scale covering relatively large areas and displayed in government offices.

These models were first used in a proactive mode by the Royal Forest Department (RFD) in the framework of the Thailand Upland Social Forestry Project (TUSFP, 1989; Tan-Kim-Yong, 1992; Poffenberger, 1993; Tan-Kim-Yong *et al.,* 1994; TG-HDP, 1998a) whose pilot sites covered three mini-watersheds nested within the larger Sam Mun Highland Development Project (SM-HDP) (Robert, 1990; Tan-Kim-Yong *et al.*, 1994).

The Upland Social Forestry Project (1987-1995) was funded by the Ford Foundation and implemented by RFD and the Resources Management and Development Programme of the Faculty of Social Sciences, Chiang Mai University (CMU). Project staff jointly conceived the idea of using relief models as a learning and communication tool. CMU researchers began using them in the framework of the new Participatory Land Use Planning (PLUP) approach they were spearheading (Tan-Kim-Yong *et al.*, 1994). Although project staff personally made the first experimental 3-D model, collaborating villagers constructed the following ones as part of the collaborative process. As the devices demonstrated their key role in the PLUP process, particularly in providing open access to information for learning, discussion and negotiation, they began to be constructed in many villages within the wider Sam Mun Highland Development Project area. After their successful use at the village level, the geographical scope of the models was extended to include a number of villages located within entire sub-watersheds to support multi-stakeholder collaborative planning by newly established watershed management networks.

> "**Participatory Land Use Planning** (**PLUP**) is an operational tool or process which creates conditions of frequent communication and analytical discussions, hence strengthening local organization by generating common understanding and shared rights and responsibilities among project partners who carry out activities that lead to the solving of local forest management and other related community problems" (Tan-Kim-Yong, 1992:9-10

Since the PLUP process was geared towards inducing behavioural change both in insiders and outsiders through a learning, negotiation and conflict resolution process, information and communication systems were considered as key ingredients. This in turn required all parties to gain equal access to information to develop a common understanding of resource management problems (Tan-Kim-Yong *et al.,* 1994). It became apparent that in a situation of existing language barriers[5], information exchange could best occur via *visual* communication means like diagrams, aerial photographs and 3-D models in particular. These means provided the focus for organized discussions and were instrumental in providing participants with a clearer understanding of local problems vis-à-vis a wider social and environmental context. Through a progressive learning and negotiation process, this led to the settling of disputes among villagers, between villages, and between villagers and government officials, thus opening up avenues for dialogue between people of different ethnic backgrounds and cultural conditioning (Tan-Kim-Yong, 1992; Tan-Kim-Yong *et al.*, 1994).

Recorded results of the PLUP process have been a more equitable distribution of farmland among villagers, clearly defined resource use (i.e. village) boundaries, the creation of fire protection groups, a notable decrease in opium cultivation and an improved agency-community dialogue. Added transparency on actual land use and regular interactions with government officials reduced the need for farmers to gain quick returns from temporary "*illegally*" occupied land and stimulated their interest in more long-lasting soil and water conservation investments. All this resulted in improved land management under the responsibility of the villagers and in co-operation with the RFD-Sam Mun Highland Development Project.

The PLUP experience has since been widely recognised as an important example of effective local resource management by minority groups (TG-HDP, 1998:27) and has been adopted by other projects in Thailand and neighbouring countries.

The Thai - German Highland Development Programme (TG-HDP), which started in 1981 and went through several phases, adopted relief mapping in 1990. Three-dimensional polystyrene or cardboard models were used in meetings between the survey teams and members of the community as part of a process called Community-based Land Use Planning and local Watershed Management (CLM) (TG-HDP, 1998).

In 1995 the project started assisting the villagers in updating the models and periodically transferring the information to baseline maps to be used for monitoring purposes. In their 1998 final review and "Lessons Learned", the TG-HDP management stated that "of the many working tools such as maps, aerial photographs and GPS that have been used during CLM, the 3-dimensional model has been found to be the most useful" (TG-HDP, 1998a:48). This consideration has been reiterated by Jantakad and Carson (1998) as follows: "During actual implementation of the CLM process, the three-dimensional topographic model has been found to be a very effective and useful tool in assisting the community leaders and government officers to assess present land limitations, problems and conflicts".

Figure 18. Village model, Upper Nan Watershed, Pa Nam Yao Lae Pa Nam Suad National Forest Reserve, Thailand, 1998

The 1997-2003 Upper Nan Watershed Management Project (UNWMP) has been making use of relief models of different scales and sizes (**Figure 18**) in its action to develop a partnership between the Royal Forest Department and local communities living within two national forest reserves. The project involves 45 villages, each provided with its own model. Acknowledging the limitations of village models (see **Table 1** on page 22), the project made larger models encompassing 6-8 villages in 1998 to cater to intra-village dynamics and to support the development of village watershed network rules and regulations dealing with fire management, harvest of Non-Timber Forest Products (NTFP) and livestock grazing rights (Hoare *et al.*, 2002).

Another project, which has made use of participatory relief models, is the Integrated Natural Resources Conservation Project (INRCP), which has been operating in the northern provinces of Chiang

[5] RFD government officials and TUSF programme staff had a hard time communicating with the hill tribe communities as spoken languages differed considerably.

Mai and Mae Hong from 1994 to 1999. In this context, the devices have been successfully used in negotiation processes dealing with disputes over resource use and access and in favouring the use of more sustainable natural resource management practices (Srimongkontip, 2000).

The Collaborative Natural Resources Management (CNRM) project (2000-2004) evolved from the INRC Project into an intervention having a wider geographical scope and focusing - in the light of the 1997 Thai constitution and associated local governance reforms - on institutional development for collaborative natural resource management at village, sub-watershed network, and sub-district government levels. The use of 3-D models has been incorporated as an integral component of more elaborate pilot spatial information and environmental monitoring systems owned and operated by local institutions (Thomas, personal communication, 2001).

In Thailand, the use of 3-D models is quite common within activities of the Royal Forest Department; many research and development workers now believe that their use, increasingly linked with GIS, will continue to expand under recent constitutional and local governance reforms and community forestry legislation currently pending in the Thai parliament (Thomas, personal communication, 2001).

Vietnam, a Recent Adopter

Over the past decade, government policy in Vietnam has gradually shifted away from a centrally planned economy with collective land tenure and resource management, towards a system aimed at decentralizing the management of natural resources. The rights of individual households introduced in 1988, were further secured by the 1993 Land Law, where the State recognized customary land use as a prerequisite for issuing Land Use Right Certificates (LURC) that entitled the awardees to exchange, transfer, lease, inherit and mortgage such rights. Concurrently, the duration of land allocation was extended to 20 and 50 years for land respectively under annual and perennial crops, and made renewable provided careful use was being made. This new land policy has since represented a formidable challenge for the concerned government agencies, requiring the deployment of substantial resources and the promulgation of a supporting legal framework ensuring policy implementation. In this respect, the Government issued Decree 64/CP on Agricultural Land Allocation in September 1993 and Decree 02/CP on Forest Land Allocation in January 1994. Decree 64 specifies that all agricultural land except land allocated to organizations and land required for public needs shall be allocated to households or individuals for agricultural production. Decree 02 provides detailed guidance for the allocation of forestland and forests in accordance with the Forest Protection and Development Act and the Land Law (Christ, 1998).

As a contribution to this effort, in Son La and Lai Chau provinces, the 1993–2004 Social Forestry Development Project (SFDP) has been actively involved in Participatory Land Use Planning (PLUP), land allocation and watershed management. Since 1995, the project has been using relief models (**Figure 19**). The technique was imported from Thailand where it was already in use within GTZ-funded projects (Forster, personal communication, 2001).

The tool – a simplified relief modelling process - has been used for addressing conflicts on land use, facilitating the land allocation, discussing potentials and constraints and developing land use plans (SFDP, 1999). Seen as low-cost inputs aimed at addressing specific time-bound situations, most of the models were produced by villagers using mud, colour powder, tree branches and leaves. Due to their nature most of them have vanished after being used (Forster, personal communication, 2001).

In 2001, the Mountain Agrarian Systems Program produced a first geo-referenced 1:3,000 scale model in Cho Don, Bac Kan Province as part of the CGIAR-

Figure 19. Relief model made in the framework of the Social Forestry Development Project in Na Nga village, Chieng Hac Commune, Yen Chau district, Son La Province, Vietnam; 1999

coordinated initiative. The model has since been used for conducting a participatory diagnosis on spatial management of livestock systems (Castella, personal communication, 2001).

At the end of year 2001, the National Environment Agency (NEA) organized in collaboration with the Social Forestry and Nature Conservation Project in Nghe An, the Vietnam National Parks and Protected Areas Association (VNPPA) and the ASEAN Regional Centre for Biodiversity Conservation, the conduct of the 3-D modelling exercise for the South-eastern portion of Pu Mat National Park covering a total area of 700 km^2. The model has been manufactured by the locally residing ethnic minority groups and has since been used for collaborative planning and zoning.

The Philippine Springboard

For at least a century, the Philippines' biological and cultural diversities have been placed under great pressure by logging, mining, conversion of forests into farmland, population increase and movement of lowland communities into areas traditionally occupied by Indigenous Peoples (IPs). This ignited in the '70s long-lasting conflicts between minority groups and the central government. In 1992, a National Unification Commission was created to identify the root causes of the conflicts through nation-wide consultations. As a result, the Social Reform Agenda and other peace initiatives were launched.

Under present law, all land over 18-percent slope is deemed "public forest land" to which access is legally granted only in the form of time-bound agreements or concessions. Thus, while the Constitution (Art. XII, sec. 5) recognizes the "rights of Indigenous Cultural Communities to their ancestral lands," until 1993 they were considered as "squatters" on public lands.

Cognitive Maps and People's Rights in Natural Resources Management

The first significant step towards fulfilling Indigenous Peoples' (IPs) constitutional rights was taken with the issuance by the Department of Environment and Natural Resources (DENR) of DENR Administrative Order No. 2, series 1993 (DAO 2, S. 1993). This order established the Certificate of Ancestral Domain Claim (CADC) and stipulates a process through which IPs can delineate, document, and gain "recognition" of their "claim" to portions of the territory. In order to avail of the legal stewardship entitling IPs to live, manage and utilize their ancestral domain, an applicant group has to meet a series of requirements including providing proof of use and occupation of given portions of the territory "since time immemorial".

In this context, maps exerted all their power in stimulating change within the existing land tenure and resource access pattern and in influencing national policy making: cartography resulting from two and three dimensional community-based mapping supported by GPS and GIS applications formed the foundations upon which IPs filed numerous applications.

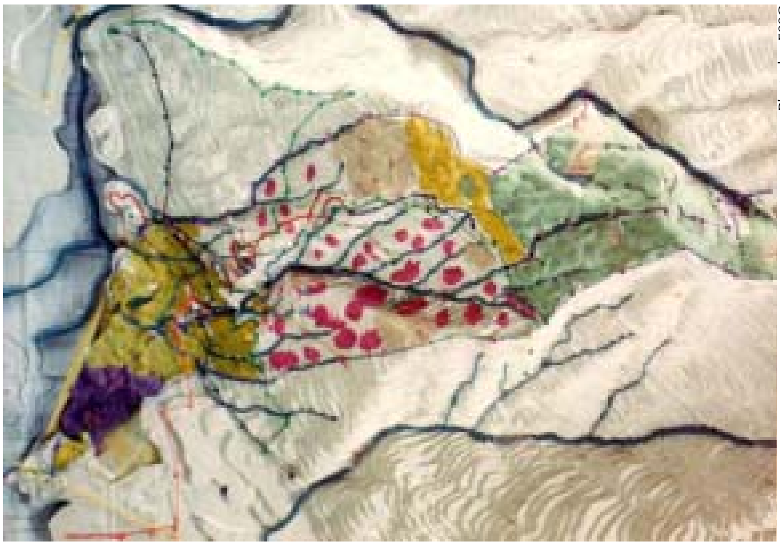


Photo by ESSC

Figure 20. Scale model of the Malaylay-Bucayao Watershed in Sangilen and Maltanday, Baco, Philippines, 1993. Vegetation cover and land use were depicted with the use of clay, coloured yarns and other natural materials

As early as November 1993, the Environmental Research Division of the Manila Observatory assisted the Mangyan Alangan community in Mindoro Oriental in generating cartographic information (see **Figure 20**) to support the filing of an ancestral domain claim and for preparing the related domain management plan (Walpole *et al.,* 1994).

In year 1995, the Philippine Association for Inter-Cultural Development (PAFID), an NGO set up in 1967 to advocate for customary land tenure by IPs, adopted the technique and tailored it for developing ancestral domain management plans, delineating domain boundaries and addressing boundary conflicts. As of the writing of this report, PAFID assisted almost 90 indigenous groups in preparing their maps[6] and plans and in obtaining the desired tenurial instruments (PAFID, 2001).

[6] The delineation activities have been carried out under the auspices of the DENR and the National Commission on Indigenous People (NCIP).

In 1997, PAFID assisted Green Forum-Western Visayas (GF-WV) - a coalition of NGOs and People's Organizations - in adopting GPS, GIS and 3-D modelling. A combination of these three technologies has since been used by the GF-WV to assist indigenous communities in applying for tenurial instruments[6], raising local awareness on outsiders' interventions (e.g. large-scale mining operations) and enhancing community participation in natural resource management (Purzuelo, personal communication, 2002).

The issuance of CADCs was suspended in September 1998, but by then, the application of the DAO resulted in the issuance of 181 ancestral domain certificates covering 8.5% of the national territory.

In addition the appeal and communication power of these accurate, well presented maps has been instrumental in building public support for the passage of Republic Act No. 8371, known as the Indigenous People's Rights Act (IPRA), which provides indigenous groups tenurial rights on their ancestral domains (Alcorn, 2000). The Philippine Congress ratified the Act in October 1997. Article 51 specifies that self-delineation[7] shall be the guiding principle in the identification and delineation of ancestral domains.

As of the writing of this document, the IPRA law had limited implementation first because of a petition[8] filed in 1997 before the Supreme Court questioning its constitutionality, strong opposition made by the mining and commercial forestry sectors and low priority attached to its implementation by the Estrada Administration. With the new administration in place, several certificates of Ancestral Domain Title (CADT) are being processed.

The situation has been clarified by the issuance of a series of Administrative Orders promulgated by the National Commission on Indigenous Peoples (NCIP) during the first quarter of year 2002. The recent instruments maintain, among others, the rights of IPs to self-delineation as spelled out in RA 8371 and call on inter-agency, NGO and community collaboration in the delineation of such domains, provided written authority is granted by NCIP, instruments used are certified by the National Mapping and Resource Information Authority (NAMRIA) and the survey is conducted with the participation of a licensed geodetic engineer.

Additional legislation supporting community-based natural resources management (NRM) includes the 1995 Presidential Executive Order No. 263 adopting community-based forest management as the national strategy to ensure the sustainable development of the country's forest resources, and providing mechanisms for its implementation. One year later, the EO was put into practice by virtue of DENR Administrative Order No. 1996-29 defining a Community-Based Forest Management Strategy (CBFMS) that entails a 25-year production-sharing arrangement entered into by communities and the government to sustainably develop, utilize, manage and conserve a specific portion of forestland. DAO 29-1996 calls for the submission of resource use plans, annual work plans and forest management maps by the communities to the competent authorities for approval and issuance of relevant permits.

The Third Dimension in Conserving Biodiversity

In June 1992, at the Rio Earth Summit, the Government of the Philippines signed the Convention on Biological Diversity and adhered to Agenda 21, thereby endorsing the concepts of conservation through participatory resource management, and environmental protection as the basis for sustainable development. Concurrently, the Philippine Congress enacted the National Integrated Protected Areas System (NIPAS) Act aimed at conserving biodiversity through, among others, the full participation of local communities.

In this context, the European Union and the Government of the Philippines initiated and co-financed the National Integrated Protected Areas Programme (NIPAP), a five- and a half-year (1995-2001) intervention aimed at establishing eight protected areas within the NIPAS framework. The challenge faced by the Programme has been how to give due weight to the interests of local communities in delineating protected area boundaries, identifying resource-use zones and formulating policies on and participating in protected area management.

In 1996, NIPAP started its action research. Protected area-dependent communities were introduced to participatory approaches in data collation, analysis and interpretation. Spatial methods such as transect diagramming and participatory resource mapping were readily adopted, yet with reservations about "translating" sketch maps into more precise, useable information. In 1997, with the objective of generating durable, true-to-scale and "meaningful-to-all" information, the Programme developed a method called Two-Stage Resource Mapping (Rambaldi *et al.*, 1998) which was pilot-tested in the El Nido-Taytay Marine Protected Area in Palawan.

[7] Self-delineation implies that designated and *trained* community representatives identify and survey, jointly with accredited geodetic engineers, cultural boundary markers.

[8] On December 6, 2000, the Philippine Supreme Court has upheld the constitutionality of the Indigenous Peoples Rights Act (IPRA) of 1997.

Figure 21. Information is transferred from the sketch to the topo map

Figure 22. Fisherman presenting the results of two-stage resource mapping

Basically, the system worked as follows: Local communities together with representatives from the local administrative units produced sketch maps portraying their economic domains and transferred the information to blown-up topographical maps as shown in **Figure 21**. Following validation by the involved parties (**Figure 22**), information from topographical maps was imported into a GIS environment, plotted in the form of thematic maps and returned to the communities for a second validation. Once a consensus had been reached, community-specific resource maps were collated and used in subsequent consultations on zoning.

In a general assessment of this approach, it was observed that the basic input - the participatory resource maps - were spatially confined to the social, cultural and economic domains of those who had produced them. Thus, in the case of protected areas and their buffer zones, covering hundreds of square kilometres and numerous *barangays* (the smallest unit of local government), the production of a sufficient number of community-specific sketch maps became unrealistic from both practical and financial points of view.

Furthermore, the Programme had to acknowledge that a consistent part of the comprehensive analysis was carried out away from the field. Communities had to wait for several months to "comment" upon the GIS outputs, rather than being provided from the onset with a tool enabling them to do a comprehensive analysis of the protected area and its environs as a whole, locally.

These were the limitations the Programme experienced in integrating people's knowledge and GIS capabilities, through conventional participatory resource mapping, in a collaborative planning process.

However, a solution to these difficulties suggested itself in extending the resource mapping process by using scale relief models, as outlined in **Figure 23** on page 21.

LESSONS LEARNED

During the last few years, Participatory 3-D Modelling has been rapidly evolving in the Philippines in the sectors of biodiversity conservation, natural resource management and human rights advocacy, both from technical and political points of view.

On January 4, 2001, the Philippines' Department of Environment and Natural Resources institutionalized P3DM by virtue of Memorandum Circular No. 1, S. 2001 as a method to be adopted in protected area planning and management (**Appendix 1**).

As of June 2002, supported by the publication of the first edition of this document and by the proactive role of the National Integrated Protected Areas Programme (NIPAP), the ASEAN Regional Centre for Biodiversity Conservation (ARCBC) and a number of Non-Government Organisations (NGOs), about 8% of the initial 209 components of the Philippine National Integrated Protected Area System (NIPAS) have developed their own scaled participatory 3-dimensional models. These protected areas include terrestrial, coastal and marine ecosystems.

Close to one hundred ethno-linguistic groups have been using Participatory 3-D Models in preparing ancestral domain management plans or in resolving boundary conflicts. Some Local Government Units manufactured their municipal 3-D models to support public participation in the preparation or revision of municipal development plans, and some People's Organizations, holding Community-Based Forest Management Agreements, developed articulated resource use plans making use among others of relief models.

Compared to other ASEAN member countries, the Philippines has been offering a particularly favourable legal framework for community mapping, and 3-D modelling in particular, to take off and to become key instruments for dialogue between the public and formal institutions.

In Thailand on the contrary, even though scale 3-D modelling started being used earlier than in the Philippines, its evolution and impact on natural resource governance has been constrained by a number of factors including the rigid regulatory framework associated with the existing watershed classifications and the absence of a legal basis for community forestry and land tenure allocation in the highlands. These factors deeply conditioned the use to which community-generated maps could be put, thus narrowing the outreach of Participatory Land Use Planning (PLUP/P3DM) to localized decision-making.

Additional factors, which contributed in the early '90s to the stalling of PLUP include limited access to official large scale (>1:50,000) topographic maps still under the control of the military and limited attention paid by the development community to geo-referenced and scaled people's knowledge until the relatively recent spread of Geographic Information Technologies (GIT), which triggered enormous interest for geo-coded data. In addition, in the late '80s development practitioners were inclined to adopt PRA *sketch mapping* tools rather than venture into more complex and time consuming *scale mapping*, particularly because preference was given to community process and interdisciplinary communication, rather than to courses of action enabling communities to interact efficiently with policy makers.

In recent years, the situation has changed, with the diffusion of modern Geographic Information Systems (GIS), low-cost Global Positioning Systems (GPS) and remote sensing image analysis software, open access to data via the Internet and steadily decreasing cost of hardware. This has resulted in spatial data, previously centrally controlled, becoming increasingly available on the open market to sectors of society traditionally disenfranchised by maps.

The situation is likely to rapidly evolve in Thailand under recent constitutional and local governance reforms, and community forestry legislation currently pending in parliament. Article 46 of the 1997 Constitution recognizes communal rights in the conservation and use of natural resources, and spells out that "Communities shall have the right to preserve and restore the traditional culture, knowledge and fine arts of the local community and the nation, and participate in the management, maintenance, preservation and utilisation of natural resources and the environment in a balanced way, as provided by law". Article 79 further emphasises the duty of the State to promote and encourage public participation in the conservation and use of natural resources.

If enacted, the Community Forestry Bill will translate these articles into practice and give local communities the right to design their own rules governing the management, use and conservation of portions of forest. In this context, many research and development workers now believe that the use of 3-D models, *increasingly linked with GIS*, will rapidly expand and gain value in terms of actual natural resource governance.

A similar situation is evolving in Vietnam, where Government is progressively driving towards more consultative community-based decision-making processes and decentralization of powers.

The most important lesson learned with respect to the analyses done is that the use to which the physical P3DM outputs can be put, definitely depends on its integration with GIS and GPS facilities and on the existing regulatory framework. In some countries, community-mapping initiatives dealing with land and resource tenure have to be technically supported by licensed geodetic engineers. Depending on the purpose of the mapping exercises, these legal aspects have to be clarified in advance to work in full respect of the law.

From a technical point of view, the lessons learned concern the choice of the scale and geographical scope of the single model as detailed in **Table 1** on page 22 and the necessity to fully integrate Participatory 3-D Modelling with Geographic Information and Global Positioning Systems to support initiatives transcending the local contexts and aiming at establishing a peer-to-peer dialogue among communities and central institutions, agencies and projects.

PARTICIPATORY 3-D MODELLING, STEP BY STEP

Participatory 3-Dimensional Modelling is a process that can be used to generate a series of physical outputs, the information from which may be stored in a database for use in a Geographic Information System (GIS).

The basic steps in producing a 3-D model and derived maps comprise the following:

1. Conducting preparatory work
2. Assembling the blank model
3. Preparing the map key
4. Depicting information
5. Handing over the model
6. Extracting data
7. Digitizing and manipulating data
8. Crosschecking and validating

Each Phase is described in the following sections of this book.

P3DM's main function is to generate, through a collaborative process, spatially defined, geo-referenced and scaled data. This is not the case with most sketch mapping techniques. Its adoption needs thorough preparation in the procurement of supplies, discipline in adhering to colour coding and precision in the conduct of all phases.

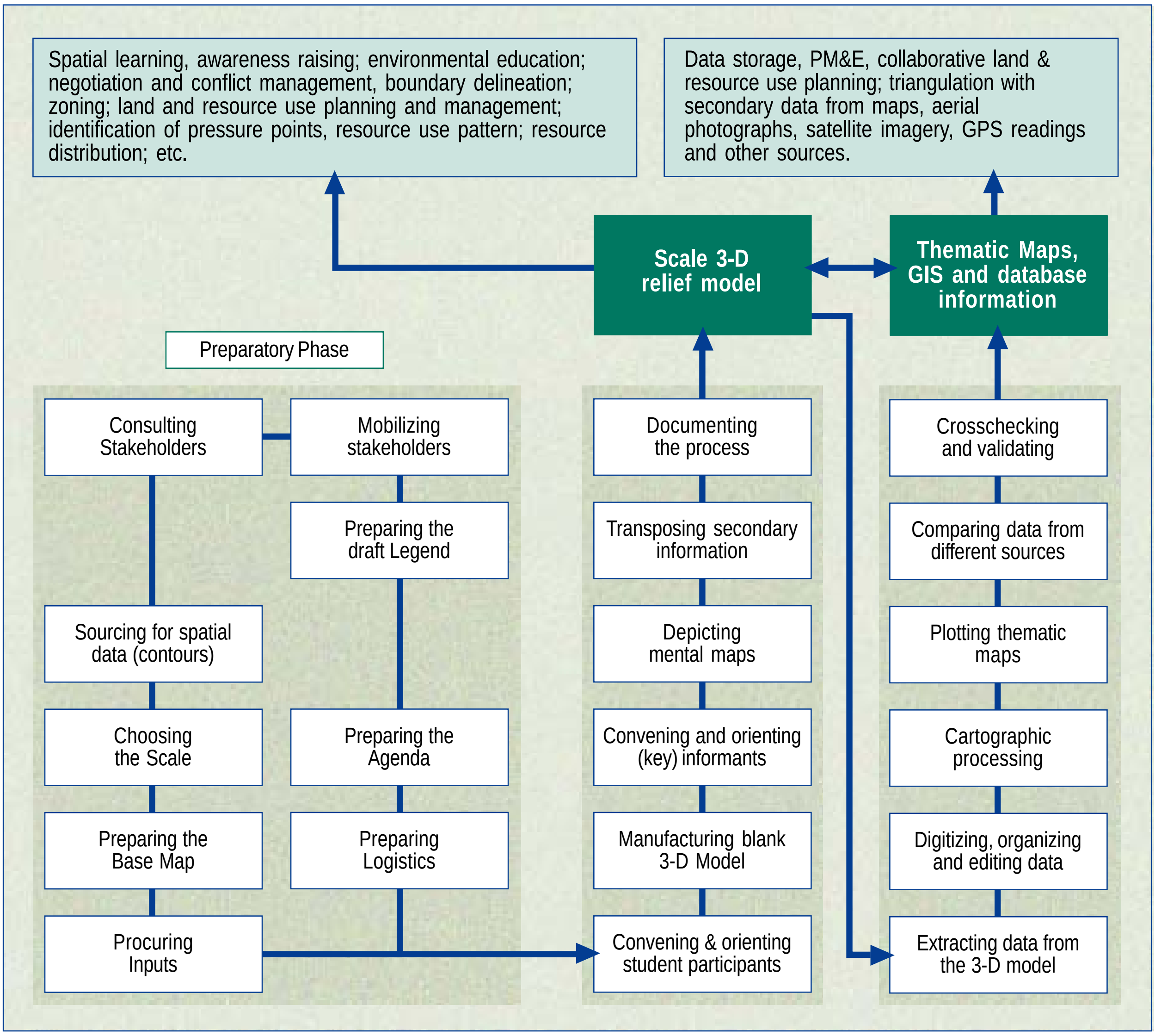


Figure 23. 3-D Modelling and its integration with GIS

P3DM STEP BY STEP

PHASE ONE: PREPARATORY WORK

Selecting the Area

In line with the objective of the exercise, you may adopt and combine different criteria for defining the geographical scope of a model:

- Physical (topography, watershed, sub-watershed, location of infrastructures, roads, etc.)
- Administrative (protected area, buffer zones, land use classification, etc.)
- Environmental (ecosystems, habitats, etc.)
- Cultural (ethnicity, ancestral rights, values, customary tenure, etc.)
- Socio-economic (settlements with associated resource-use realms, harvesting or grazing areas, livelihoods, etc.)
- Issues (conflicts, disputes, causes and effects, etc.)

Based on a combination of the above criteria, you may – in collaboration with concerned stakeholders – identify the area on existing topographic and administrative maps.

Identifying an area is simpler if physical parameters (e.g. watershed) are prevailing because they are relatively easy to distinguish. More complex is the definition of areas where cultural and societal aspects

Table 1. Advantages and disadvantages of small and large models

Purpose	Village model including its traditional natural resource use zones. (Usually at 1:5,000-scale, 1 ha corresponding to 4 cm^2)	Model including several villages and the respective natural resource use zones (1:5,000 - 1:10,000 scale. Usually at 1:10,000 scale; 1 ha corresponding to 1 cm^2)
Learning	Detailed but confined to the geographical coverage of the model.	Expanded, to include areas frequently beyond the usual cognition of the participants.
Community cohesion, self-actualization and self-determination	Of limited use for self-determination if used in isolation. Aggregating data from models representing adjacent villages that are part of the area of interest may overcome this limitation.	Relevant, provided the geographical scope of the model has been chosen on the basis of kinship and cultural affinity.
Awareness raising	Efficient if causes and effects (e.g. uphill erosion and downhill sedimentation areas) are visible within the geographical scope of the model.	
Land use planning	Allows detailed land use planning at farm and plot levels.	Best for overall land and resource use planning, zoning, etc.
Collaborative research	Allows quite detailed localization of resources.	Useful for outlining the distribution of resources over larger areas. Accommodates quite precise location of point information.
For supporting traditional knowledge	Useful.	Useful.
Protected Area management	Use limited to village based issues.	Useful, provided the model includes a substantial portion of the protected area and its buffer zones.
Participatory M&E	Of use mainly by the concerned village.	Quite productive, because its geographical coverage is likely to expand beyond the collective cognitive boundaries of the single villages.
Conflict management	Useful for dealing with territorial conflicts among villagers. Of limited use for negotiating conflicts between neighbouring villages.	Useful for dealing with conflicts among adjacent villages.
Access to resources	Useful for defining zones within the geographical scope of the model. Confines the identification of outer village resource use boundaries to unilateral decisions.	Useful for defining zones within geographical scope of the model. Allows for conducting bilateral or multilateral boundary negotiations.
Watershed management	Valuable, if the geographical coverage includes pertinent watershed or sub-watershed.	Valuable, if the geographical coverage includes pertinent watershed or sub-watershed.
Tenure	Useful for discussing both individual and community tenure.	Best for defining community tenure (e.g. ancestral domains). The 1:10,000-scale is too small to discuss household tenure.
Fire management	Useful for village-based fire management.	Broadens the scope of fire management to adjacent communities. Likely to yield better results.
Logistics	Model generally stored at village level. Easily accessible to those who produced it.	Because of its nature this type of model is located at most within one village among those depicted. Requires displacement of users for consultation.

are the lead criteria for selection.

As a general rule, all areas that could be the subject of discussion should be included in the geographical coverage of the model. This is particularly relevant where the model is meant to serve defining or negotiating boundaries. In turn this calls for an important consideration on the pros and cons (see **Table 1**) of expanding the geographical coverage of the model to include several communities or villages.

Understanding Social Dynamics

As previously stated, you need to have a thorough understanding of the social dynamics in the area. When interactive processes bring stakeholders having different levels of power and interests together, both apparent and latent conflicts often become an issue. Conducting a stakeholders' analysis (more details are provided in **Appendix 4**) and producing a stakeholders' map would be of great advantage. The stakeholder analysis implies doing a preliminary assessment of the different interests at stake and understanding if these embody latent or open conflicts and space for mutual cooperation. Such assessment will guide you in defining the composition of the groups, which could best collaborate during the process.

Groundwork at Community Level

The next step in the Preparatory Phase is to introduce the concept of participatory 3-D modelling to the various stakeholders as a method that could help them in implementing actions to address selected problems and aspirations. This interaction should lead to a consensus on the use to which the P3DM process is to be put. Particular attention has to be paid to the existing institutional space, which would accommodate innovations resulting from the process. Such decisions should lead to the preparation of an agenda that will provide the focus for the P3DM activity. The agenda set for the 3-D modelling exercise should be tailored to provide a tangible contribution to the overall intervention logic.

Organizing the Logistics

Logistical organization includes finding a venue sufficiently large to allow the community to manufacture the model. It may be necessary also to organize transport, accommodation and catering.

Selecting Participants and Making Follow-up Arrangements

Essentially there are two types of participants who can best contribute to the construction of the model.

The first category is made up of students, possibly from locally based institutions dealing with arts and crafts or sciences. They will be instrumental in assembling the "blank" model. In doing this, they will learn a lot about topography and local geography.

The second category includes representatives of those having vested interests in the area, and identified through the conduct of the stakeholder analysis as discussed in the section "Understanding Social Dynamics". These may include indigenous groups, various economic sectors (farmers, fishers, tourist operators, etc.), government and non-government organisations and others. Their participation – particularly when dealing with conflicts – may occur at different stages of the process.

Each stakeholder should nominate its representatives. This is best done once all stakeholders have been thoroughly briefed about the activity, its mechanics and potentials in terms of addressing their problems or aspirations.

Once the participants are identified, you may want to cluster them into smaller groups on the basis of residence, economic endeavour, cultural affinity, advocacy and other criteria. Always ensure that women[9] and elders are adequately represented. In order to maximize the objectivity of the sessions and validity of the output, you have to schedule overlapping sessions.

> Participation is frequently described as the panacea of all problems, in the assumption that the mere fact of people getting together would generate consensus. On the contrary, enlarged participation may surface an increased number of interests, which may in turn ignite new conflicts. An inclusive participatory approach (that is the one which brings all relevant stakeholders together) only makes sense during the final stages of a conflict cycle (Leeuwis, 2000).
>
> In this respect minority groups asserting their rights on resources, or struggling for the preservation of their cultural identity, may wish to limit participation in the construction of the model to participants sharing similar concerns and aspirations. This type of focus group action may lead to the preparation of tailored communication means (e.g. maps, written documents, etc.) to be used for exerting pressure on or for entering into a dialogue with a broader audience or with selected institutions at a later stage of the process.

Gathering Secondary Information

Cheap and easy access to digital contour lines is a prerequisite for cost-effective Participatory 3-D Modelling. In the absence of data in this format, contour lines can be digitized from existing maps, but the costs are relatively high.

An alternative solution, which is a compromise between cost and quality, is to enlarge topographic maps by using digital copiers and to eventually

[9] Women's participation may vary, depending on the cultural background of the participating communities.

manually re-trace the single contour lines on special paper. Some practitioners simply use enlarged copies, a cheaper process done at the expense of accuracy.

Additional information that need to be gathered includes demography, land use, vegetation cover, resource tenure, existing regulatory framework, and whatever else might be of relevance to the facilitators to understand the physical, social and economic characteristics of the area.

The Base Map[10]

A Matter of Scale

A map or relief model, to be most useful, must accurately show locations, distances and elevations on a given base of convenient size. This means that everything featured on the map or model (land area, distances, elevation and so on) must be shown as a proportion to its actual size. This proportion is the scale of the map (**Figure 24**). Scaling exceptions include symbols like lines and points used to depict e.g. roads, rivers and households. All these have to be drawn sufficiently large to be visible.

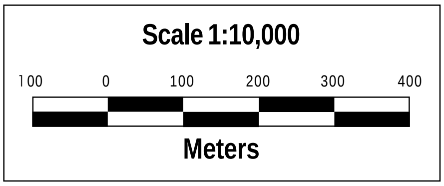


Figure 24. 1:10,000-scale (reference)

The ***scale*** of a map can be defined simply as *the relationship between distance on the map and the distance on the ground, expressed as a proportion, or representative ratio.*

This "representative ratio" means that 1 cm on a map is equivalent to

- 1,000 m on the ground at a 1:100,000-scale
- 500 m on the ground at a 1:50,000-scale
- 200 m on the ground at a 1:20,000-scale
- 100 m on the ground at a 1:10,000-scale
- 50 m on the ground at a 1:5,000-scale

Why do we need to adjust the planimetric scale?

The smaller the scale of a map is, the fewer the features that can be accommodated. Obviously, therefore, the larger the scale the more comprehensive the map and of more use to the planning process.

Considering that Participatory 3-D Modelling aims at providing a visual aid capturing the details of the terrain, the larger[11] the scale the better.

The choice of the scale and hence the size of the model should take account of the need for accuracy as well as the need for enough space in which to physically construct and store the model.

The ideal scale for 3-D modelling is 1:10,000 or larger. If your reference map is at 1:50,000-scale, it needs to be re-scaled to 1:10,000 to make it suitable for the activity. At 1:10,000, one centimetre on the model corresponds to 100 meters on the ground - a pretty comfortable scale for people to pinpoint salient features.

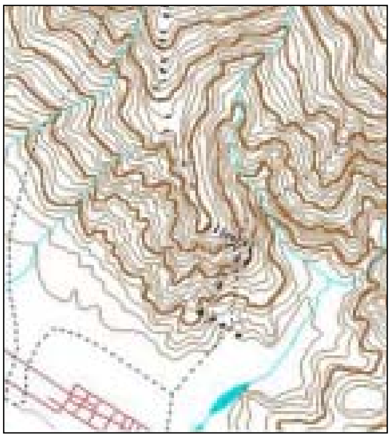
Table 2 demonstrates the simple arithmetic of re-scaling smaller scale maps (1:50,000, for example), to larger scale maps (1:10,000), and the relationships between the physical dimensions of the model to the geographical area represented by the same.

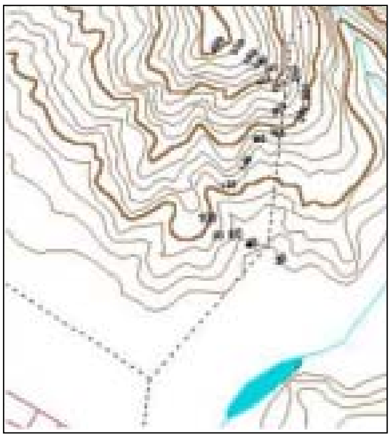
A number of factors influences the options for re-scaling.

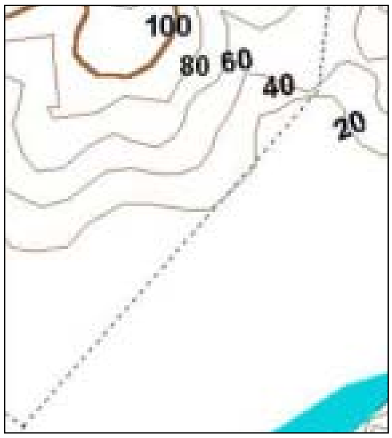
First, you have to identify and measure the area you want to reproduce. For your ease, you will select a rectangular shape. In the case of a protected area, this will include the core area, the buffer zones and its environs of ecological, cultural and economic significance. More details on how to select the geographical scope of a 3-D model are provided on page 22.

If the core of a protected area is a mountain, the rectangle will include the downhill catchments and possibly the settlement areas where most dependent

[10] References on "map reading" are provided in **Appendix 3**.
[11] N.B. 1:10,000 is a larger scale than 1:50,000.


1:50,000 scale


1:25,000 scale



1:10,000 scale

Table 2. Choice of scale: some examples

Scale for the refernce map	Size of the selected area on the reference map to be represented in the form of a P 3-D Model (Centimetres)	Selected scale for the P3-D Model	Size of P3-D Model (Centimeters)	Total area represented by the model
1:50,000	24 x 48	1:10,000	120 x 240	288 km^2
1:50,000	48 x 96	1:10,000	240 x 480	576 km^2
1:50,000	40 x 50	1:20,000	100 x 125	450 km^2
1:50,000	40 x 50	1:10,000	200 x 250	450 km^2
1:50,000	40 x 50	1:5,000	400 x 500	450 km^2
1:75,000	40 x 50	1:10,000	300 x 375	1,125 km^2
1:100,000	40 x 50	1:10,000	400 x 500	2,000 km^2

communities reside.

If the core is a lake or coastal area, all catchments draining into the main water body should be represented.

This is important for the analytical process, which usually follows the construction of the model and whence all those referring to the model can assess *causes and effects*.

> Make sure that linked ecosystems are visible on the model (e.g. upland and lowland tropical forest, mangroves and coral reefs, etc.)

Having defined the area of interest, the next step is to decide on the scale in which it is to be reproduced. The scale should permit the desired level of detail on a model that is of manageable size.

Scale 1:10,000 is the limit beyond which individuals start having difficulties in locating point data (e.g. their household) with precision . This could be considered as an indicator of the limits of our mind in establishing spatial relations between a scaled 3-D model and the real world. Larger scales (e.g. 1:5,000) allow for quite accurate location and visualization of features. A one-hectare plot would measure 4 cm^2 at a 1:5,000-scale, a pretty comfortable area to depict single plots and associated crops. Depending on the purpose of the exercise, 1:20,000 is still manageable, provided the vertical scale is set at 1:10,000 or larger to enhance the perception of slope and assist mental data processing by providing better cues to memory.

The physical size of the model needs to be seriously considered in view of the space needed both for display, and for storage.

Generally, models are constructed and stored at the same location. The question of dimension therefore, should be defined beforehand with the prospective caretaker, which could be the local government, a school, a people's organisation or others.

Last but by no means least, the larger the model, the more time is needed for its manufacture and the more resources (human and financial) needs to be mobilised.

The Vertical Scale

For relief models, scaling has to be applied both horizontally and vertically. The vertical scale may be the same as the planimetric one, or differ for the purpose of exaggerating slopes.

When do we need to adjust the Vertical Scale?

On a 1:10,000-scale relief map, a 1,000-meter high mountain will be 10 cm tall. To enhance the visual perception of the ruggedness of the landscape or to highlight erosion hazards or accessibility, the vertical scale could be increased, say to 1:5,000, by maintaining the horizontal.

The concept of vertical scale is closely associated to the contours because these are the lines that join points of equal elevation on the earth's surface. The smaller the scale, the greater will be the interval between contours. A 1:1,000,000-scale map may feature 200-m contour lines, while a 1:10,000-scale map can accommodate up to 4-m contours. What makes the difference is what we discussed before: *a small-scale map accommodates less information!*

The contour intervals that are shown on maps depend on the technologies used to generate them. The closer the intervals, the more accurate the process has to be.

Considering the scope of this book, the discussion will be limited to how to chose the contour interval when manufacturing a scaled relief model.

What Contour Intervals should we use?

Assuming a 1:10,000 scale (horizontal and vertical), you need to decide what contour interval to use.

Generally, 1:50,000-scale reference maps feature 20-m contours, which conveniently may be applied to a 1:10,000 model.

If you intend to produce the relief of an island, which has, for example, the lowest elevation (seabed) at -40 m, and the highest (mountain peak) at 2,400 m above sea level, you would need 122 layers to reproduce a gradient of 2,440 meters using 20-m contours [(2,440/20) = 122]. This would involve a work group of 12 people to trace, cut and paste

Table 3. The choice of the contour interval determines the workload

Gradient between the lowest and highest elevation (meters)	Contour intervals (meters)	Scale of the P 3-D Model	Thickness of each layer representing the contour interval	Number of contour intervals (layers)
2,440	40	1:10,000	4 mm	60
800	20	1:20,000	2 mm	40
2,000	40	1:5,000	4 mm	25
360	8	1:2,000	4 mm	45

approximately 15 layers per day, and take about 7-8 days to complete.

But if you use 40-meter contour intervals, you would be able to prepare and assemble 61 layers [(2,440/40) = 61] in 3-4 days.

Table 3 illustrates the relationship between scale and contour interval.

Often, the availability of the materials used to construct a model dictates which vertical scale to apply. In the Philippines and Vietnam for instance, single-wall corrugated carton board is available only in 3 mm and 4 mm thickness as detailed in **Appendix 9**.

Preparing a Customized Base Map

GIS technology is becoming more and more widely used for storing and manipulating geo-referenced information. It is an important tool in the construction of P3DM, in optimizing data interpretation and in converting people's knowledge into a mobile, negotiable format. For further discussion of this topic, please refer to page 6.

Once **scale**, **size** and **contour intervals** have been defined, a customized topographic map, hereafter called base map, has to be generated.

Basic data needed by the GIS facility include:

- Desired scale;
- Contour interval;
- Desired grid; and
- Features (e.g. protected area boundary).

Elevation labels should be placed close to the contour lines. The latter should be drawn in a sequence of at least five different colours to facilitate the work of the tracers as discussed on page 30. More details on the preparation of a base map are found in **Appendix 5**. You have to prepare at least two copies of the map.

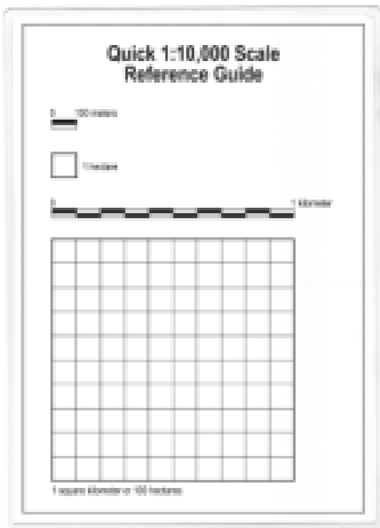
> A Geographic Information System (GIS) is an organized collection of computer hardware, software, data, and personnel designed to capture, store and update, manipulate, analyze and display geographically referenced information.

What to do in the Absence of Digital Contours

In some countries, digital topographic information is hardly available to the public, either because it does not exist, or because it is treated as confidential for national security reasons. Nonetheless, with the recent diffusion of Geographic Information Technologies, the decreasing cost of satellite imagery, and related hardware and software, and the openings offered by digital communications, access to this type of data has been rapidly increasing and government policies on the treatment of spatial data have been progressively relaxing. However, during the past decade, its shortage, high cost or centralized control, have made its acquisition problematic in many Southeast Asian countries. For this reason, a common technique used by practitioners in Thailand and in the Philippines for preparing P3DM base maps has consisted in blowing-up 1:50,000-scale topographic maps (available on the open market) to the desired scale with the use of digital copiers. To ease work at village level and to remove information that could bias[12] participants, these enlarged maps may be further transferred to tracing paper. This may add to the workload, but favours quality and precision.

The Quick Reference Guide

One of the prerogatives of P3DM is to generate scaled and geo-referenced data. The fact that relief models display the vertical dimension definitely helps informants in internalizing the landscape by identifying reference landmarks and by subsequently arranging data spatially. On-field experience has



[12] Typically, cartographic data that have some bearing on the way people would depict or describe their cognition include boundaries and borders.

shown that scale translations between the real world and a map, or vice versa, are difficult. While the presence of the vertical dimension does facilitate the *location of point and line data*, blatant inaccuracy may occur in the *sizing of areas*. As an example, farmers delineating the boundary of a woodlot of 3 ha (3 cm^2 on a 1:10,000 scale model) may erroneously portray it larger say, as a 25-hectare (25 cm^2) plot. In fact, the natural tendency of informants would be to size an item according to perceived importance rather than to its scaled dimensions. While informants' perceptions are of paramount importance, 3-D modelling - as conceived in this document - is meant to support communities in generating geo-referenced and scaled qualitative and quantitative data. Therefore people's perception and values may be better visualized by the choice of a particular colour or symbol or simply noted down as part of the process documentation, rather than through exaggerating or diminishing sizes. The 'Quick Reference Guide' has proved to be an extremely useful tool both for informants and facilitators when estimating distances and areas on the scaled model. Therefore it is strongly recommended that a number of *ad hoc* reference guides be prepared for each exercise. Measurement units vary from country to country and frequently also within a particular country. Quick Reference Guides should match the system in use. A sample is found in **Appendix 6**.

Procuring Materials

Assembling the materials needed for a 3-D Model is one of the most critical tasks you will face during the preparatory phase. A supply inventory is presented in **Appendix 7**.

Various map symbols should be available in sufficient quantity to accommodate the many variables that people may want to record onto the model.

Different coloured map pins of various shapes, a rich choice of water-based colours and matching yarns are vital to the exercise (**Figure 25** and **Figure 43** on page 33).

Figure 25. The Range of coding Items

Map Symbols

Map symbols should be chosen according to principles of logic and communication to serve as a graphic code for storing and retrieving data in the three-dimensional geographic framework of the model.

Appreciating their logic begins with understanding the existence of three distinct categories: point, line and polygons. Models and derived maps generally include a combination of all three. These categories can be further differentiated – particularly on maps - by variations in "hue" (colour), "grey tone value", "texture" "orientation", "shape" and "size". Each of these variables or their combinations stands out in portraying particular features and their variations (Monmonier, 1996:19).

When using colour (hue) to characterize areas, decoding is made simpler when darker means "more" and lighter means "less". Colour conventions allow map symbols to exploit idealized associations of water with blue and forested areas with green. This implies that dense primary forest is dark green, secondary forest mid-green, and grassland light green, and that deep waters are dark blue and shallow waters light blue (Monmonier, 1996:22).

> The legend is the key to decoding data shown on a model. Therefore a model without a legend is mute and meaningless.
>
> Informants and facilitators should clearly define and agree upon each feature displayed on the model, paying due respect to local cognition and values. In choosing colours and shape, be aware of cultural implications!

"Size" is more suited to show differences in number, whereas "variations in grey tone" are preferred to distinguish differences in rate or intensity. Symbols varying in orientation are useful mostly for representing directional occurrences like winds, migration streams or others. Line symbols best portray watercourses, roads, trails, and boundaries and may integrate additional variables like colour and size (thickness). A heavy line rather than a thin one readily suggests greater capacity or heavier traffic (Monmonier, 1996:23).

Each symbol should be easily discernible from all others to clearly distinguish unlike features and provide a sense of graphic hierarchy. A poor match between the data and the visual variables may frustrate and confuse the map user.

While 2-dimensional mapmaking is limited only by imagination (with logic) in

P3DM STEP BY STEP

the choice of symbols, 3-D modelling frequently depends on the availability of materials, particularly push and map pins that generally represent point features. Colour-coded yarns and different colour paints can easily represent lines and polygons.

You have to pay due attention to the cultural and symbolic language used in the area, including the significance of colour and shape. "White" may be associated with "death" or "purity"; "red" with "danger" or "happiness", depending on the cultural background of the participants.

Once you have properly addressed this prerequisite, you should consider that standardization of symbols serves for ready unambiguous recognition of features and promotes efficiency in producing and using 3-D models and maps, and in exchanging and comparing data. Sometimes 3-D models are manufactured at different locations and later on assembled. In these cases, consistency in the use of codes is essential.

Maps or models sharing a common graphic vocabulary are definitely more powerful in conveying the intended message and in simplifying decoding. **Appendix 8** provides a guideline for coding data on participatory 3-D models.

In obtaining materials, you should relate the quantity and shape of pins and other items to the quantity of features that need to be depicted. For example, you should be aware of the approximate number of households found in the area. This will guide you in determining, for example, the number of white bullet-headed pins required. In the same area, you may expect to find a number of schools and day care centres. Make sure that you have enough colour-coded pins to identify these two items independently.

It is best therefore to make a first assessment of the features you may encounter in the area of interest before purchasing materials.

To do this, you have to draft a preliminary map key (legend). This will be revised during the conduct of the exercise to accommodate additional features identified by the informants and to fine-tune the definitions of single items. You will need the draft legend – possibly in collaboration with local stakeholders – as a guide for compiling the procurement list.

Construction Materials

3-D mapmakers around the world have been using a variety of materials including plywood, corrugated or solid carton board, polystyrene sheets and foam mats to produce scaled relief models. Non-scaled relief models are frequently made with soil, sand, concrete, sawdust, papier-mâché and others.

As much as possible, community mapping should be an environment-friendly exercise. Waste disposal may become a problem when using non-biodegradable materials like polystyrene or other petroleum derivates. Both for environmental and handling purposes, corrugated carton board would be the best solution, provided you could obtain the correct quality. Ideally, you should avail of either "custom-cut sheets of single-wall corrugated carton - inner and

Table 4. Features and the means to code and display them

	Features	Displayed by means of
Points	Water bodies (springs and waterfalls); mountain peaks; social infrastructures (municipal/district halls, administrative centres, day-care centres, schools, rural health centres, hospitals, bus stops); cultural places (churches, burial caves, cemeteries, sacred areas, etc); tourist establishments; human settlements (households); scenic spots, turtle nesting sites; diving spots; docking sites, and others.	Map and push pins of diverse colours, shapes and sizes.
Lines	Watercourses; communication ways (roads, bridges, trails); social infrastructures (rural water supplies), classifications (e.g. watershed classifications), boundaries (administrative units, protected area, ancestral domains, land status, areas where destructive methods are employed, fish breeding and spawning areas; feeding grounds of endangered species; fishing grounds; features of the seabed like coral reefs differentiated into "intact" and "damaged", seaweed areas, etc); borders, coordinates (grid).	Yarns of different colours.
Polygons	Water bodies (rivers, creeks, lakes, springs and waterfalls); cultural places (cemeteries, sacred areas, etc); tourist establishments; land uses (rice fields, swidden, vegetable gardens, sugarcane and coconut plantations, orchards, reforestation sites, residential areas, resettlement areas, etc.); land covers (different types of forest cover, grassland, brushland, mangrove, etc.); landslides and bare land; and others.	Acrylic paint – different colours.
Attributes	Names, annotations	Text on labels.

outer liner and flute 180 g/m^2" - or of rolls of "single side corrugated carton outer - liner and flute 180 g/m^2". To know more on the topic, please refer to **Appendix 9**.

Solid carton board is a valid alternative because it is strong and durable and has a relatively wide assortment of thickness. Its relative disadvantages are its higher cost and weight. Due to its firmness, the board has to be cut with coping saws.

In the Philippines, some NGOs use foam mats, which are cut, assembled and covered with epoxy paint. These materials make the model more durable.

PHASE TWO: ASSEMBLING THE MODEL

Orienting Participants

Participant orientation to the mechanics of construction (**Figure 26**) should be accompanied by some rudiments of map reading (**Appendix 3**) related to the materials being used: *"We are going to use a four-millimetre thick carton board for each layer because - at a 1:10,000 scale - 4 mm represent a 40-metre contour interval, or a 40-metre difference in altitude"*.

Organizing Work

Organize four distinct work groups, as shown in **Table 5**, each of which should be allocated and coached on a specific task by one facilitator.

Organized in this manner, a team of fifteen students guided by three facilitators, constructing a 1:10,000-scale model measuring five square meters (500 km^2 on the ground) and involving the cutting of, say, 60 layers, can complete a "blank" model in three to four days.

Figure 26. Prepare visual aids to support your presentation

Figure 27. Details of the base table

Table 5. Workgroups & facilitators

Working group	Assemblers	Tracers	Cutters	Gluers
No.of participants	3	4	4	4
Facilitators		1	1	1

The Base Table

You will need a purposely-constructed wooden base or table(s), 60-70 cm high, that would exactly match the base map and be strong enough to support the weight of the model. Reinforce the base (**Figure 27**) to avoid bending while the wet carton and papier-mâché dry up.

One side of the base table should measure less than 1.8 m, to permit easy access to otherwise hard-to-reach sections. It may sometimes be easier to work on two or more units rather than one, joining them on completion of the exercise.

Assembling the Base Maps

Base table, base map, carton board and carbon paper should all be exactly of the same dimensions.

As discussed on page 26, ahead of the exercise you have to prepare two copies of the base map usually in A0 continuous format. These need to be composed to match the size of the base table. In doing this you have to pay careful attention to joining the sheets correctly (**Figure 28**). Use the existing grid as reference.

Figure 28. Mapmakers at work

Figure 29. The carbon paper is assembled

Figure 30. Drilling landmarks

Figure 31. Table with reference nails

Once you have completed this exercise, glue one map on top of the table. The second one is bonded to a large carbon paper purposely assembled (**Figure 29**) with the use of staples and some adhesive tape.

Identify matching landmarks on both maps. Using a marker, draw a small circle around hills or mountaintops. Drill holes through the table board, and punch through the base maps at all selected landmarks (**Figure 30**). Hammer the nails or steel bars of adequate[13] length into the holes through the bottom of the table, but allow a maximum protrusion of 2 cm (**Figure 31**). This preparatory work is essential for properly geo-referencing all contour layers.

An alternative method for geo-referencing layers is discussed on page 32 (**Figure 40**).

Tracing, Cutting and Pasting

The first group, "*the Assemblers*", prepares carton sheets, exactly corresponding to the size of the

[13] The length of a nail should be sufficient to guide you until the placement of the highest elevation contour. Should the length of available nails be insufficient, than you have to use a steel bar and cut it at the desired measurement. In other words, for a gradient of 1000 m at 1:10,000-scale you will need a nail of at least 12 cm (10 for the gradient and 2 for the thickness of the table). For a gradient of 2000 meters at 1:7,500-scale you will need a 30(+2)-cm long steel bar.

Figure 32. Tracing sandwich

Figure 33. Each contour line is traced on a separate carton board

wooden table and base map. In a well-organized exercise, the carton board should have been cut at the desired size at the factory.

A second group *"the Tracers"* fastens the second base map with carton boards one at a time with the use of binder clips as shown in **Figure 32** and selects one corner of the map as a reference[14]. To start, the lowest elevation contour is identified (please refer to **Appendix 5**) and traced on the map with a pencil. Its outlining is mechanically transferred to the carton board.

Once the first contour is traced, the carton board is handed over to the third group, *"the Carvers"*, who cut out the layer with the use of scissors, cutters or coping saws. Each elevation contour is traced on a separate carton board (**Figure 33**) and cut out independently (**Figure 34**).

Once the contour lines have been traced onto the appropriate carton layer, all reference marks are transposed from the base map to geo-reference the single layer. In essence, the carton layer is perforated according to the holes already present on the tracing map and representing the selected landmarks.

[14] You have to refer to the *reference corner* whenever you overlap or relate layers of information.

For clear identification each layer is marked with a directional arrow indicating the North and an annotation on the elevation.

Thereafter, the carton layer is passed on to the fourth group, *"The Gluers"*, who pastes it on the top of the previous making sure that each perforation is matched to the corresponding nail (**Figure 35** and **Figure 36**), thus making sure that each layer is correctly placed on the top of its antecedent.

The various layers are then consolidated with the use of crêpe paper and water-based glue (**Figure 37**). Crêpe paper cut into small squares measuring 5 cm x 5 cm results in a strong and resistant papier-mâché.

Particularly when reproducing mountain areas, the higher the elevation, the more segmented each layer will be. Depending on the complexity and segmentation of the layers, you may resort to independently assembling the selected portions of the model as shown in **Figure 38** and **Figure 39** on page 32.

An alternative method for tracing and properly geo-referencing the single contour layers has been in use in Thailand for the past decade.

After tracing the selected contour line with a plain trait, use a dotted line to trace the following one (identifying a higher elevation) on the same carton board.

Figure 34. Contour layers are cut

Figure 36. The single layer is pasted

Figure 35. Geo-referenced nails are used to properly locate the layers

Figure 37. Layers are consolidated

Figure 38. Different elevation contour are traces sequentially

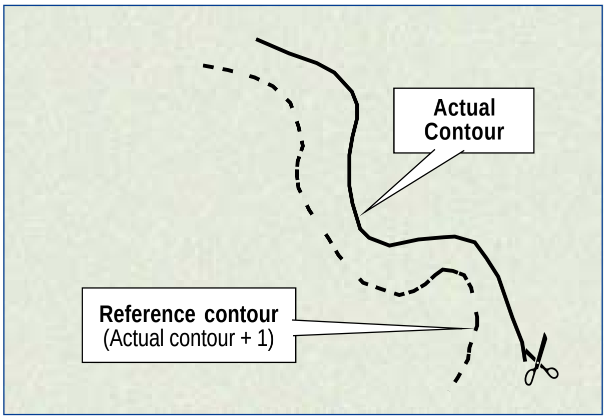


Figure 40. Alternative geo-referencing method

Figure 39. A complete hill is joined to the model

Figure 41. The "blank"

The first contour will serve as a guide for cutting, and the second, as a reference for pasting the succeeding contour layer.

The "Blank" Relief Model

The outcome of the first phase is a scale relief model following the bare contours of the landscape (**Figure 41**).

In the process of assembling the model, the team learns about scaling, contour intervals, slopes, gradients and other cartographic concepts. Already, the blank model provides a bird's eye view of the area.

The subsequent phases progressively enrich the model with geo-referenced information, most of which reflects the mental maps of community informants.

PHASE THREE: DEPICTING INFORMATION

Composing People's Knowledge

Now that the basic relief model is completed, key informants step in for a period depending on the size and complexity of the model and the number of participants you invited.

Make sure that the venue is not overcrowded. A model measuring 2.4 x 1.6 m can accommodate approximately 20-25 participants at a time. If 100 informants have been invited, they should be convened into groups as discussed on page 23. The exercise should last for 5-6 days. Informants' sessions should overlap to encourage cross-fertilization in order to maximize the veracity of depicted data.

Orienting Key Informants and Updating the Legend

In front of the blank model, refresh informants on the objectives of the exercise, explain the pro-

Who decides on what is important?

A 3-D model is meant to distinguish the territory with the use of coded polygons, lines and points. Each feature needs to be identified, defined and associated to a particular symbol. All these symbols and their descriptions are summarised in the form of a map key or legend, which is the graphic vocabulary that allows users to decode and interpret displayed data. The preparation of the legend, particularly the listing and description of the different items, is a key factor that determines the usefulness of the model as a communication means and the final intellectual ownership of the output.

While for practical reasons it is important to prepare a draft legend ahead of the event, it is even more important to solicit its thorough revision in the course of the exercise.

cess of depicting mental maps and remind them of the importance of making reference to the legend in choosing colours and symbols.

Use this opportunity to solicit the revision of the legend (**Figure 42**) to include additional features relevant to the participants and also to ensure that all understand definitions and associated symbols.

Primary forest is a term that may have a different meaning for a scientist, a farmer, or mean nothing at all. You need to establish a common ground and understanding. Use of local definitions for land use and land cover and vernacular translations help.

In updating the legend, participants and facilitators have to match the features to be depicted with the symbols made available (pushpins, yarn and water-based paint).

Depicting Mental Maps

A 3-D model offers a convenient scale and format and users can gain a holistic and shared perspective. Maps and models elicit strong alignment effects and get confusing if improperly oriented. You thus have to orient the model North-South with the use of a compass.

As a facilitator, you should arrange and display all coding means (**Figure 43**) making sure that each one is clearly associated with the real-world feature it is meant to stand for. You may also prepare several copies of the legend to be distributed among the participants.

Recall that in humans, cognitive spatial knowledge is organized and developed through a process that initially looks for landmarks, thereafter establishes links between these and, lastly, develops a broader, encompassing understanding of landforms. For more details, please refer to page 2. Thereafter invite informants to locate and name in sequential order: mountain peaks, islets, water courses, roads, trails, social infrastructures and other features they use to orient themselves when moving around within their domains (**Figure 44**).

This is a critical process that follows people's inborn orientation and learning mechanisms and allows participants to progressively deepen their grasp of their whereabouts *vis-à-vis* the model.

Invite informants to delineate with the use of colour-coded yarns vegetation types, land use, and other aspects that they consider relevant to their environment (**Figure 45**).

Initial contouring of areas using yarn and dressmaker's pins instead of immediate painting or drawing allows informants to negotiate the distribution, location and extent of any particular feature.

Figure 42. The legend is updated

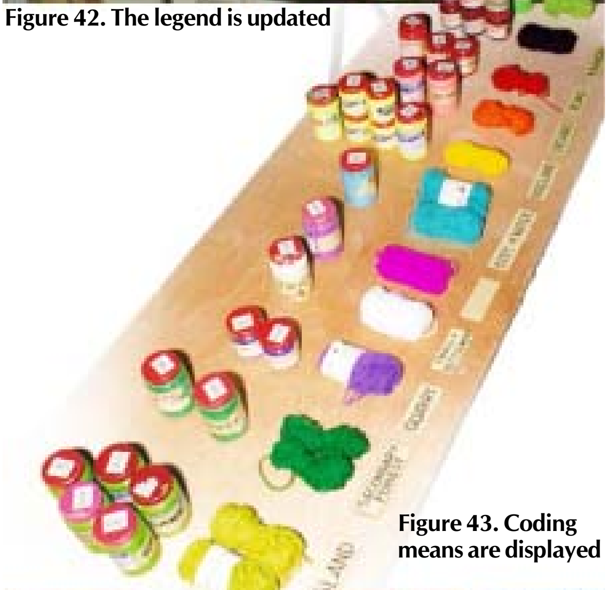


Figure 43. Coding means are displayed

Figure 44. Landmarks are identified

Figure 45. Land uses and land cover are identified

During this process you should regularly call attention to the scale of the model. This is best done by using the Quick Reference Guide as discussed on page 26.

Once the participants have agreed upon the location and extent of single features, they are now ready to apply water-based coloured paint[15] (**Figure 46**), according to the coding system and remove the corresponding yarns.

> **Note:** Always use *lines* to depict *virtual* and *conceptual* features like national and administrative boundaries, resource-use areas, zones, tenure, top-down land use classifications and values (e.g. sacred forest), and colour paint to depict *real-world features* like land use and vegetation types.
> Adopting a hierarchical approach, participants may use different colour paints to differentiate *crops* and one colour-coded yarn to encompass all *farmland*.

After the paint has dried, invite the participants to locate with the use of colour-coded pushpins and paper-tags, (**Figure 47**) the names of locations and administrative units, households and whatever point data they consider to be important within their life-world.

This process calls for the concurrent participation of groups of people from neighbouring locations for cross-fertilization and data validation.

During the process, participants may add new features to the legend. You have to select the appropriate medium (pin, yarn or paint) and colour-code, and add the definition and the corresponding symbols to the legend.

The use of a well-articulated coding system allows 3-D models to serve as rudimentary community-based Geographic Information Systems (GIS) accommodating overlapping layers of information and facilitating analysis of spatially defined data.

Adding Secondary Information

After the informants have completed depicting their mental maps, crosschecking the data and eventually validating them on the field, other features can be added.

These may include secondary data obtained through official sources. Boundaries and borders are cases in point:

Boundaries and Borders

Resource distribution, tenure and access are focal issues when it comes to management of natural resources. They are all spatially defined by boundaries frequently set (on paper) without undergoing

[15] In some countries you can buy water-based paint in different colors off the shelves. Elsewhere, as in Vietnam, you have to buy color powder and convert it into liquid paint before use. The process is described in **Appendix 2**.

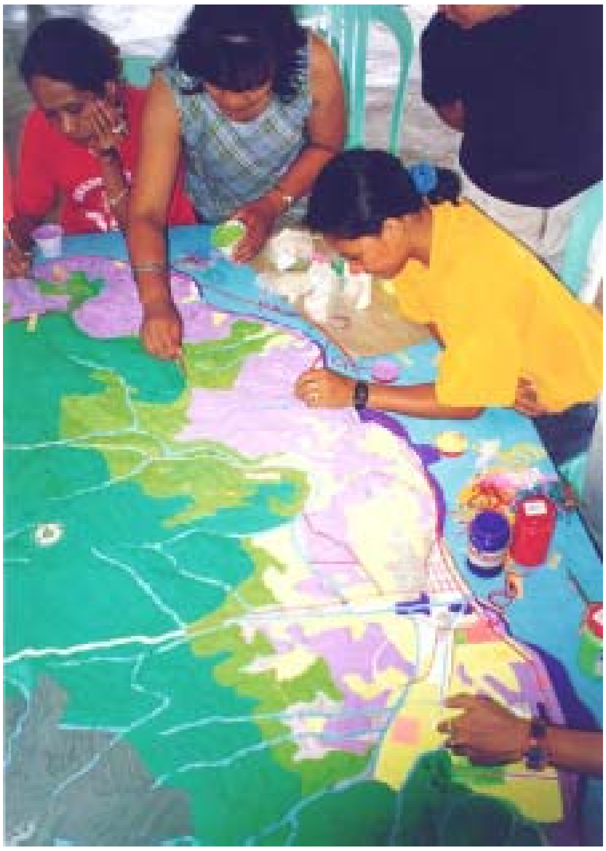


Figure 46. Water-based colours are applied after validation

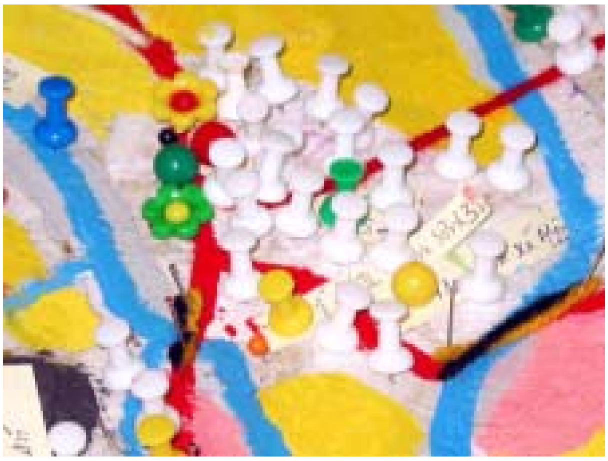


Figure 47. Point data are located with the use of colour-coded pins

Figure 48. Group dynamics are enhanced


Photo by Dave de Vera, PAFID

Figure 49. Boundary negotiation in the Cordillera, Philippines, 2001

proper consultative processes. Adding them to the model broadens the basis for learning and negotiation making sources of conflicts visible, hence setting the basis to address them (**Figure 49**).

To add boundaries to the model you have to establish a spatial relation between reference map (repository of the data) and the relief. This is done by super-imposing a geo-referenced grid on the top of the model.

Placing the Grid

For a 1:10,000-scale model it is advisable to use a 10-cm interval grid, each square corresponding to 100 hectares or one square kilometre. Grid placement on the model should match the one on the base map. To ensure correct positioning you have to measure the intervals starting from the reference corner shown in **Figure 50**, proceed as shown in **Figure 51** and use a plumb line where needed. The grid is intertwined with the use of a strong fine yellow thread (**Figure 52**). The grid should form - as far as possible - a horizontal plane above the model by eventually fitting a wooden frame at the edges of the model.

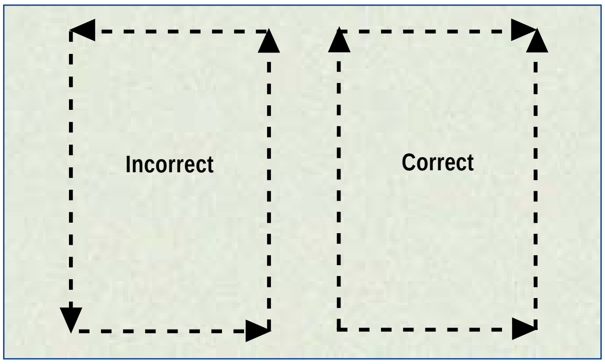


Figure 51. Path for marking intervals

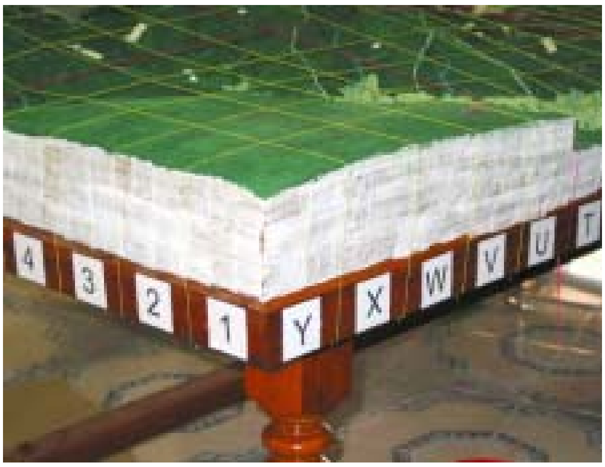


Figure 50. The grid is placed with the use of letter/figures coordinates

Figure 52. The grid is intertwined

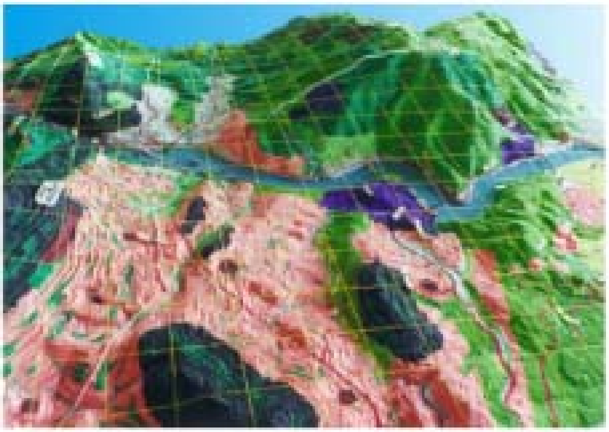


Figure 53. Model with 10-cm grid

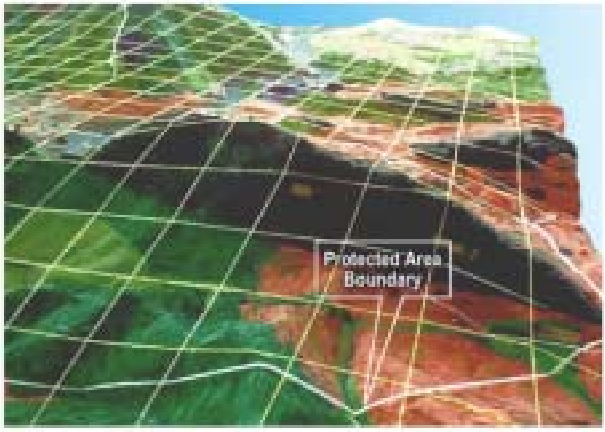


Figure 56. Model with visible protected area boundary

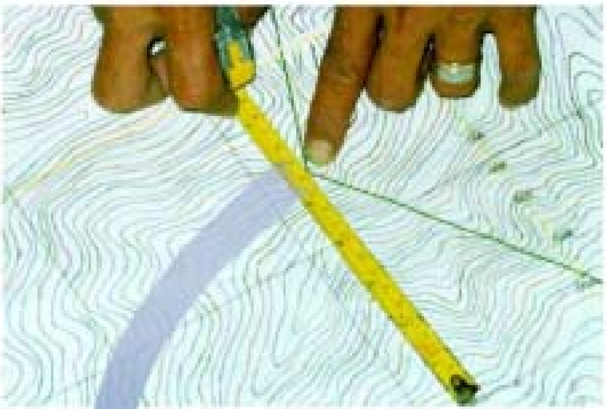


Figure 54. Coordinates are identified on the base map

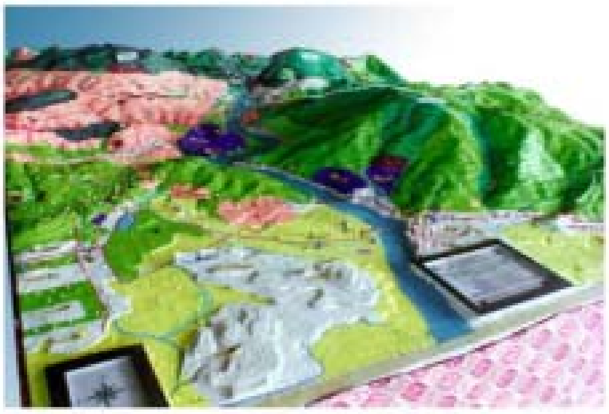


Figure 57. Embedded elements of the map key

Figure 55. Coordinates are replicated on the relief model

Once the grid has been placed (**Figure 53**), you can start transferring information from the base map.

Transposing Data

Latitude and longitude co-ordinates of the boundary corners are identified on the source map (**Figure 54**) making use of its corresponding grid and transcribed to the relief model (**Figure 55**).

Each corner is then connected to the next using a coloured yarn (**Figure 55**).

At the end of this exercise, the boundary is visible to everyone (**Figure 56**).

Finishing Touches

The prerequisite of a 3-D Model is that everyone should understand it.

Therefore once the model is complete, you have to finalize and layout the legend which should necessarily include both a scale ratio (e.g. 1:10,000) and a graphic scale. Additional necessary attributes are a North-labelled arrow and an acknowledgement plate (see **Appendix 10**). Do not forget to list the source of information (e.g. origin of the key informants) and the date at which the model was last updated. These critical bits of information are best printed with the use of a colour printer, plastic-laminated and later embedded into the model (**Figure 57**).

PHASE FOUR: HANDING OVER OF THE MODEL

A handing over ceremony follows which formally transfers ownership of this asset to the community.

Unlike other spatial tools, a P3D model is never completed. Like a living organism, it needs to be nurtured by regularly updating and enriching its information.

Gathering dust?

We came across statements by a few authors that some 3D models were "gathering dust" in a corner of a village without being used.

A 3-D model is like a book. How many times do we read the same book? What happens to it after use?

It is shelved and gathers dust until we need it and get back to it.

3-D models are like books, handwritten notes, picture libraries, maps or even digital files on hard disks. All these are data repositories and are consulted when the need arises.

What is essential is to be able to decode the displayed graphic vocabulary, hence the importance of acknowledgements to know the source of the data, legend, ratio scales, directional arrow and date in order to allow users to decode and interpret the displayed information and place it in clearly-identifiable socio-cultural, geographic and historic contexts.

The model has to be entrusted to an entity with the means and the commitment to safeguard and maintain it, and to make it accessible to those who would like to use, update, integrate or correct previously input data. P3D Models assure that accurate, meaningful-to-all information is kept among the people who generated it.

Representatives of concerned stakeholders should be present at the handing-over ceremony.

For the purpose of monitoring, the custodians of the model should keep a visitors' book, where users would be asked to record their personal particulars, purpose of visit and comments.

PHASE FIVE: EXTRACTING AND DIGITIZING DATA

Data can now be extracted and entered into a Geographic Information System. While transferring from one medium to the other your concern should be minimizing data loss or erroneous geo-referencing.

Those who will be extracting the information should familiarize themselves with the model as annotated in the process documentation. They should be fully familiar with its attributes summarized in the legend in the form of scale, symbols and the definitions used. Stakeholder representatives should participate in the extraction process.

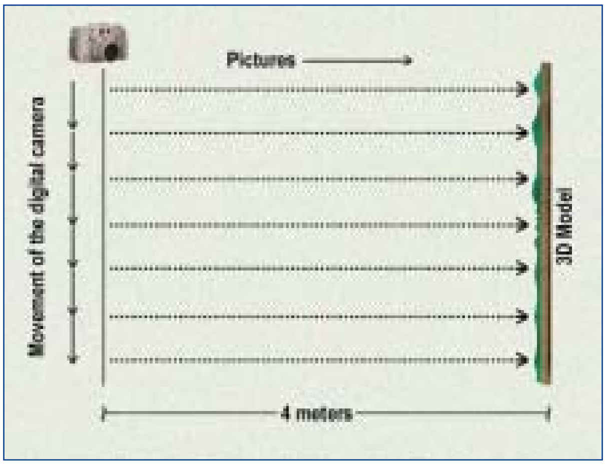
So far, two methods have been experimented at the community level. In both cases, referencing relies on the presence of the grid.

The technique described in the first edition of this document made use of transparent plastic sheets. While simple and easily accessible to anybody, the method carries the risk of generating errors due to the fact that in most cases the plastic sheets were not placed on a plane surface, but adhered to the grid which in turn followed the relief of the model. Attempts made in placing the grid above the model on a plane surface by using Plexiglas or a wooden frame, and later on extracting the information with the combined use of a laser pen fixed together with colour-coded markers, proved to be tedious and hurt the eyes of those involved.

Hence, digital photography combined with on-screen digitizing has been identified as a promising way forward.

Digital Photography and Onscreen Digitizing

To reduce radial and relief displacements, Parallel Camera Movement shooting[16] is recommended. This technique involves moving the camera at a set distance from an object, such as the 3-D Model, to capture it in sections.



Each picture should be shot perpendicularly to the model surface.

A convenient alternative to climbing to the ceiling to take "aerial" photographs is to tilt the model by 90 degrees.

Place a high-resolution digital camera on a tripod at 4-m distance from the base of the tilted model[17]. Draw lines perpendicular to the model's horizontal plane on the floor at 40 cm intervals. Add a reference line at the end of the orthogonal lines to serve as guide in moving the camera from one position to the following one.

Adjust the focal length setting to capture an area of approximately 40 cm x 50 cm (see **Fig-**

[16] A second technique is called "Panning". This technique, typically used to shoot a scenery, involves the camera remaining in one spot and being panned up or down or left to right to shoot the desired images.

[17] 4 meters at a 1:10,000 scale correspond to 40,000 meters. In other words the model landscape if recorded from a virtual altitude of 40 km. This definitely reduces radial displacement, due to relief to a minimum.

Figure 58. "Aerial photography"

Figure 59. Sequential shots are taken

ure 58). Set the camera to the maximum resolution (e.g. 2272 x 1704 pixels) and compression capacity. This setting will provide high quality images of approximately 2 MB each. The number of images that can be stored on the Compact Flash-card depends on its storage capacity. A standard CF-32M card may contain up to 14 images shot at these high quality settings. To cover the entire area of a model measuring 2.5 x 1.2 meters, shoot at least 24 pictures. Intermediate downloads to a separate storage device may therefore be necessary.

Position the camera with the use of a plumb line exactly above the intersection of the orthogonal and the reference lines. The height of the camera above ground is chosen and has to be constant throughout the first passage (**Figure 59**).

Once you have taken all images and safely stored them on a computer, you may use them independently or merge them using appropriate software. Merging techniques are generally well described in

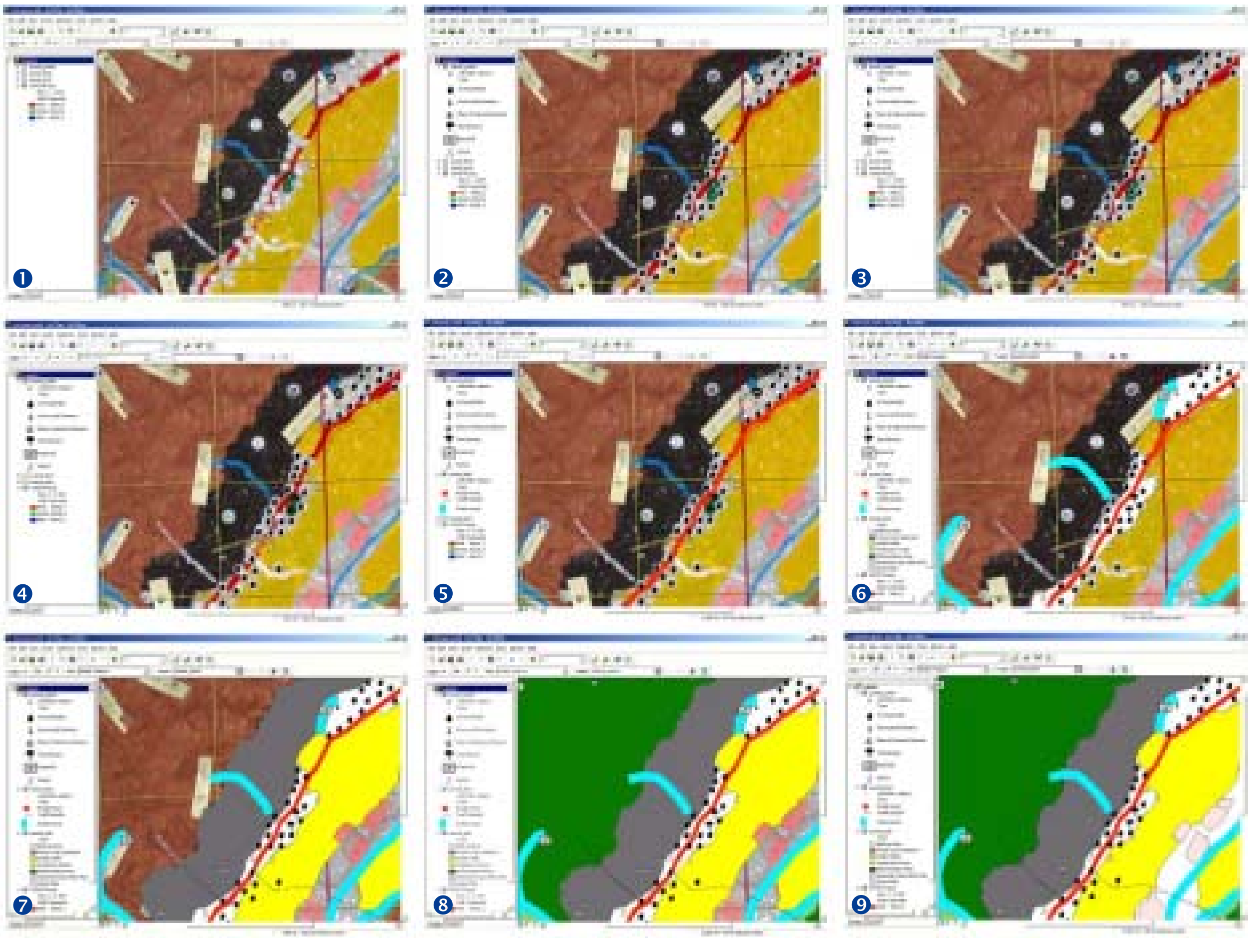


Figure 60. On-screen digitizing sequence

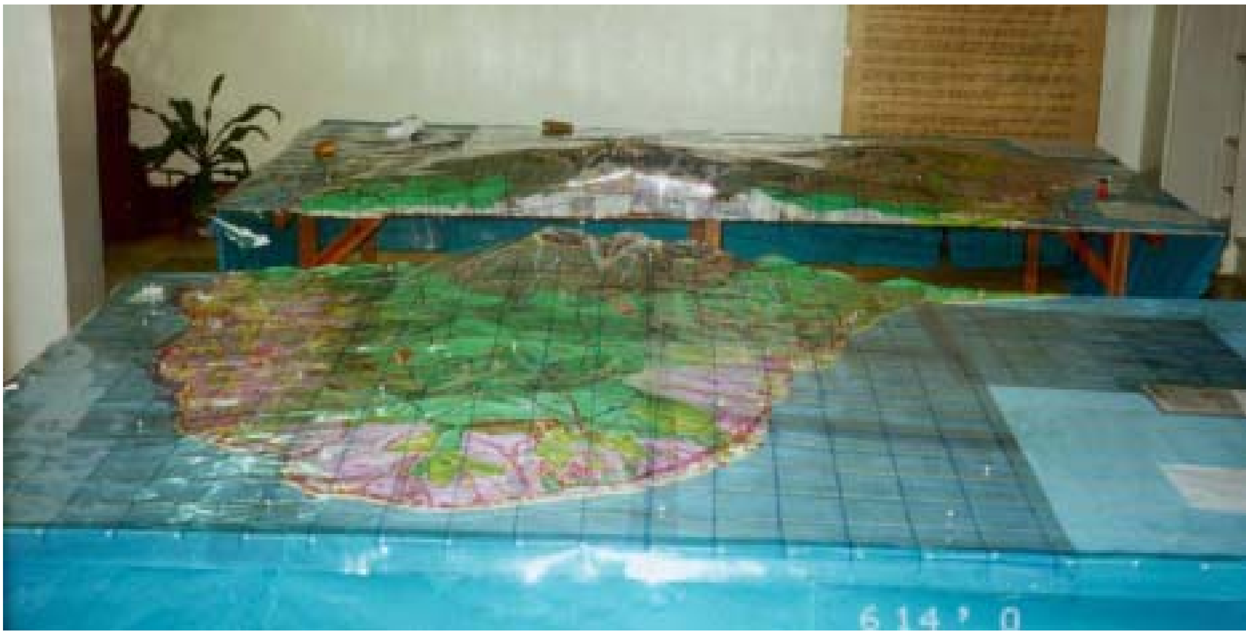


Figure 61. Matching grids

the manuals accompanying the software provided together with professional digital cameras.

The saved image(s) are now in raster[18] image format ready for digital extraction, correction and georeferencing. This requires their conversion to vector[19] format through onscreen digitizing.

Onscreen digitizing (**Figure 60**), as opposed to tablet digitising, is increasingly becoming the most popular means of creating GIS spatially organized data. On-screen digitizing captures data from digital images or scanned maps by using the mouse instead of the cursor. This allows for creating map layers by adding labels during tracing. While the features are still manually traced, and provided images have been taken at high resolution, on-screen digitizing grants a higher level of accuracy because the operator can use the zoom facility. In addition, on-screen digitizing allows for editing features when enough information is available from the image.

Transparent Plastic Sheets for Tablet Digitizing

In spite of its lower accuracy this basic technique is still described because it can be of use to all those who cannot afford to purchase a high-resolution digital camera and where the relief of the model is limited. Supplies necessary for this operation include transparent plastic sheets, generally bought in rolls, overhead marker pens, scaled ruler, measuring tape, push pins, alcohol, cotton and one copy of the reference map. The plastic sheet needs to be cut to a manageable size (say 0.6-m x 0.6-m). Ahead of actual fieldwork, a grid matching the one on the base map needs to be drawn on each sheet using a permanent marker.

Extraction can start, provided the reference grid has been placed on the model. Location of the grid has to be accurate to limit any errors that may be made in transferring information from one medium to another. In this process the regular referral to the base map is helpful.

Place the plastic sheets on top of the model as shown in **Figure 61**.

Where islands are concerned, you can trace the coastline on the plastic sheets directly from the base map (**Figure 62**). This eases geo-referencing.

Figure 62. Tracing the coastline

[18] A **raster image** file is generally defined as a rectangular array of regularly sampled values, known as pixels. Each pixel (picture element) has one or more numbers associated with it, generally specifying a colour, which the pixel should be displayed in.

[19] A **vector image** is generated through a sequence of commands or mathematical statements that place lines and shapes in a given two-dimensional or three-dimensional space.

Figure 63. Looking straight

Figure 64. Data are digitized

At least three people are needed for a period of 2-3 days to extract information from a 6-7 m^2 model.

Extraction should be done systematically. Points, lines and polygons are the three features representing the data. These should be separately transferred to the plastic sheets.

Accurate documentation is essential. Attributes (non-graphic information like names, descriptions of land use and cover, demographic characteristics, etc.) are associated with single features. An ad-hoc legend is prepared for this.

Those involved in extraction should bear in mind that the data transferred to the plastic sheets have to be digitized elsewhere. Therefore, information contained in the plastic sheets, accompanying annotations and legend must be understandable to other people as well.

Despite the simplicity of the technology involved in transferring information from a 3-dimensional to a 2-dimensional medium, errors and distortions are inevitable. A major source of error originates from the perspective of the extractor when tracing information onto the plastic sheets. In order to limit distortions, the extractor should observe perpendicularly as shown in **Figure 63.**

Taking pictures of the model still carrying the grid and the grid references limits errors. Enlarged prints may serve as visual reference during the tablet-digitizing phase.

The transparent plastic sheets, accompanying legend and colour prints are handed over to the GIS for digitization (**Figure 64**), editing, and data storage.

PHASE SIX: DATA ELABORATION AND MANIPULATION

Information obtained from official and other sources like administrative and political boundaries, can be integrated

Attributes are ascribed to points, lines and polygons. The entire output is subjected to cartographic processing wherein colours, symbols and lines are chosen to represent the different attributes of the model.

Customized thematic maps are produced at predetermined scales (**Appendix 11, 13, 15, 17, 18, 19, 20, 21** and **22**).

A legend is prepared and joined to other cartographic information like scale, title, source of information (including date), coordinates, directional arrow, and others as shown in **Appendix 10**.

The use of standardized coding in producing thematic maps is important for sharing information, comparing data sets from different sources or data collected from the same source but at different dates, especially when 3-D models are used as a means for conducting Participatory Monitoring and Evaluation (PM&E).

PHASE SEVEN: FIELD VERIFICATION

GIS translation of the model data can be compared with other existing spatial information, like maps produced from satellite-interpreted imagery (**Appendix 11** and **Appendix 12**) or other cartographic information obtained from institutional sources. Examples are shown in **Appendix 13** vs. **Appendix 14** and **Appendix 15** vs. **Appendix 16**.

Inconsistencies between data sets need to be verified. This should be done by reconvening around the P3-D Models with a sufficient number of informants and through community-based on-field investigation.

Philippine experience has shown that cognitive maps, supplemented by conventional spatial information (contours) and some field verification, are not only accurate but more detailed and more current than information maintained in official circles as discussed in **Appendix 23**.

FREQUENTLY ASKED QUESTIONS (FAQ)

Can P3DM be used for reproducing large areas (e.g. > 100,000 km²)?

Key-informants' knowledge can be successfully collated on relief models made at 1:20,000 or better at larger scales. It follows that the geographical coverage of a model is influenced by its final size. Reducing the scale, to, say 1:50,000, in order to cover larger areas limits accuracy and the ability of informants to internalize the model and to transpose their knowledge. A solution is to produce a series of models – to be made and displayed at different locations – each one covering a portion of the desired area. Obviously this process would require more time and added financial and human resources.

Do participants get paid?

The essence of participatory approaches is the full participation of people in the processes of learning about their needs and opportunities, and in the action required to address them. Informants and representatives from all stakeholder groups generally work in a voluntary capacity. Facilitators should support the costs of transport, lodging and catering.

How many participants (informants) are required for a 3-D model?

The number of participants working at one time should allow everyone to physically access the model. An overcrowded venue causes distraction and loss of motivation by the participants. Splitting informants into groups of 20-25 and making provisions for brief overlapping of groups to allow cross-fertilization and crosschecking would be best.

Who does the community mobilization?

Community mobilizing is one of the most important components of the process, which leads to the construction of a 3-D model. Locally based organizations (NGOs, LGUs, protected area offices, etc.) best do the job.

How do you deal with conflicting information?

What is the truth? Whose knowledge counts? These are recurrent questions surfacing while doing community-based work. A P3D model accommodates a blend of knowledge collated by key informants. Outsiders may inject additional information (e.g. aerial photography or satellite imagery) as the starter for further community-based discussion and analysis. Field verification done jointly with interested parties and the use of GPS (in the case of boundary disputes) may help in resolving disagreements.

How do you deal with the implementation of the study results?

The purpose of the exercise should be defined beforehand jointly with the stakeholders' community. Participatory 3-D Modelling should not be seen as an extractive research practice, but as a means to enhance community-based awareness and develop analytical skills, by broadening local perspectives. Therefore - in an ideal world - the outputs (relief model and thematic maps) should be owned by the participating stakeholders, who should use them to fulfil their purpose.

Remember that P3DM has been conceived to be part of a broader intervention, aimed at full *Participation* of people who are in the process of *Learning* about their needs and opportunities, and ready to take *Action* to address them.

Thus, in order for outsiders to apply this process, they must fulfil two preconditions: The first is to have a thorough understanding of the cultural and socio-economic setting of the area. The second is to have the ability to support communities in implementing strategies and actions to follow-up the P3DM process.

P3DM has been used so far in Thailand, Vietnam and the Philippines in the contexts of land use planning, protected area management and self-determination. Are there any other situations where relief modelling has been adopted?

There is worldwide interest in the method. Updates are available on the Internet at http://www.iapad.org.

In addition, in order to monitor the adoption of participatory 3-D modelling and to learn from experience, a freely accessible web-based database has been set up for the purpose of sharing experiences at http://www.iapad.org/database.

To what extent is P3DM feasible in densely populated areas?

Densely populated areas can be reproduced in 3-dimensional format at a scale, which meets the purpose of the exercise. 1:10,000-scale or larger would suffice to generate household level information. Densely populated areas are generally located in alluvial planes. Small-interval contour lines should be used to depict as many landmarks as possible. Horizontal and vertical scales should differ to enhance the perception of slope and evidence landmarks.

How long does it take to complete the process from community mobilization to the production of the model and derived digital information?

Depending on available information (including digital contours, socio-economic, land use, etc.) and community preparedness: three to four months.

What skills are needed?

The conduct of a Participatory 3-D Modelling exercise needs the support of a multidisciplinary team including at least three facilitators covering the following disciplines: geography/cartography/GIS, environment, and social sciences.

How much does it cost?

Table 6 summarizes the costs involved in the conduct of one P3DM exercise in Vietnam in November 2001. The facilitation cost has not been computed because it varies depending on the resource persons involved.

Based on the computation, the information generated in both physical (3-D) and digital formats for a total area of 700 sq. km at 1:10,000-scale, has cost USD 4.13 USD/km^2 or USD 0.04/ hectare.

Other exercises conducted in the Philippines in 1999 resulted in unitary costs ranging from 2 to 3 USD/km^2 due to the fact that neither pocket money nor translation fees had to be disbursed. ●

Table 6. Cost breakdown – P3DM exercise, Pu Mat National Park, Nghe An, Vietnam. 70,000 ha at 1:10,000 scale - Year 2001

Cost Item	P3DM exercise (USD)
Supplies (including the procurement of digital contours and the preparation of base maps: editing and attributing only)	1,090.00
Transport, 2-day accommodation, food and pocket money for key informants (76 villagers)	800.00
Three days of food for 30 students and teachers	100.00
Translation cost: two interpreters English-Vietnamese and Vietnamese-Thai	500.00
On-screen digitizing and printing of thematic maps (10-14 working days)	400.00
Laptop and Digital Camera (high resolution)(*)	
Preparatory activities (procurement, preparation of logistics, meetings, community organizing, etc.)(**)	
Facilitation (not included)	
TOTAL	2,890.00

(*) Element of cost not included in the computation because the items are already available as project assets.
(**) Element of cost not included in the computation because Project staff conducted the activity as part of the routing project activities (recurrent cost).

GLOSSARY

Attribute A characteristic of a geographic feature described in numbers or text (e.g. attributes of a household, represented by a point might include number of household members, age groups and main source of livelihood).

Base map A map containing geographic features, used for locational reference. Also, the source map of a P3DM process.

Cognitive maps Cognitive maps are internal representations of the world and its spatial properties stored in memory (also called mental maps).

Depict Paint or draw, to make a likeness of.

Digitize To encode map features as x, y coordinates in digital form.

Facilitator Someone who brings people together (networking) and catalyzes and/or directs learning and exchange processes, either in general or around a specific problem area.

Feature classes When referring to map data, feature classes include areas and surfaces (polygons), lines and points. For example, *polygons* feature land use and vegetation types; *lines* roads and rivers; *points* households and social infrastructures.

Geo-reference The relationship between page-coordinates on a planar map and known real-world coordinates.

Grid A raster-based data structure composed of cells of equal size arranged in columns and rows.

Layer A logical set of thematic data described and stored in a map library. Layers organize a map library by subject matters (e.g. soils, roads, households, land use).

Modelling The act or art of making a model of something; rendering into solid form.

Perception Perception is the active acquisition of knowledge about the self and the world through the senses.

PLA Participatory Learning and Action (PLA) is an umbrella term for a wide range of similar approaches and methodologies to involve communities in self-help and development projects. The common theme to all these approaches is the full *participation* of people in the processes of *learning* about their needs and opportunities, and in the *action* required to address them.

Topographic map A map containing contours indicating lines of equal surface elevation (relief) often referred to as *topo maps*.

Zoning Dividing an area into zones having different objectives and uses.

APPENDICES

Appendix 1. DENR Memorandum Circular No. 1 Series 2001

Republic of the Philippines
Department of Environment and Natural Resources
Visayas Avenue, Diliman, Quezon City, 1100
Tel. No. (632) 929-66-26 to 29 (632) 929-62-52
929-66-20, 929-66-33 to 35
929-70-41 to 43

JAN 0 4 2001

DENR MEMORANDUM CIRCULAR

NO. 2001- 01

SUBJECT: **Participatory 3-Dimensional Modeling as a Strategy in Protected Area Planning and Sustainable Natural Resource Management**

Pursuant to Chapter IV Section 8 of DAO 25 Series of 1992, DENR Circular Nos. 3 and 4 Series of 1993, the Participatory 3-Dimensional Modeling is hereby recommended as one of the strategies in protected area planning and sustainable natural resource management.

The Participatory 3-Dimensional Modeling integrates participatory resource mapping and spatial information to produce a stand-alone and user-friendly scaled relief model which has proven to be relatively accurate for spatial research, planning and management. The model contains information which can be extracted and further elaborated by the Geographic Information System.

A *Manual on Participatory 3-Dimensional Modeling* has been developed for the guidance of all Regional Executive Directors and concerned Assistant Regional Executive Directors.

ANTONIO H. CERILLES
Secretary

Grow a Tree for Legacy

Appendix 2. Colour Preparation

In Vietnam it is hard to find water based acrylic colours. The tendency for artists in general is to use special power colours and mix them to meet the desired hue.

The following are the necessary ingredients:

Powder glue	115 g
Hot water	500 ml
Colour (in powder)	500 g
Alcohol	On demand
Glycerine	75 ml
Mixing equipment	5 litre plastic bucket, egg beater and lidded container.

Preparation:

1. Put the powder glue into the plastic bucket and add hot water. Mix thoroughly.
2. Mix the resulting glue with the colour powder until the colour is completely dissolved. If it is difficult to dissolve the colour powder or the powder is floating on the top of the glue, add some alcohol. It will help the ingredients to amalgamate. Alcohol is essential for the preparation of red colour.
3. The consistency of the amalgam is appropriate when white paper is completely covered by a brush spread of colour.
4. If you plan to keep the colours for a long period you have to store the final colour paint in sealed containers topped up with glycerine.

Figure 65. Colour preparation

Appendix 3. Reading Maps

A map is a representation of the Earth, or part of it. Traditionally, maps have been printed on paper. When a printed map is scanned, the computer file that is created may be called a digital raster graphic.

The distinctive characteristic of a topographic map[20] is that the shape of the Earth's surface is shown by contour lines. **Contours** are lines drawn on a map to represent points of equal elevation on the surface of the land above or below a reference surface such as mean sea level. On conventional maps, they are usually printed in brown, in two thicknesses. The thicker lines are called **index contours**, and they are usually marked with numbers, giving height in meters. The **contour interval**, a set difference in elevation between the brown lines, varies from map to map; its value is given in the margin of each map. The closer the contour lines, the steeper the slope is. Contours make it possible to measure the height of mountains, depths of the ocean and steepness of slopes.

A topographic map shows not only contours, but various other natural and man-made features, each represented by colours and symbols.

Colours are applied according to standards, which differs from country to country. Some coding is common worldwide: forestlands, for instance, are shown in a green tint, waterways in blue. A road may be printed in red or black solid or dashed lines, depending on its size and surface.

Symbols include variously weighted line styles, fonts and icons to improve appearance and readability of a map.

[20] Topographic maps are maps that present the horizontal and vertical positions of the features represented; distinguished from a planimetric map by the addition of relief in measurable form.

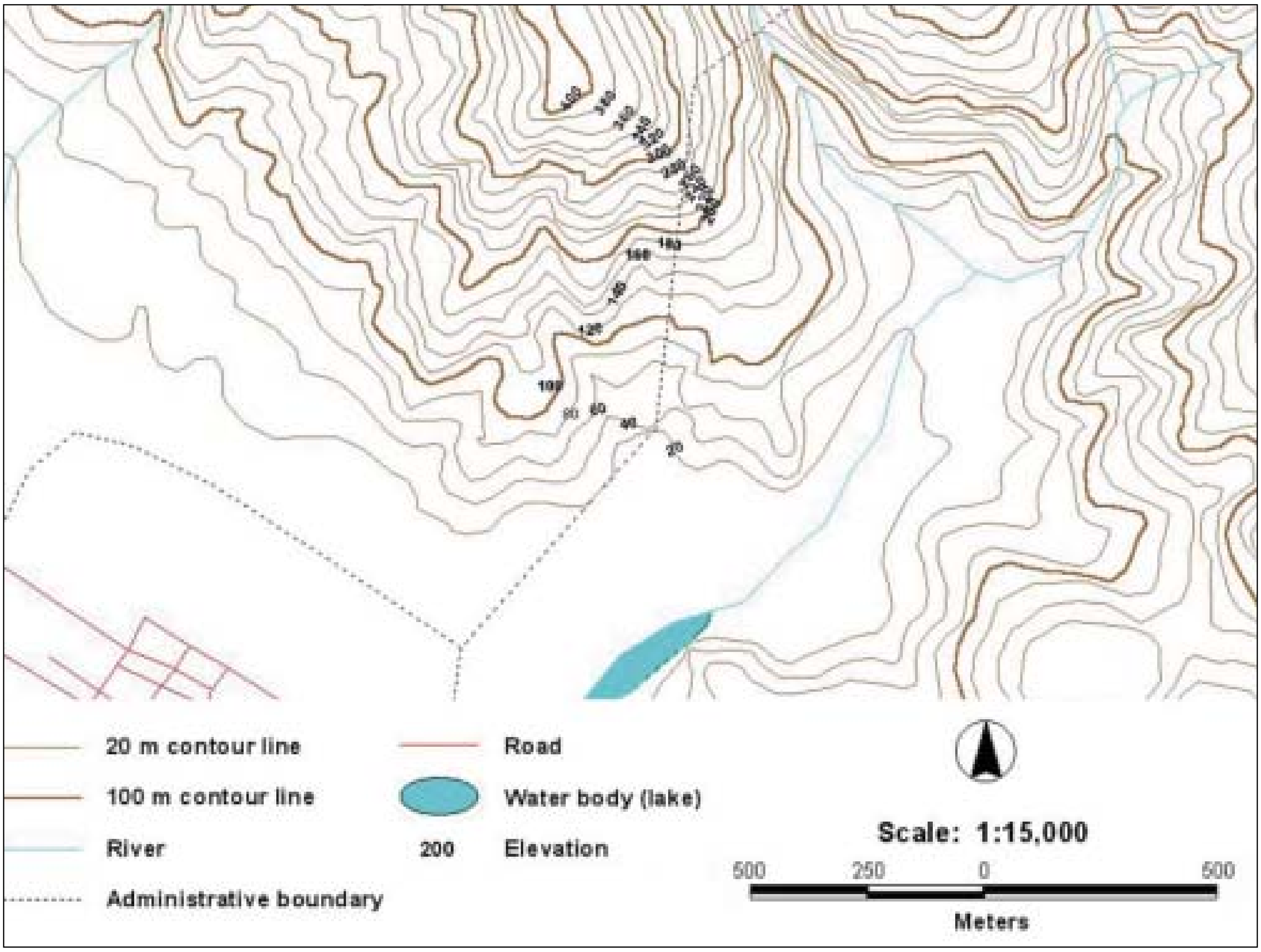


Figure 66. Sample of contour map

Appendix 4. Stakeholder Analysis

A stakeholder analysis is done to identify all those groups, institutions and individuals having interests in, control over, derive benefits or suffer consequences from a particular situation which exist or which may materialize as a consequence of change. The analysis is meant to list these stakeholders, determine their level of power and relationships. The analysis has to identify local decision-making structures, the way decisions are made and the holders of relevant specialist knowledge (e.g., resource user groups) and assess the effects change may have on them.

It could also help identifying those who could help organize P3DM activities and deal with follow-up arrangements.

A stakeholder analysis is more appropriate than an inventory when the communities affected are complex and the stakeholders and their relationships to the resources are not easily identifiable. A stakeholder analysis requires more time and resources than an inventory, since the analysis is usually carried out in the field and involves participatory exercises (e.g. Venn Diagram) and the collection of new data.

The use of natural resources is typically characterised by diverse and conflicting interests. For instance, many local communities are socially stratified; knowing the different interests of the various members will help in organizing their participation in the initiative as well as in developing local resource management institutions. Undertaking a stakeholder analysis will also provide a frame of reference for further steps in the initiative and for dealing with various consequences and conflicts which may emerge.

A possible constraint to this exercise is that it requires expertise in social analysis and community consultation techniques. Undertaking an analysis can also be costly and time-consuming and, as with inventories, the end product will need to be updated to maintain its relevance to the initiative.

References and recommended readings:

Overseas Development Administration. July 1995. Guidance Note on How to Do Stakeholder Analysis of Aid Projects and Programmes. Social Development Department Mimeo. London: ODA. http://www.dfid.gov.uk/AboutDFID/files/sdd/pdf/sddstak1.pdf

Borrini-Feyerabend, 1997. *Beyond Fences: Seeking Social Sustainability in Conservation*, IUCN, Gland (Switzerland), 1997. http://www.iucn.org/themes/spg/beyond_fences/beyond_fences.html

Appendix 5. How to Prepare a Base Map for 3D Modelling

Provided digital contours are available the recommended format for the base maps is the following:

- Scale 1:5,000 to 1:10,000
- 20-m contour lines coloured in a recurrent sequence: e.g. **brown** (100m), blue (120m), green (140m), purple (160m), black (180m); **brown** (200m), blue (220m), green (240m), purple (260m), etc.
- Format of the contour lines: 1 pt., except for the "index contours" (100m, 200m, 300m, 400m, etc.), which should be 2 pt. thick.
- 40-m contours are a valid alternative. The colour sequence could be the following: e.g. **brown** (0m), blue (40m), green (80m), purple (120m), black (160m); **brown** (200m), blue (240m), green (280m), purple (320m), etc.
- Elevation labels: many, to facilitate the identification the elevation of each contour during tracing. In addition elevation labels should be placed at all hill- and mountaintops or bottoms of depressions.
- Grid (10 cm = 1 km on the ground for a 1:10,000 scale model). Format: Solid line, black, 1 pt.
- Contour line expressing the lowest elevation: to be identified with a mark, e.g. an arrow. This allows locating the first contour line to be traced and cut out.
- Administrative boundaries (e.g. national boundary. Format: dashed line - black, 2 pt.)
- Protected Area Boundary. Format: solid line - red, 2 pt.
- Buffer Zone Boundary. Format: solid line - orange, 2 pt.

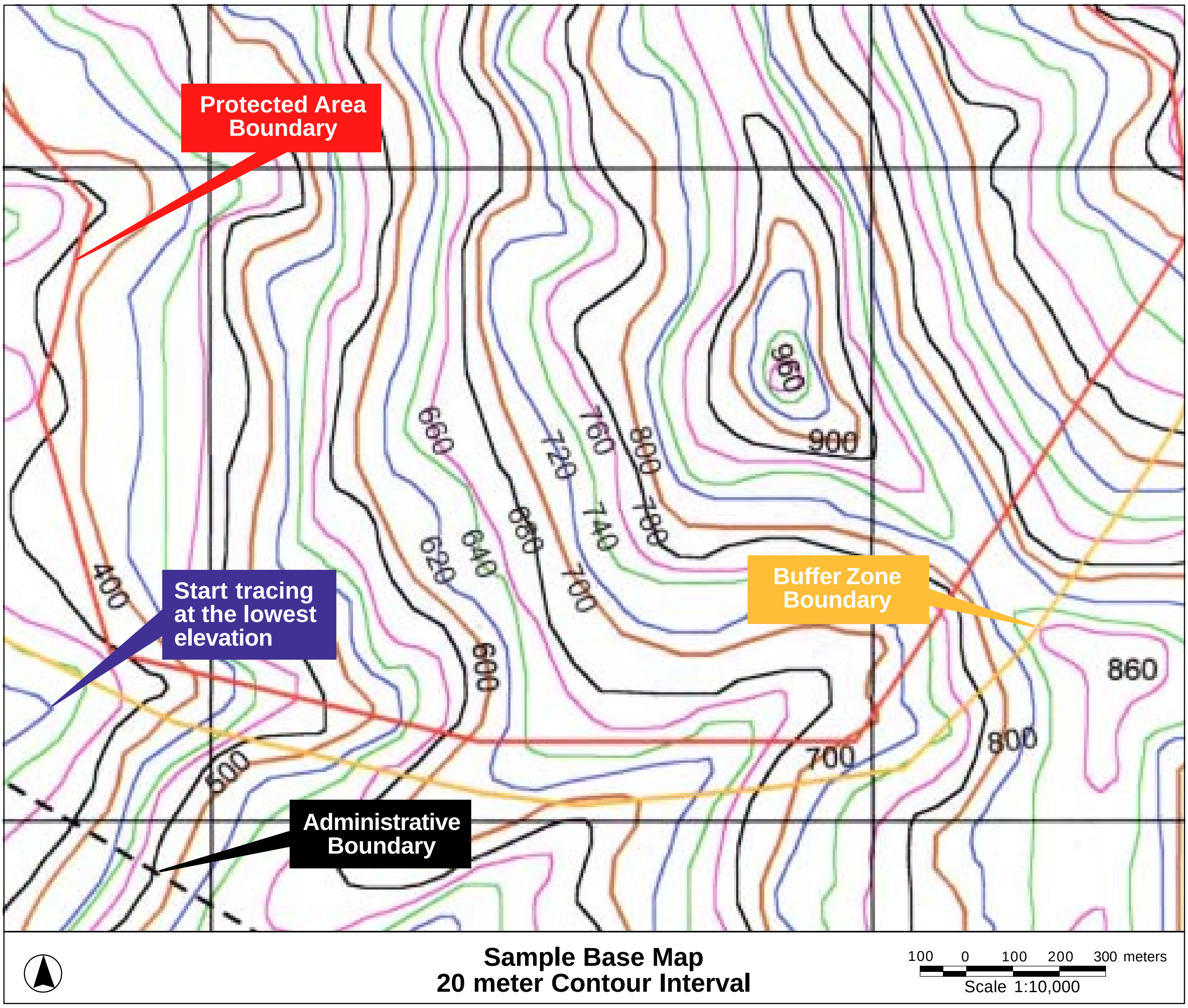


Figure 67. Example of base map for 3-D modelling

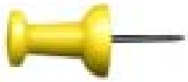
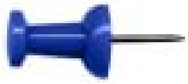
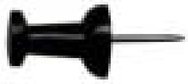
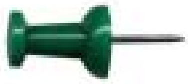
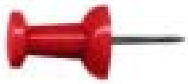
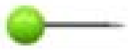
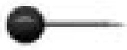
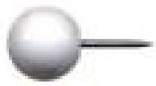
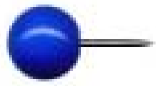
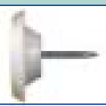
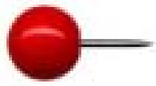
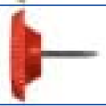
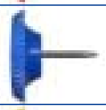
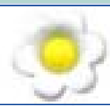
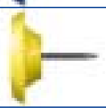
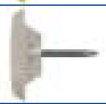
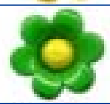
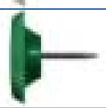
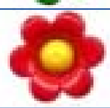
Appendix 6. Referencing, measurement and scaling tools

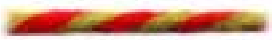
Appendix 7. Supply list for the manufacture of the relief model of Pu Mat National Park, Nghe An, Vietnam. Area coverage 700 km²; scale 1:10,000; year 2001 Model size: two units each measuring 1.4 m x 2.5 m.

QTY	Unit of measure	Article Specification	Unit cost (USD)	Total Cost (USD)
2	lit	Alcohol	0.67	1.33
200	pc	Attendance certificates	0.07	13.33
1	pc	Banner	32.00	32.00
1	set	Base maps: Editing and attributing contour lines (700 sq km, 1:10,000 scale; 20 m contour interval)	333.33	333.33
4	pc	Base maps: Plotting base map on A0 paper (2 copies each)	26.67	106.67
2	unit	Base table (1.4m x 2.5m x 0.6m) plywood (1/4") with reinforcements	26.67	53.33
3	pc	Blade cutter	0.43	1.30
5	pc	Blade for coping saw (steel)	0.33	1.67
5	pc	Blade for coping saw (wood)	0.33	1.67
20	box	Blades for above cutters	0.47	9.33
8	pc	Bucket (1 litre capacity)	0.20	1.60
1	pc	Bucket (10 litre)	0.47	0.47
2	box	Carbon paper (hand writing)	2.67	5.33
6	pc	Colour marker, black, blue and red	1.33	8.00
1	no.	Compass	1.33	1.33
4	pc	Coping saw	13.33	53.33
1	bag	Cotton	0.33	0.33
1	roll	Cotton yarn (fine); yellow	0.80	0.80
40	rim	Crepe paper (white)	0.50	20.00
24	pc	Double clip (25 mm)	0.07	1.60
5	box	Dressmaker pins	0.67	3.33
1	pc	Egg beater	3.33	3.33
4	roll	Film Kodak ASA 200 (36p)	2.40	9.60

QTY	Unit of measure	Article Specification	Unit cost (USD)	Total Cost (USD)
4	kg	Glue powder	2.67	10.67
1	pc	Hammer	0.60	0.60
1	kg	Hand-knitting yarn no. 8; 18 colours	4.00	4.00
1	pc	Labels (craft paper)	1.67	1.67
8	no.	Laminated north arrow	0.13	1.07
1	no.	Laminated plate (commemorative)	0.13	0.13
1	no.	Laminated plate (legend)	0.13	0.13
4	series	Letters (alphabet) font 72	0.00	0.00
1	no.	Logbook	1.60	1.60
1	bag (100 pc)	Pins (map pins) (13 mm long; 10 mm head; white)	5.00	5.00
4	bag (50 pc)	Pins (map pins) (13 mm long; 10 mm head; yellow, red, green, blue)	2.23	8.93
2	bag (1000 pc)	Pins (map pins) (13 mm long; 4 mm head; white)	5.00	10.00
1	bag (1000 pc)	Pins (map pins) (13 mm long; 4 mm head; yellow, blue, black, red, violet, white, orange)	5.00	5.00
0	bag (1000 pc)	Pins (map pins) (13 mm long; 6 mm head, white)	7.00	0.00
10	pc	Masking tape (2")	0.93	9.33
3	pc	Measuring tape (3 meter long)	1.00	3.00
1	kg	Nails (0.5")	0.67	0.67
1	kg	Nails (2.5")	0.53	0.53
1	kg	Nails (5")	0.53	0.53
4	series	Numbers (1 to 35) Font 72	0.00	0.00
24	kg	Office Glue (water based)	1.20	28.80
2	set	Overhead projection markers (six colours)	4.67	9.33
3	pc	Packing tape (2')	0.33	1.00
4	pc	Painting brush # 0	0.27	1.07
20	pc	Painting brush # 10	0.13	2.67
20	pc	Painting brush # 12	0.20	4.00
20	pc	Painting brush # 2	0.07	1.33
20	pc	Painting brush # 7	0.10	2.00
20	pc	Painting brush 25 mm	0.07	1.33
2	pc	Painting brush 63,5 mm	0.27	0.53
36	pc	Pencil mongol # 2	0.17	6.00
1	pc	Pencil sharpener	4.33	4.33
50	pc	Plastic jar (1 litre capacity)	0.10	5.00
10	pc	Plastic jar (3 litre capacity)	0.33	3.33
8	pc	Plastic-laminated Quick Reference Guide	0.33	2.67
1	pc	Pliers	1.33	1.33
2	pc	Plumb line weight	0.67	1.33
1	kg	Powder colour (black)	1.00	1.00
1	kg	Powder colour (blue)	2.33	2.33
1	kg	Powder colour (brown)	1.00	1.00
4	kg	Powder colour (green)	2.33	9.33
1	kg	Powder colour (light brown)	1.00	1.00
0.5	kg	Powder colour (red)	6.67	3.33
3	kg	Powder colour (white)	1.00	3.00
2	kg	Powder colour (yellow-lemon)	2.33	4.67
1	kg	Powder colour (yellow-orange)	2.33	2.33
1	bag (100 pc)	Pins (push pins), (flat head; white)	5.00	5.00
4	box (100 pc)	Pins (push pins), (white)	1.00	4.00
2	box (100 pc)	Pins (push pins), (yellow, blue, black, green, red)	1.00	2.00
2	pc	Scaled ruler	8.33	16.67
10	pc	Scissors (for hair cutting)	0.53	5.33
18	pc	Scissors (small)	0.27	4.80
3	pc	Scotch tape (2')	0.33	1.00
150	sheet	Single-wall corrugated carton (1.4m x 2.5m) sheets. Inner and outer liner 175 g/m2, B flute 175 g/m2	1.30	195.00
1	box	Staple wire #35	0.13	0.13
1	pc	Stapler	1.93	1.93
50	m	Transparent plastic sheet (1.2 m wide)	0.50	25.00
40	pc	Weights (bricks, rims of paper, tiles, pieces of lumber, etc.)	0.00	0.00
		TOTAL		**1090.77**

Appendix 8. Examples of Map Symbols used on Participatory 3-D Models

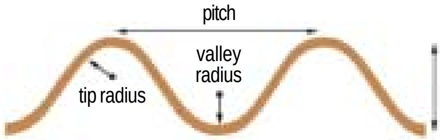
Point data			
Map Pin (head diameter: 5mm)	**Feature**	**Push Pin**	**Feature**
	Single Household		10 Households
	Elementary School		High School
	Water Source (1)		Docking Site
	Water Source (2)		Burial ground
	Forest-related data		Tree Nursery
	Ranger Station		Protected Area Office
	Religious Establishment	**Map Pin** (head diameter: 10mm)	**Feature**
	Cave		Unallocated
	Place name (with label)		Unallocated
	Sports field		Diving Site
Flat Pins accomodate text	**Feature**		Unallocated
	e.g. wildlife species		Unallocated
	Unallocated	**Push Pin** (Flower)	**Feature**
	e.g. fish species		Scientific research station
	Unallocated		Extension station
	Unallocated		Market
	e.g. plant species		Unallocated

Linear and/or area data			
Line (yarn)	**Feature**	**Line (yarn)**	**Feature**
	Forest (1)		Vegetable garden
	Forest (2)		Rice field (paddy)
	Forest (3)		Watercourse
	Grassland		Trail of Footpath
	Limestone		Mangrove area
	Landslide		Protected Area Boundary
	Swidden		Boundary (1)
	Reforestation area		Boundary (2)
	Road		Boundary (3)

Note: most yarns are used as temporary markers for features during discussion. Once imformants have agreed on the different features the yarns are removed and replaced by a matching paint. Administrative and management boundaries are best maintained as yarns to allow easy adjustments.

Appendix 9. What 3-D Mapmakers Should Know About Corrugated Carton Board[21]

Corrugated board is made largely of recycled paper and most commonly comprises three components: an outer and inner "liner", (the flat, surface components), and a "corrugating medium", the "fluting", which is glued between the liners. It is this sandwich-type construction that gives corrugated board its excellent rigidity and structural strength as well as its unique cushioning characteristics.



Over the decades, corrugated board has evolved and developed to provide a wide range of products for different applications. Standard and non-standard categories of corrugated board are based on the type of flute, whether coarse, fine or extra fine and the number of fluted walls whether single, double or triple layered.

For the purpose of 3-D modelling, options include single face-, single wall – and double wall corrugated board, each of which can be made in a variety of weights and thicknesses.

The standard range includes the coarse 'A' and 'C' flute, fine 'B' and extra fine 'E' and 'F' flutes. The 'B' flute is the most widely used. It is very robust (difficult to crush) and has good compression strength. The 'C' flute is larger with greater compression strength but offers less crush resistance and requires more space.

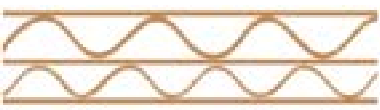
Single face corrugated board is manufactured in standard widths ranging from 56" to 36". It is easily transported in rolls. Its ability to withstand compression (an important factor for the stability of a 3-D model) is determined by the quality and thickness of the liner and the corrugating medium. For 3-D modelling, the liner and the corrugating medium should be at least 185 g/m^2 and 150 g/m^2 respectively. The best solution is to request a specially manufactured corrugated board making use of a liner (175 - 185 g/m^2) and a kraft liner (175 –185 g/m^2).

The thickness of corrugated board (an important dimension in respect to scaling 3-D models) is conventionally measured as detailed in the following Table.

If transport is not a constraint, you may wish to consider procuring single or double wall corrugated board, making sure that you get the best possible quality in terms of strengths as discussed above.

Provided you order a minimum quantity, depending on the goodwill of the manufacturer, corrugated board sheets can be cut to the desired size ahead of the modelling exercise.

In this case, the size of the board should possibly match that of the base table and the base map (see page 29)

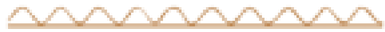
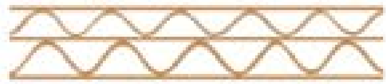
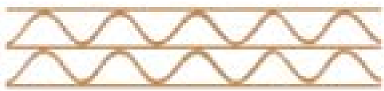


Single and *double-wall corrugated boards* are classified as detailed in the following Table and offer additional resistance to compression.

The choice between the various media will depend on their availability or the readiness of manufacturers to produce them according to the desired specifications and to the transport facilities available to haul the material to where the model will be assembled. Rolls of board are easier to transport, as they can easily fit into the back of a pick up. Large carton board sheets are necessarily placed on the roof of a vehicle or in a truck you may want to get for this purpose.

[21] This Appendix has been prepared with the assistance of Dr Martin Oldman, Director, Corrugated Packaging Association Northampton, United Kingdom. http://www.corrugated.org.uk

Different types of corrugated carton board

Standards	Typical Calliper (mm) (i.e. Thickness)	
Single-face corrugated board		
E Flute	1.1 – 1.8	
B Flute	2.1 – 3.0	
C Flute	3.2 - 3.9	
A Flute	4.0 - 4.8	
Single-wall corrugated board		
B Flute	2.95	
C Flute	3.78	
Double-wall corrugated board		
EB flute	4.06	
BC flute	6.50	
CC flute	7.33	

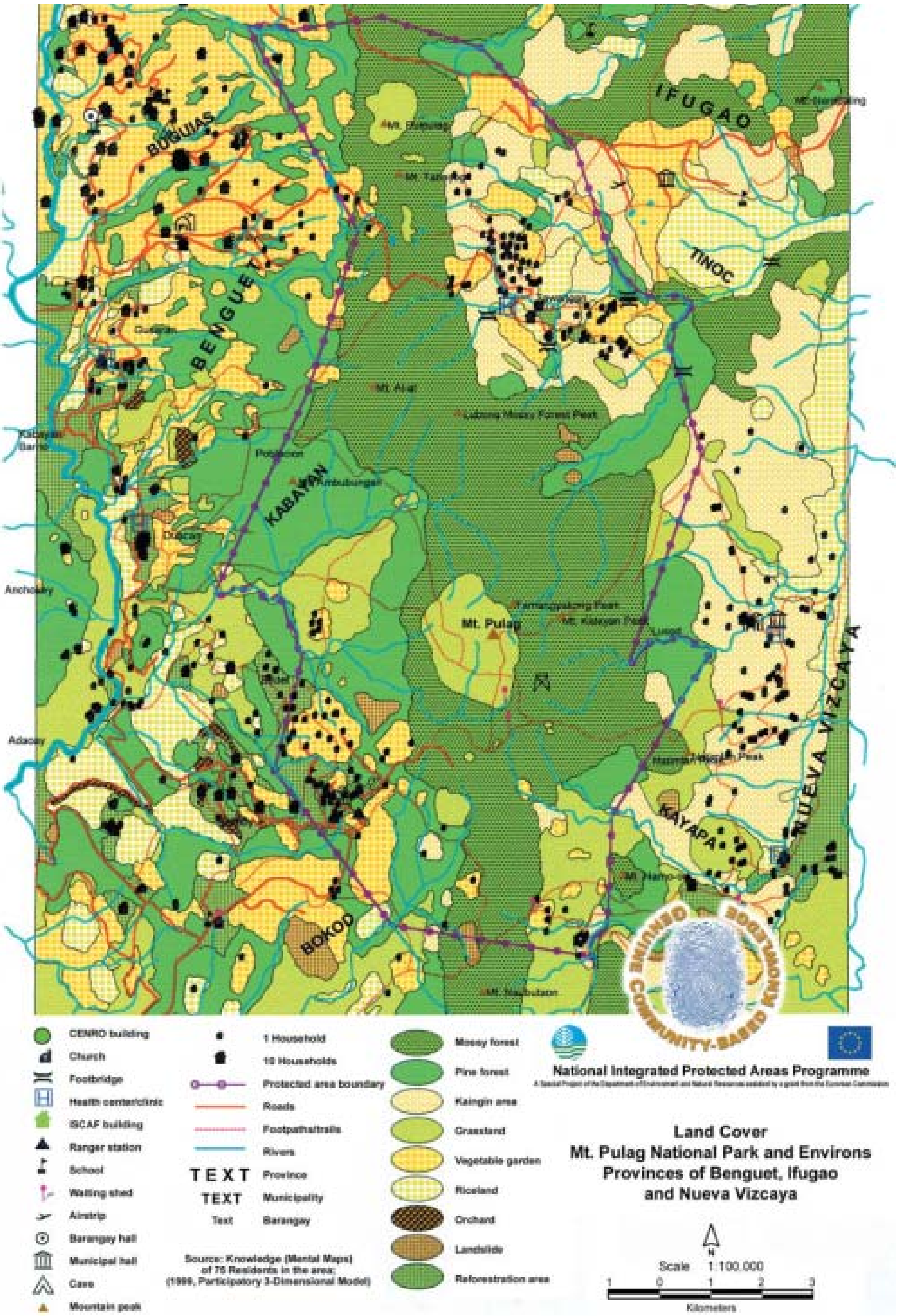
Compared to other supplies used for making 3-D models, like polystyrene or other petroleum-derived materials, corrugated board is environment-friendly, being recyclable and ultimately biodegradable. As a matter of fact 70% of the board produced each year is made from recycled fibres.

Corrugated board is not made from paper derived from tropical forest hardwoods - they are entirely unsuitable for the process. In fact the paper industry uses fast-growing softwoods, which are being replanted faster than they are being used.

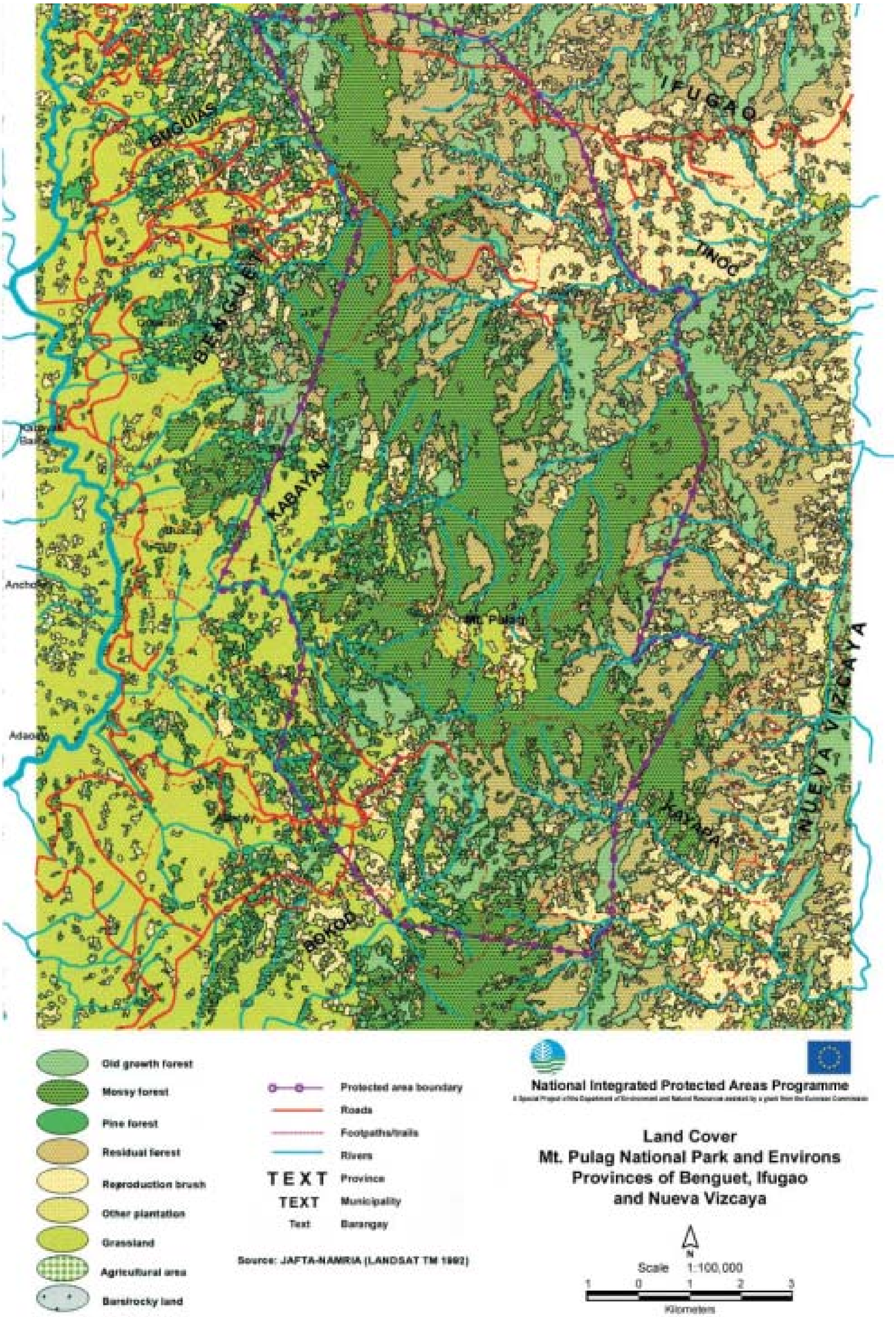
Corrugated carton is a reusable material made from a renewable resource.

Appendix 10. Legend, Directional Arrow and Acknowledgement Plate (3-D model)

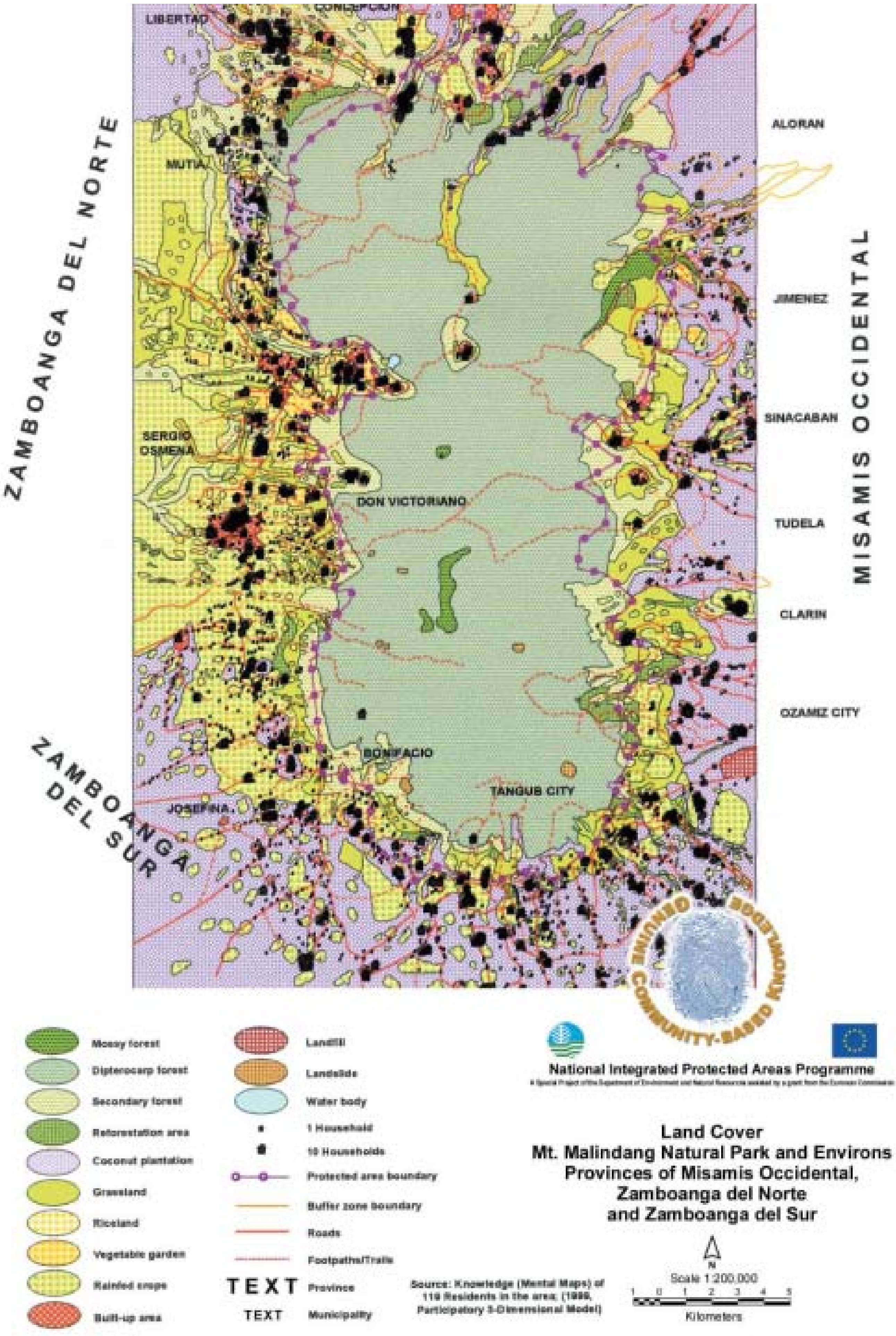
Appendix 11. Land Use and Cover. Mt. Pulag National Park and Environs. Provinces of Benguet, Ifugao and Nueva Vizcaya, Philippines (Source JAFTA-NAMRIA; LandSat TM, 1992).



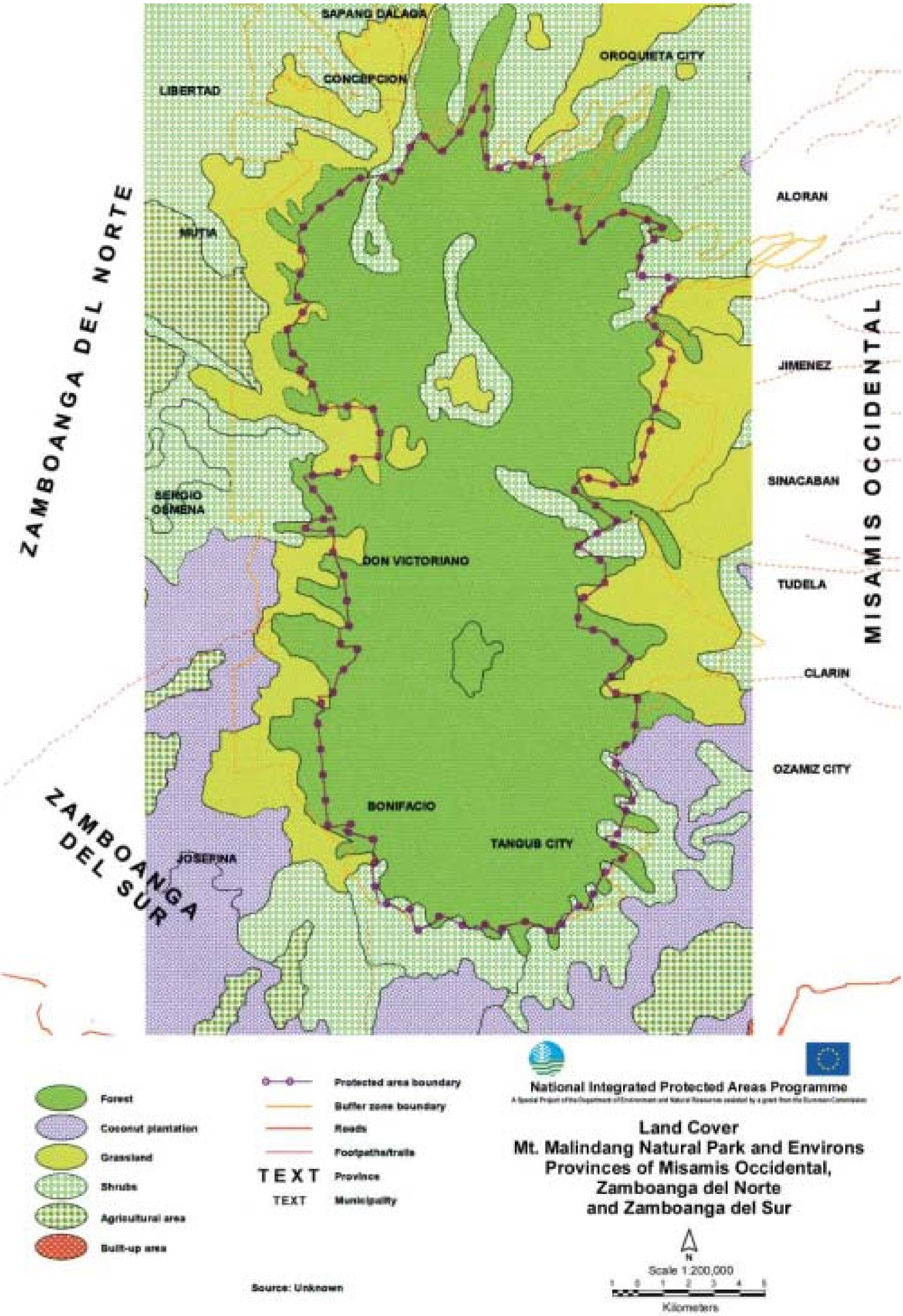
Appendix 12. Land Use and Cover. Mt. Pulag National Park and Environs. Provinces of Benguet, Ifugao and Nueva Vizcaya, Philippines (Source JAFTA-NAMRIA; LandSat, TM, 1992)



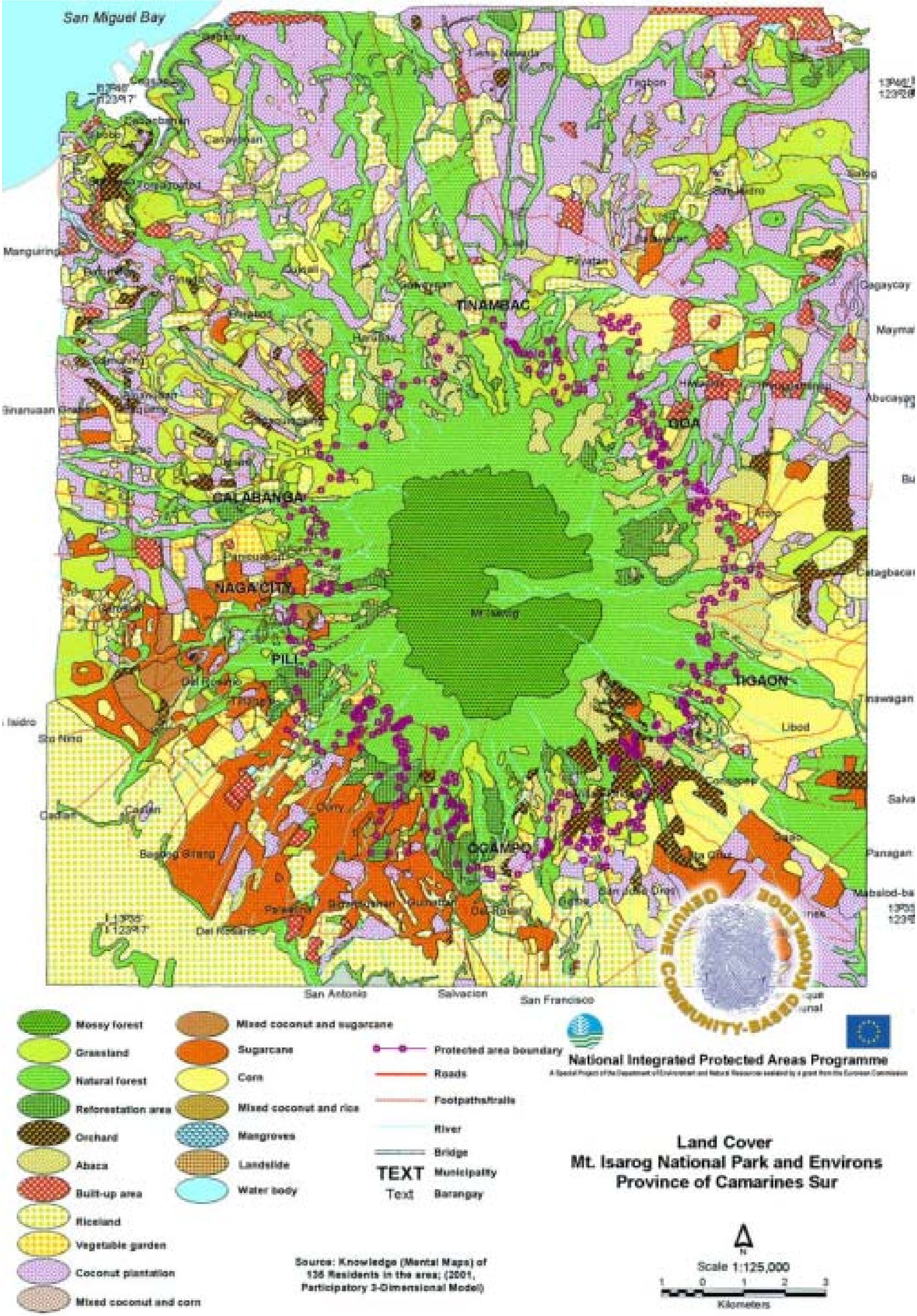
Appendix 13. Land Use and Cover. Mt. Malindang Natural Park and Environs. Provinces of Misamis Occidental, Zamboanga del Norte and Zamboanga del Sur, Philippines (Source: P3DM 1999)



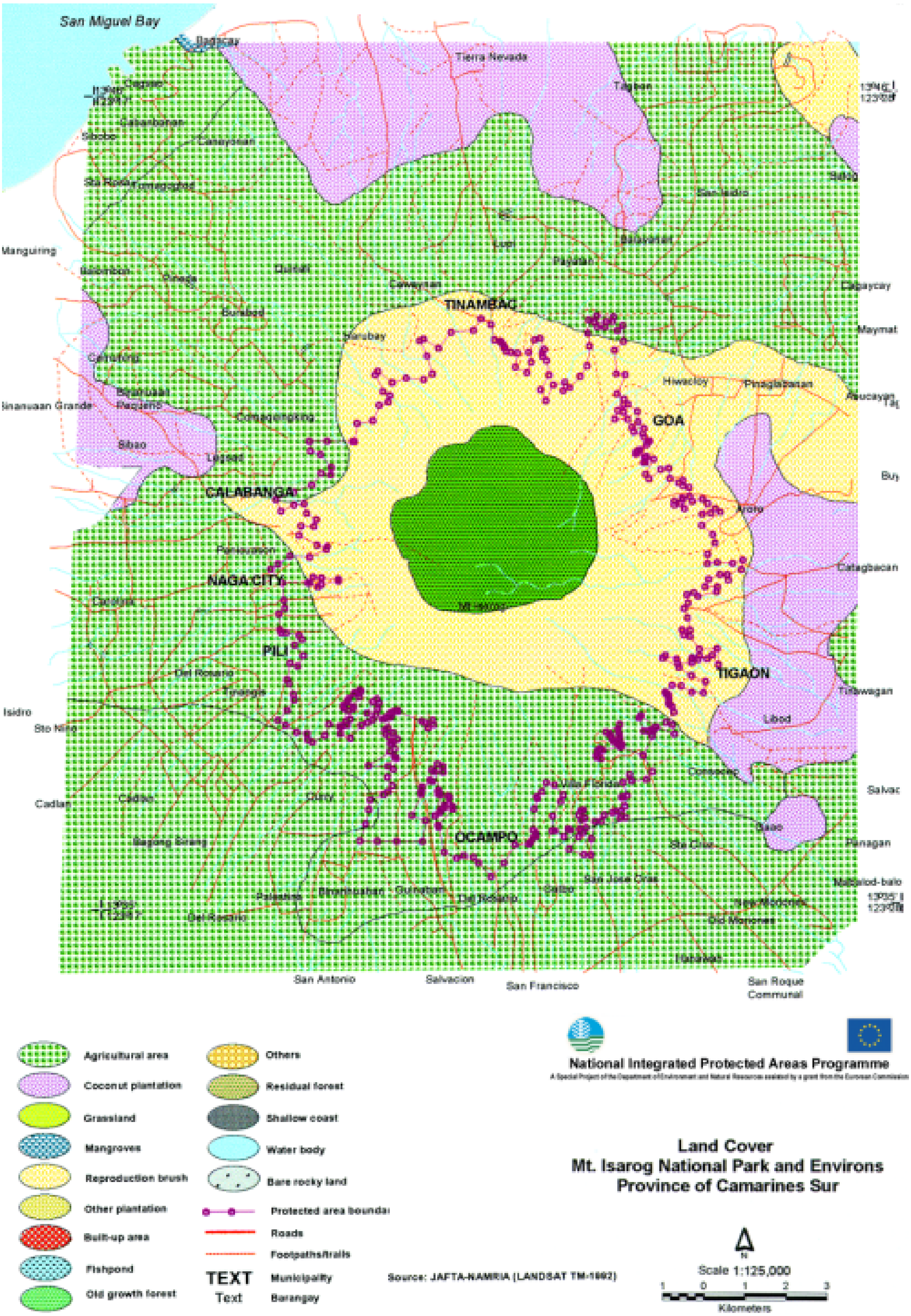
Appendix 14. Land Use and Cover. Mt. Malindang Natural Park and Environs. Provinces of Misamis Occidental, Zamboanga del Norte and Zamboanga del Sur, Philippines (Source: DENR, undated)



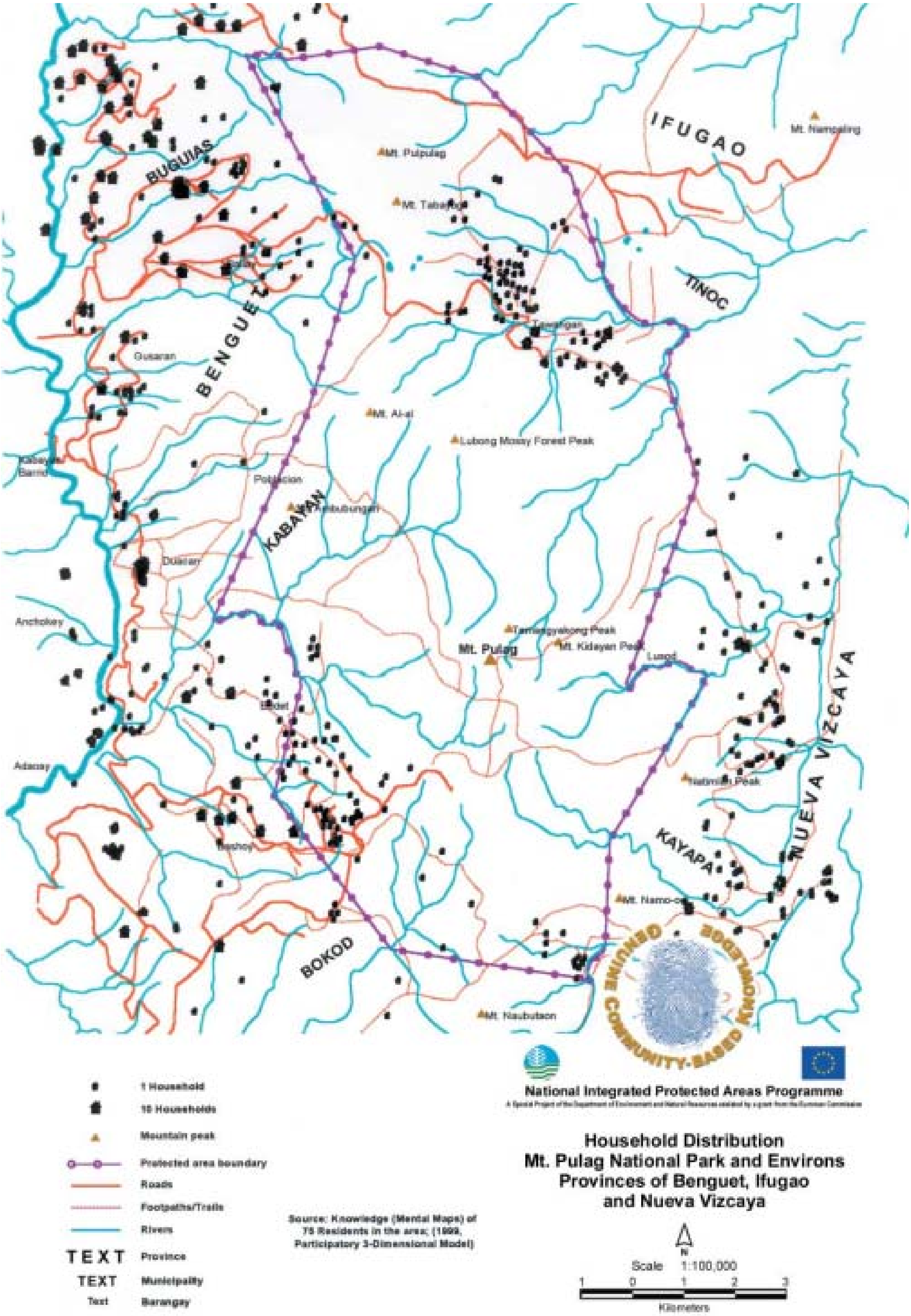
Appendix 15. Land Use and Cover. Mt. Isarog National Park and Environs. Province of Camarines Sur, Philippines (Source: P3DM, 1999)



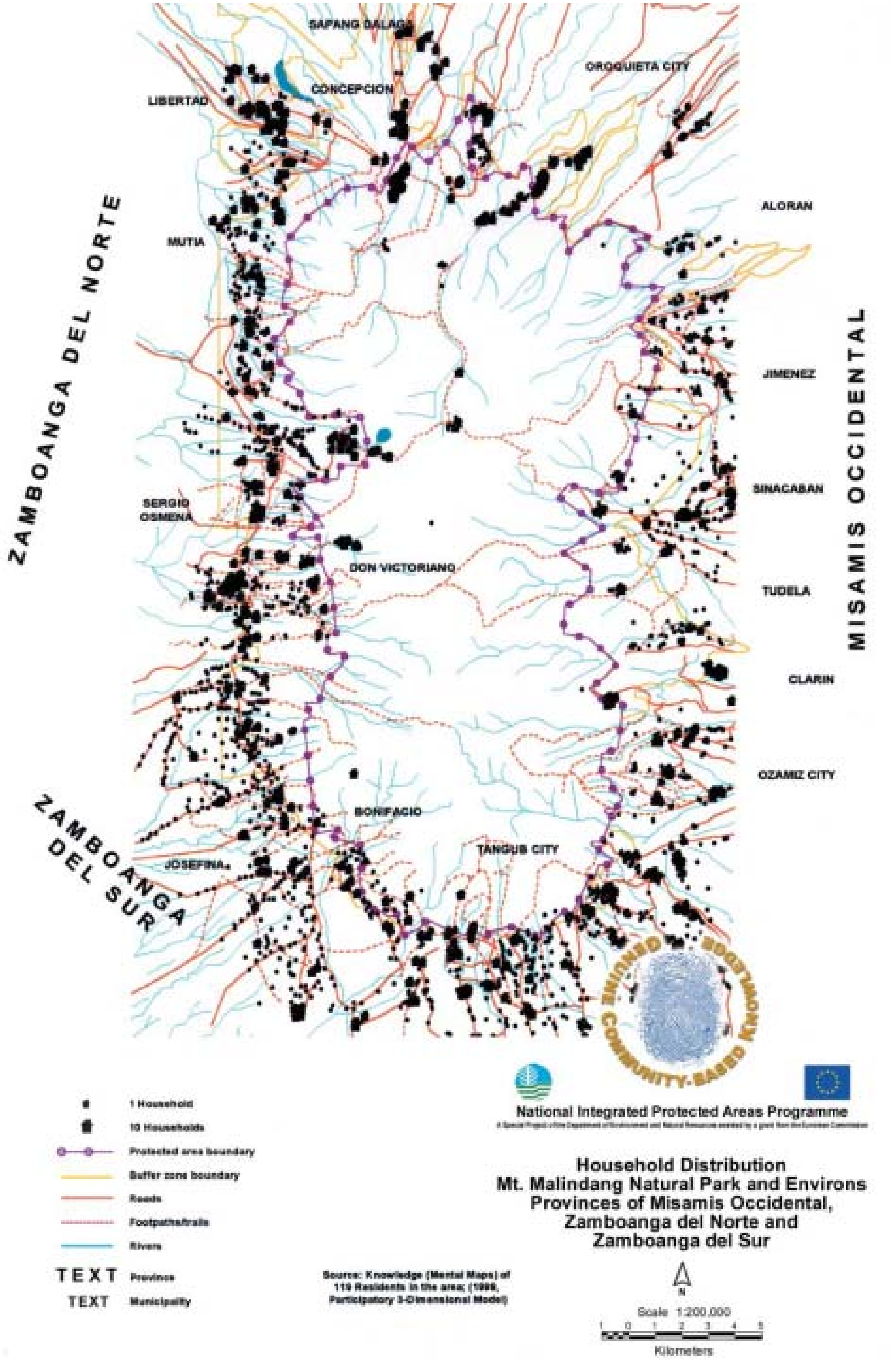
Appendix 16. Land Use and Cover. Mt. Isarog National Park and Environs. Province of Camarines Sur, Philippines (Source: Bureau of Soils and Water Management, date: unknown)



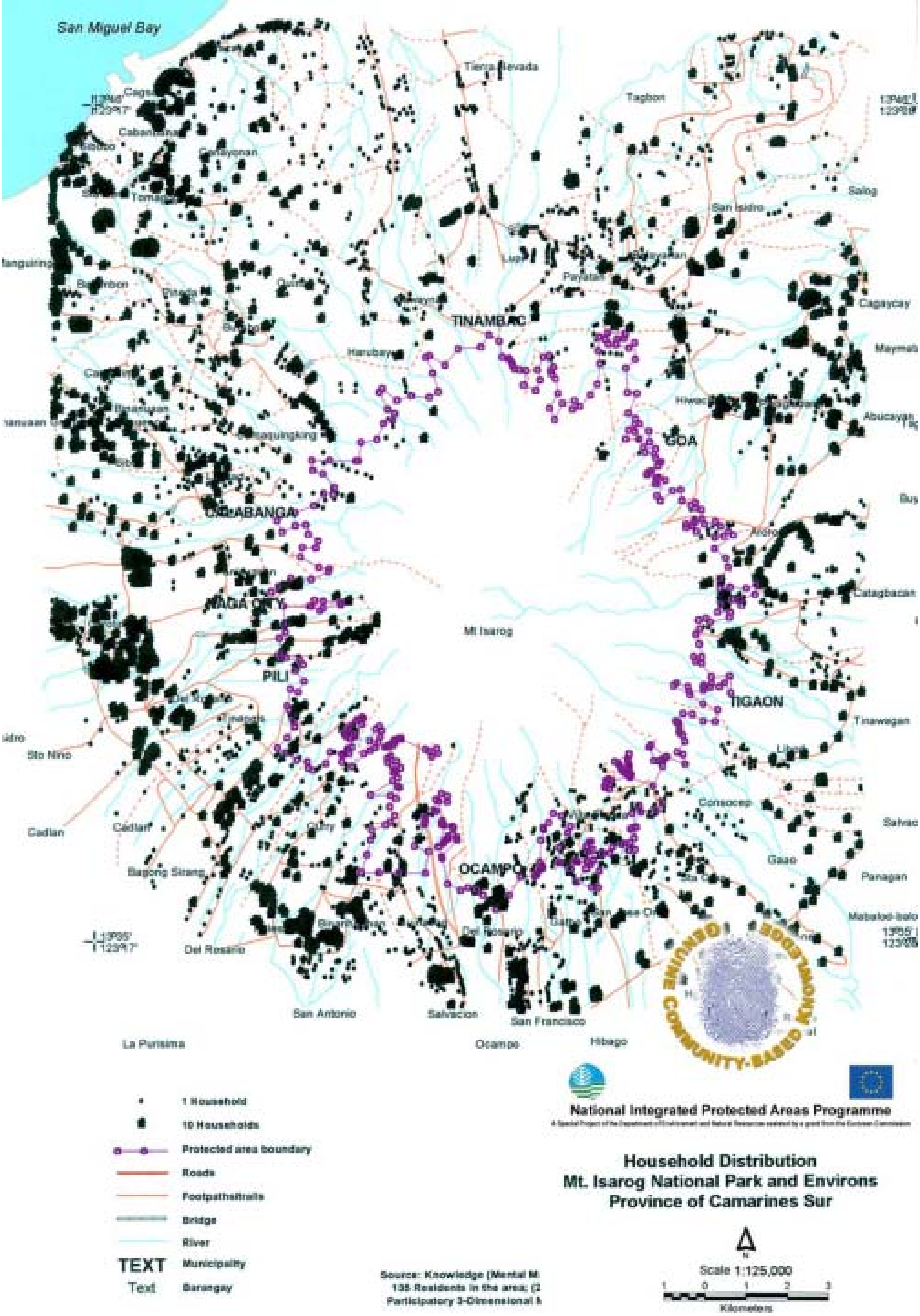
Appendix 17. Population Distribution Map. Mt. Pulag National Park and Environs. Provinces of Benguet, Ifugao and Nueva Vizcaya, Philippines (Source: P3DM, 1999).



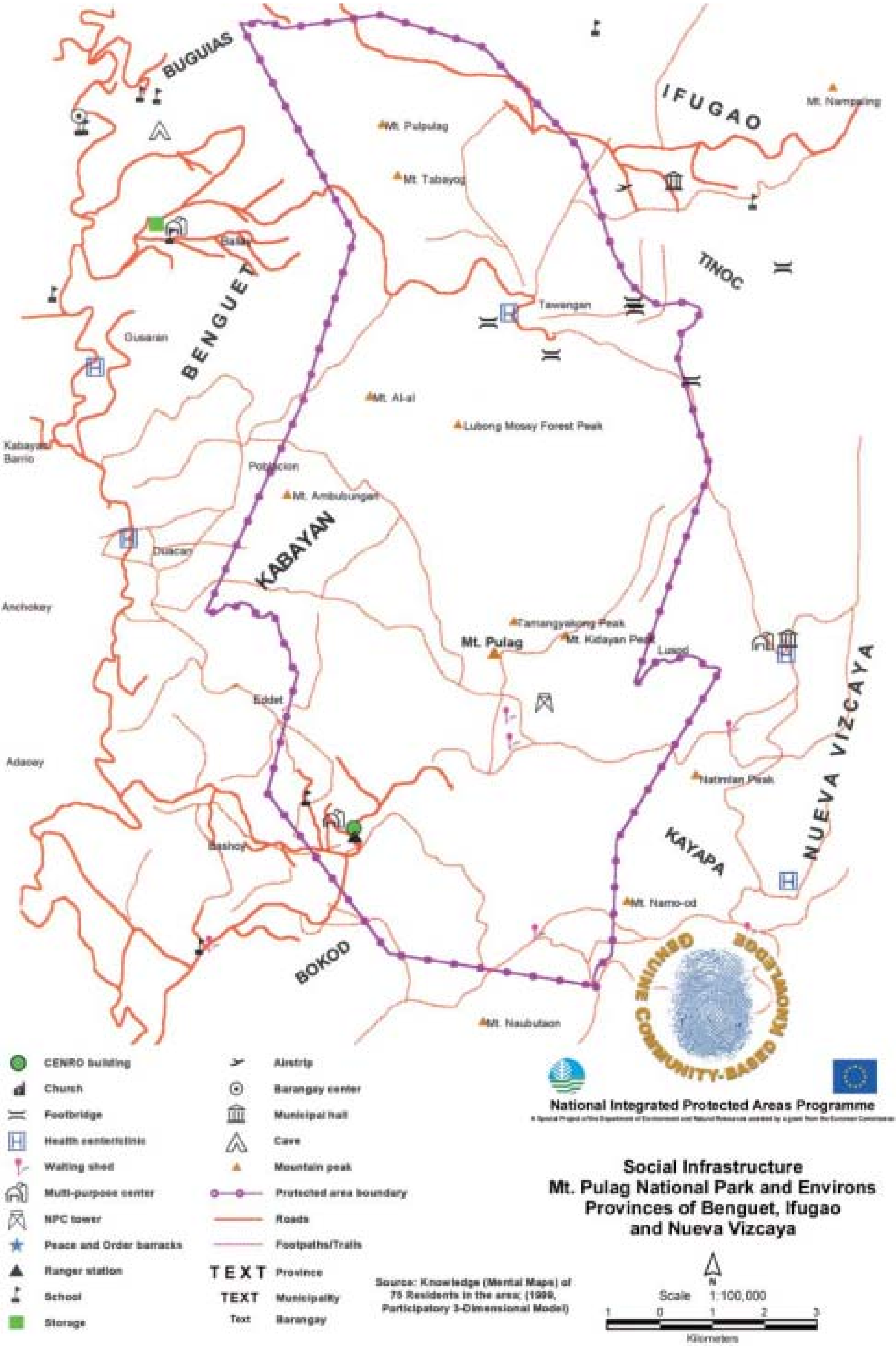
Appendix 18. Population Distribution Map. Mt. Malindang Natural Park and Environs. Provinces of Misamis Occidental, Zamboanga del Norte and Zamboanga del Sur, Philippines (Source: P3DM, 1999).



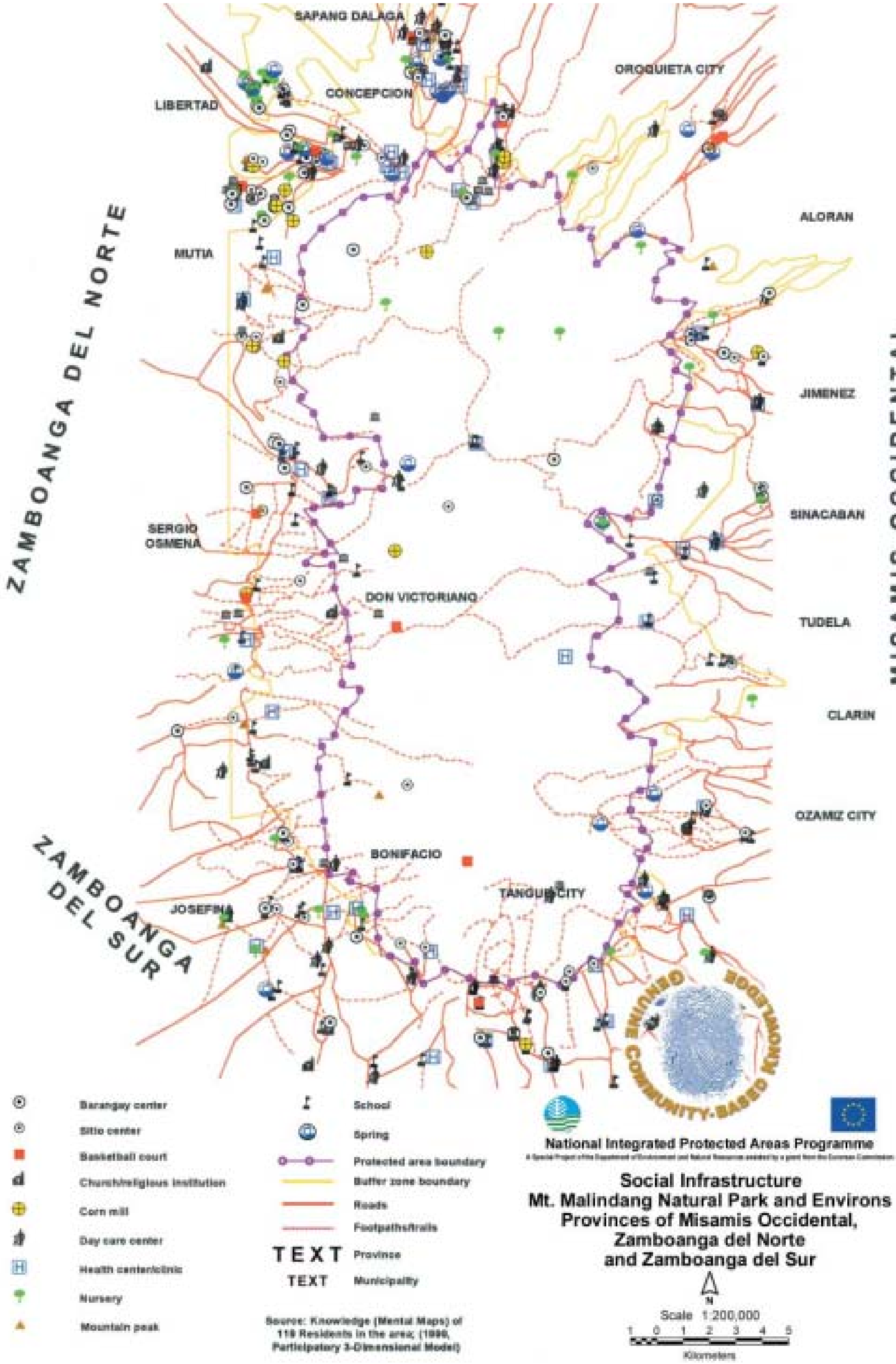
Appendix 19. Population Distribution Map. Mt. Isarog National Park and Environs. Camarines Sur, Philippines (Source: P3DM, 1999).



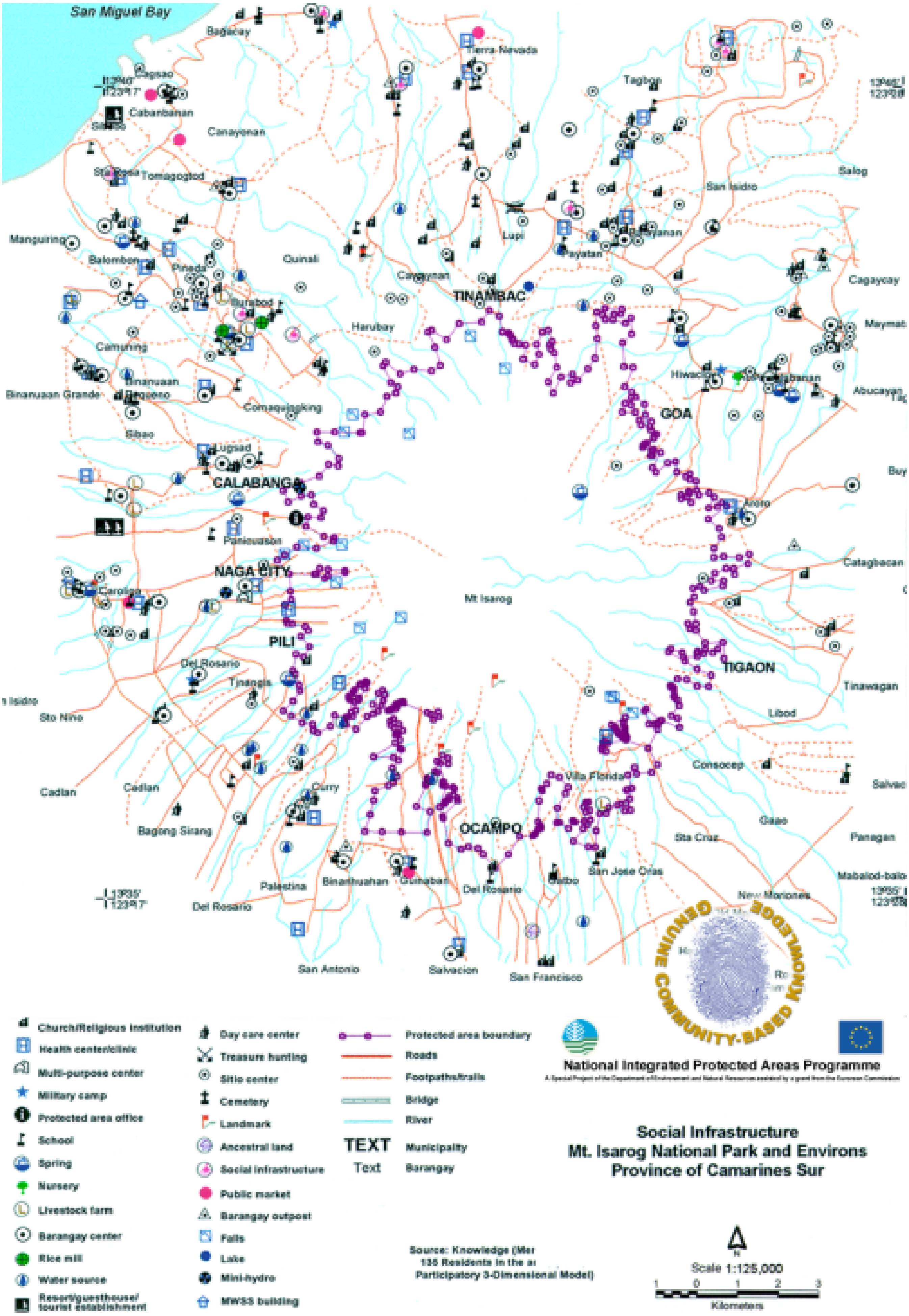
Appendix 20. Social Infrastructure Distribution Map. Mt. Pulag National Park and Environs. Provinces of Benguet, Ifugao and Nueva Vizcaya, Philippines (Source: P3DM, 1999).



Appendix 21. Social Infrastructure Distribution Map. Mt. Malindang Natural Park and Environs. Provinces of Misamis Occidental, Zamboanga del Norte and Zamboanga del Sur, Philippines (Source: P3DM, 1999).



Appendix 22. Social Infrastructure Distribution Map. Mt. Isarog National Park and Environs. Camarines Sur, Philippines (Source: P3DM, 1999).

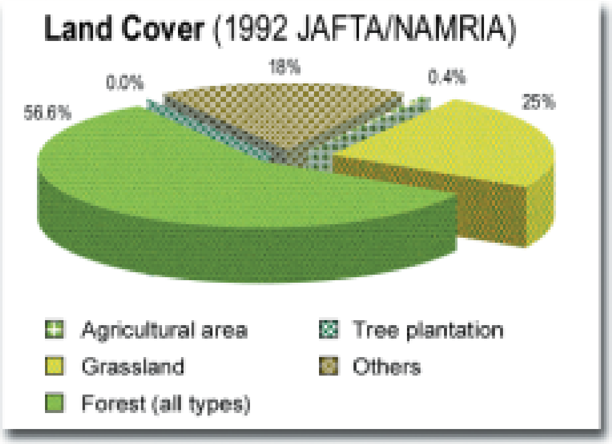


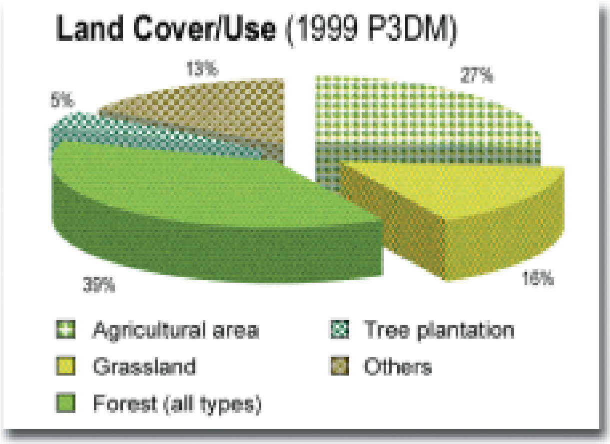
Appendix 23. Discussion of discrepancies encountered in comparing collective people's knowledge with interpreted satellite imagery and other secondary information

Appendices 10-17 show a series of maps of different origin. As part of the validation mechanism, we compared them using simple means accessible to field staff. The outcome is summarized in two case studies.

Case 1: Appendix 11, 15 and **17** reflect information extracted from the 1:10,000-scale 3-D model (Yr 1999) of Mt. Pulag National Park. The model (i.e. the map) covers a total area of 360 km^2 or 36,000 hectares. **Appendix 12** is a land cover map of the same area based on 1992 interpreted satellite imagery.

Case 2: Appendix 13, 16 and **18** represent thematic maps produced on the basis of data contained in a 1:10,000-scale model (Yr 1999) covering an area of 1,176 km^2 or 117,600 hectares, including Mt. Malindang Natural Park. **Appendix 14** shows a corresponding map, which has been regularly used by the Department of Environment and Natural Resources. The source of these data is unknown.





Case 1: Mt. Pulag National Park and Environs

The 3-D model contains 10 different categories of land cover compared to 9 of the satellite-interpreted information set.

Comparing these categories as a percentage of the total area (360 km^2) yields a remarkable number of differences. In terms of land use for agricultural purposes, the discrepancy is striking: The JAFTA/NAMRIA map portrays only 0.4% of the total area as farmland against the 27% provided by people's knowledge. This 27% is composed mainly of vegetable farms (67.4%) and rice paddies (32.4%). People's knowledge is definitely closer to reality according to ground verification. The inconsistency cannot be explained by changes in land use that occurred over a period of seven years (1992-1999), because the areas classified as "grassland" by JAFTA/NAMRIA on the western portion of the map are mainly terraces where rice and vegetables have been grown since time immemorial. The incorrect classification is probably due to lack of ground truthing.

Where forest cover is concerned, The JAFTA/NAMRIA derived map (**Appendix 12**) shows a total forest cover (mossy, pine, old growth, residual forests) of 56%, compared to a lower percentage (40% including mossy and pine forests) depicted by key-informants (**Appendix 11**). Interestingly – in an area known for its pine forests – JAFTA/NAMRIA identifies only 3.1% of the area as covered with Benguet Pine, compared to 19.2% resulting from the 3-D model.

The people's perspective has also been extremely useful in providing insights on economic trends. In fact the description of land use (**Appendix 11**) instead of land cover (**Appendix 12**) provides a scenario of increasing pressure put on the western side of the protected area, due to capital intensive irrigated farming (rice paddies and vegetable gardens). On the eastern side, slash and burn subsistence farming appears to be prevailing, representing 11.7% of the whole area (see chart no. 2 "other"). According to people's knowledge, aside from slash and burn farms, "other" land uses (17.2%) include landslides (1.1%), orchards (0.3%) and reforestation areas (4.3%).

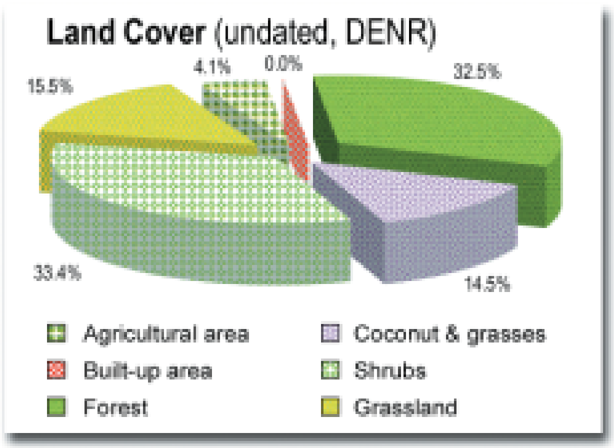
JAFTA/NAMRIA attributes 17.6% of the total area to "reproduction brush", a land cover classification comparable to *slash and burn* in terms of land use.

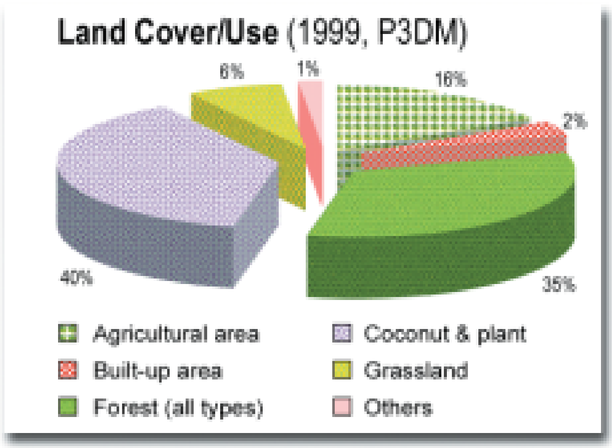
Comments to Case 1: People's knowledge appears to be more accurate and useful for collaborative planning purposes, because it portrays *land use* rather than *land cover*. JAFTA /NAMRIA interpretation of satellite imagery definitely lacks field verification. Therefore, large areas of farmland have been classified as grassland and existing pine forest more generally as "old growth forest".

Information extracted from the 3-D model includes household distribution, trails, social infrastructure (**Appendix 17** and **20**) and names of landmarks (rivers and mountain peaks), either absent or inaccurately defined on the JAFTA/NAMRIA or on other "official maps".

Pressure points (hot spots) are easily detected on **Appendix 11**, simply taking into account the protected area boundary, communication ways, land use and household distribution. The first hot spot is located in the south-western and the second in the north-eastern corners of the park.

Experience acquired in Mt. Pulag has shown that "pooled people's knowledge" supplemented by conventional spatial information is more accurate and useful for community-based analysis than information maintained in official circles.





Case 2: Mt. Malindang Natural Park and Environs

The DENR map (**Appendix 14**) contains six categories of land cover, half of those (12) contained in the map produced on the basis of the 3-D model (**Appendix 13**). Both maps reproduce a total area of 117,600 hectares. In terms of percentage distribution, there is little difference between "forest" cover: 32.5% on the DENR map and 34.8% on the P3DM map. The latter is more specific in differentiating among Dipterocarp (25.7%), mossy (0.4%) and secondary forests (8.7%).

However, there are remarkable differences in the quantification of other land use and land cover: agricultural areas cover 4.1% and 16.1% on the DENR and P3DM maps respectively. Areas described as coconut plantations amount to 14.5% (DENR map) and 39.8% (P3DM map).

According to the DENR map, shrubs cover 33.4% and grassland 15.5% of the area. These are the areas of dubious interpretation. Key informants described these as coconut plantations (shrubs on the DENR map) and rainfed crops (grassland and shrubs on the DENR map).

Appendix 13 and **18** describe the distribution of households. The first one combines different layers of information and shows an on-going settlement trend (i.e. trail and households) in the north-western portion of the protected area which could lead, in the short term, to the "ecological" separation of approximately 20% of the protected area. This hot spot is by no means detectable from the map shown in **Appendix 14**.

The map shown in **Appendix 21** shows the distribution of social infrastructures - differentiated by type - within the protected area and its buffer zones. This precious information - existing only on the P3DM map – is extremely important when analyzing socio-economic aspects of rural development and inherently management of the environment.

Comments to Case 2: As in the first case, "pooled people's knowledge" provides a comprehensive picture of both the land cover and use. The combination of these features with distribution of settlements, communication ways and social infrastructure provides excellent insights useful for grassroots planning, awareness raising and participatory monitoring purposes. Also in this case, people's knowledge appears to be more useful than what has been used as a reference within Government circles for a long period of time.

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The accompanying CD-ROM contains a **Multimedia P3DM Resource Kit**, which can support you in organising and implementing Participatory 3-D Modelling exercises.

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- Resource Book: *Participatory 3-D Modelling: Guiding Principles and Applications*, July 2002; ISBN: 971-8986-47-2. [Adobe Portable Document Format (PDF) format]
- Magazine: *GIS and the Fingertips*; ASEAN Biodiversity Vo. 2, No. 1, March 2002 ISSN: 1655-0471 9 [Adobe Portable Document Format (PDF) format]
- Manual: *Manual on Participatory 3-D Modelling for Natural Resource Management*, September 2000. ISBN: 971-8986-21-9 [Adobe Portable Document Format (PDF) format]
- Movie: "*Giving Voice to the Unspoken*": a 20-minute video production showing the hands-on aspects of 3-D modelling. [MPEG format]
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Note for viewing the movie: Once Windows Media Player® has been launched, select [View] and from the drop-down menu [Full screen].

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