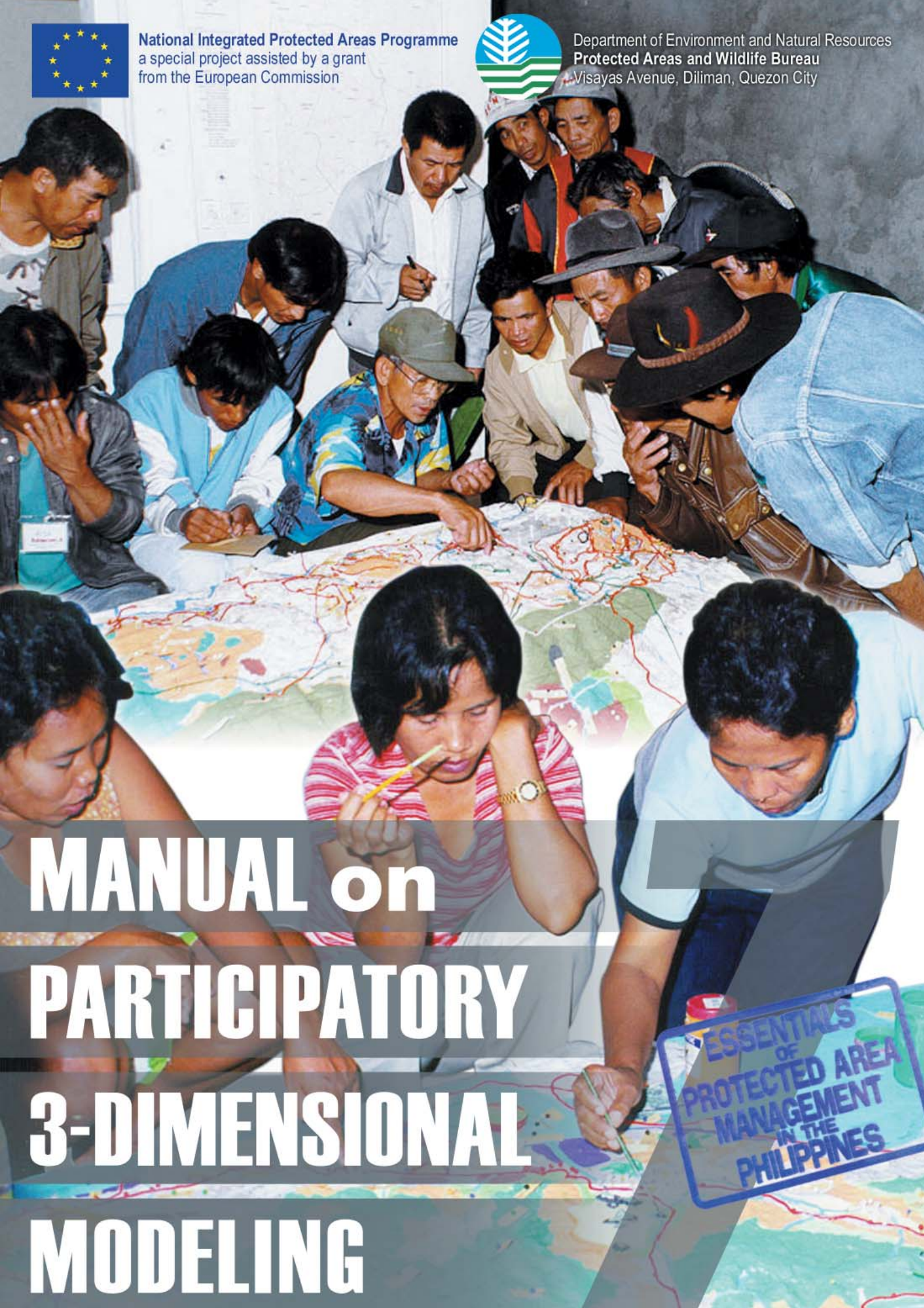




National Integrated Protected Areas Programme
a special project assisted by a grant
from the European Commission



Department of Environment and Natural Resources
Protected Areas and Wildlife Bureau
Visayas Avenue, Diliman, Quezon City



MANUAL on PARTICIPATORY 3-DIMENSIONAL MODELING



**Essentials of Protected Area Management
in the Philippines
Volume 7**

Manual on
**Participatory 3-Dimensional
Modeling**
for Natural Resource Management



Department of Environment and Natural Resources

Supported by the



European Commission

October 2000

Manual on Participatory 3-Dimensional Modeling for Natural Resource Management

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and **Jasmin Callosa-Tarr**

Published by: **National Integrated Protected Areas Programme
PROTECTED AREAS AND WILDLIFE BUREAU
Department of Environment and Natural Resources**

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Citation: RAMBALDI G., CALLOSA J. 2000. *Manual on Participatory 3-Dimensional Modeling for Natural Resource Management*. Essentials of Protected Area Management in the Philippines, Vol. 7 NIPAP, PAWB-DENR, Philippines.

ISBN: 971-8986-21-9

Editor: Struan Simpson
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Printed by: Creative Organizational Resources-Asia, Inc., Philippines

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

Technical Assistance
Service Contract: Agriconsulting S.p.A., Rome, Italy

Available from: **PROTECTED AREAS AND WILDLIFE BUREAU**
DENR Compound
Visayas Avenue, Diliman
1101 Quezon City
Philippines

FOREWORD

One of the main thrusts of my Administration is to conserve the environment through participatory resource management and environmental protection to attain sustainable development.



I believe that active participation of all stakeholders in planning and implementing actions and policies aimed at protecting habitats, conserving and sustainably utilizing natural resources are the key to success.

One of the major objectives of the National Integrated Protected Areas Programme is to encourage the full participation of concerned communities in protected area planning and sustainable natural resource management within its eight priority sites.

As such, NIPAP in collaboration with DENR-PAWB, has been exploring ways to better meet their common objectives in the framework of the NIPAS law.

One successful avenue has been the adoption of community-based mapping techniques at various stages of project implementation. Believing that Participatory Learning and Action (PLA) has its merits and that the approach should be widely adopted, I am pleased to introduce this Manual on Participatory 3-Dimensional Modeling. It is an important guidance for all those interested in "community-based mapping" and in undertaking a bottom-up approach to conducting research, protected area boundary delineation and zoning, resource use planning and participatory monitoring and evaluation.

Appreciation is hereby expressed to the Project for its contribution in testing and fine-tuning this innovative technique, embodying a huge potential for a better and more proactive conservation and sustainable management of natural resources of the Philippines.

ANTONIO H. CERILLES
Secretary
Department of Environment
and Natural Resources

In 1992 the Government of the Philippines signed the "Convention on Biological Diversity". Following its commitment under the Convention, the Philippine Congress enacted the National Integrated Protected Areas System (NIPAS) Act.



To support the Philippine Government in the implementation of the Act, the European Commission co-financed the National Integrated Protected Areas Programme (NIPAP). This project, which started in 1995 is implemented by the Protected Areas and Wildlife Bureau (PAWB) of the Department of Environment and Natural Resources (DENR).

NIPAP was set up contribute to the conservation, protection and management of natural habitats and biodiversity within the country's Integrated Protected Areas System (IPAS).

The active participation of stakeholders in planning and management is an essential element in the sustainability of Protected Areas.

The Participatory 3-Dimensional Modeling technique, which has been developed by NIPAP, facilitates the communication between local stakeholders and external agencies.

This technique is critical to institutionalize "participation" in conservation and development.

The methodology described in the manual is based on actual field experience in the Philippines, and is readily replicable elsewhere.

I would like to congratulate the National Integrated Protected Areas Programme of the Protected Areas and Wildlife Bureau for this important achievement.

YVES GAZZO
Ambassador
Head of Delegation
European Commission in the Philippines

PREFACE

The National Integrated Protected Area Programme (NIPAP) is a special project of the Philippines Department of Environment and Natural Resources (DENR), Protected Areas and Wildlife Bureau (PAWB), supported by financial and technical assistance from the European Commission.

A major portion of PAWB's responsibility is to disseminate information about the management and operations of protected areas in the Philippines, at policy, technical and field levels.

Therefore, in collaboration with the Bureau, NIPAP has produced a series of case studies, field and training manuals, other educational material and legal reference documents under the title of "Essentials of Protected Area Management in the Philippines".

The series builds not only on NIPAP's and PAWB's field experience, but reflects the work and knowledge of sister institutions in the Philippines, including the ASEAN Regional Center for Biodiversity Conservation (ARCBC), the Conservation of Priority Protected Areas Project (CPPAP), and the Technical Assistance for Improving Biodiversity Conservation in Protected Areas of the Philippines Project (TABCP).

Background

Within the terms of the Biodiversity Convention, the European Union and the Government of the Philippines, co-financed the National Integrated Protected Areas Programme (NIPAP), set up for a five-year period (1995-2000) to be an operating model for the Philippine protected area system, as legislated for in the 1992 National Integrated Protected Area System (NIPAS) Act,

NIPAP's aims were to demonstrate within eight protected areas the operation of a system strongly advocating the participation of communities in local policy making and implementing plans to conserve biodiversity.

The challenge faced by NIPAP and its successors is how to give due weight to the interests of local communities in deciding the critical issues of protected area boundary delineation, resource-use zoning and formulating policies on sustainable use of natural resources.

While the NIPAS Act provides for the establishment of Protected Area Management Boards (PAMBs), getting to the grassroots presents numerous practical difficulties. These range from logistical constraints to cultural, political and educational differences, language barriers and differing perspectives, all of which hinder a genuine sharing of information.

In 1996, NIPAP started on-field research among protected area dependent communities introducing them to participatory approaches in data collection, collation, analysis and interpretation.

Methods such as transect diagramming and participatory resource mapping were readily adopted even though there were reservations about "translating" sketch map data into more precise, "negotiable" information.

More importantly, experience has shown that while informal maps meet local needs, technical maps tend to be more fruitful in dealing with bureaucracies.

Another challenge to NIPAP, lay in providing different stakeholders, with the means of portraying the extent of their interest or domain in the area, thus availing themselves of an accessible, commonly understood medium that could convey authority and impart a sense of empowerment.

The Method

One approach that satisfies these desiderata is Participatory 3-Dimensional Modeling (P3-DM), a cartographic method of merging Geographic Information System (GIS) generated data with people's knowledge.

P3-DM produces a stand-alone, user-friendly and usefully accurate spatial research, planning and management tool in the form of a scaled relief model containing information which can be extracted and further elaborated by the GIS.

Regular updating allows stakeholders to monitor change and thus apply (Participatory) Monitoring and Evaluation activities over large areas.

The method has large potential for collaborative research, planning and management in the fields of environmental protection, community-based natural resource management, tenure, customary rights, social analysis, agricultural production, fisheries, rural development, transport and water supply.

The Manual

The manual is intended to assist Participatory Learning and Action (PLA) practitioners, non-governmental and other civil organizations, society or scientific institutions and others who would find community-based mapping a powerful tool for increasing the capacity of local stakeholders to interact with national and international, and to express their views and assert their rights.

ACKNOWLEDGEMENTS

Publications like this are based on knowledge acquired from direct field experience. They are the final product of collations of annotated drafts, observations, comments and chance remarks.

This manual is a synthesis of the inputs from local mapmakers and program facilitators during the various phases of the construction process. It reflects whatever mistakes happened to be noted but also the successes achieved in shaping a tool matched to the interests and skills of people with something to communicate in areas where the logistics of communication pose serious obstacles.

We have to say that everyone involved in this innovative map making process, from national and local government agencies, community elders, students, indigenous people, non-governmental organizations, and the private sector, all have shown immense enthusiasm and dedication to a process that they could see, touch, understand and shape.

We wish we could list all 650 individuals, whose knowledge, dedication and skills carried the process forward from concept to final “commissioning”.

There are however, certain individuals who deserve mention for the special effort they provided. First, we would like to thank our colleagues from PAWB Protected Area Community Management Division, particularly Carlo C. Custodio, Marlynn M. Mendoza, Teodora B. Sandoval, Rosita P. Pariña, Cristeta A. Castro, Marites Viste Agayatin, Leland Taoingan and Gerardo Lita for their constant support both in the field and at headquarters. Second, we would like to thank Fernando Ramirez, senior agriculturist, who acted as lead facilitator during all exercises; Royce Eustaquio and Bunny Soriano, GIS operators, who prepared base maps, assisted in the construction of models and led the process of data extraction and digitization; the Protected Area Superintendents (PASus) of Mt. Malindang and Malampaya Sound, PASus Rolando Dingal and Pete Velasco, for their superb logistic arrangements and back-up during the exercises and for having promoted adoption of the method to local government administrators. Special mention goes to all the Mayors who supported these initiatives and to the indigenous peoples of Mt. Pulag, Mt. Guiting-guiting, Mt. Isarog and Mt. Malindang who shared their valuable knowledge of remote and still pristine areas; to the fishers of El Nido, Malampaya Sound and Sibuyan Island, who revealed the hidden features of the seabed; to the farmers who shaped and classified the details of agricultural lands; to the rural health workers, women in particular, who best unveiled details on health, education and demography.

We further acknowledge the support of Struan Simpson, patient editor.

We must make special mention of PAWB Director Reynaldo C. Bayabos and Assistant Director Mundita Lim, who successfully brought about the institutionalization of 3-D modeling into the DENR system.

Last but not least we would thank the Program Co-Directors, Dr. Antonio C. Manila and Nick Ashton Jones, for providing us with the means and moral support to direct this challenging and innovative task.

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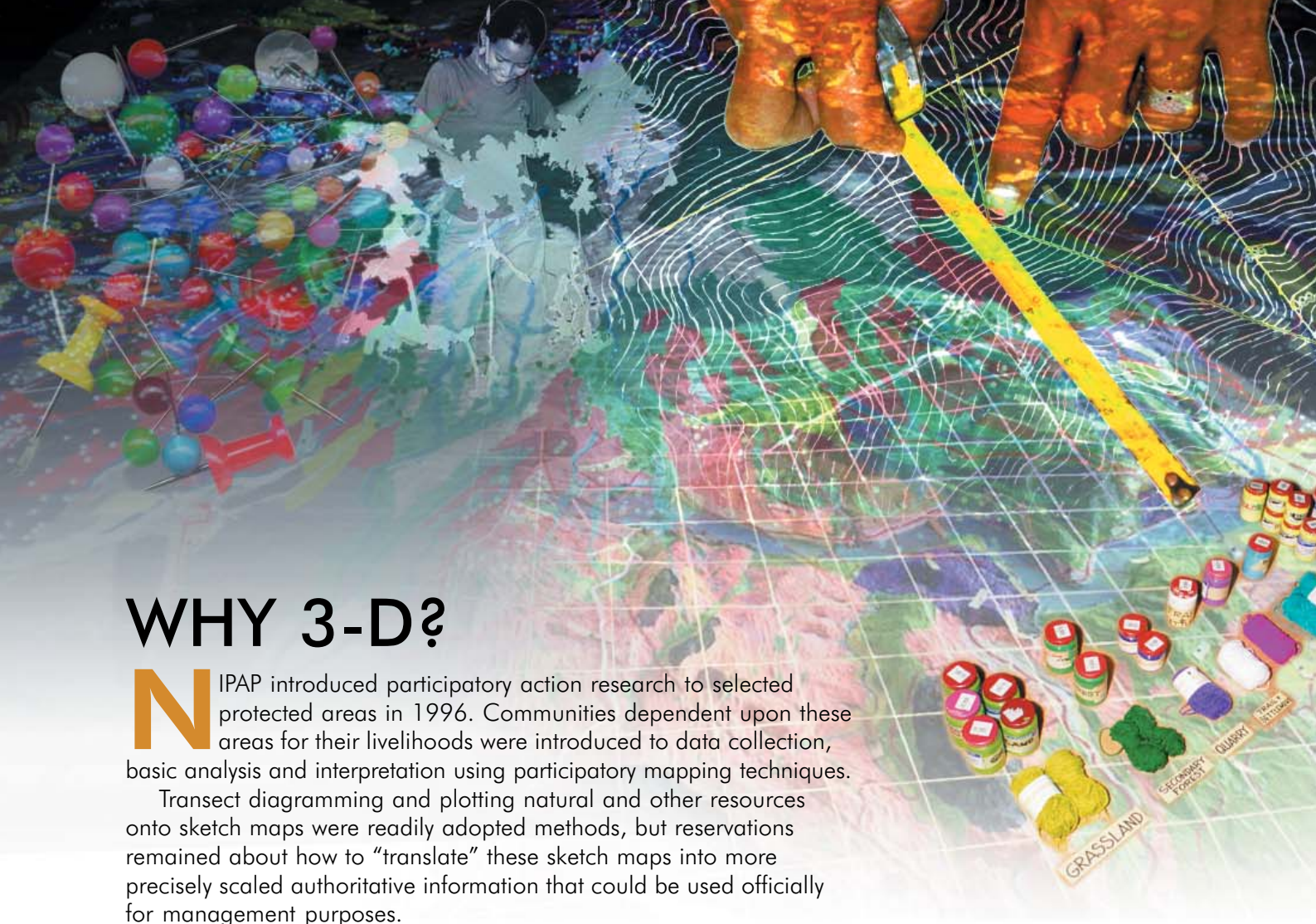
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ABBREVIATIONS

3-D	Three-dimensional
CADC	Certificate of Ancestral Domain Claim
DENR	Department of Environment and Natural Resources
ENTMRPA	El Nido-Taytay Managed Resource Protected Area
GIS	Geographic Information System
JAFTA	Japan Forest Technical Association
LGU	Local Government Unit
MGGNP	Mount Guiting-Guiting Natural Park
MIBNP	Mounts Iglit and Baco National Park
MINP	Mount Isarog Natural Park
MMNP	Mount Malindang Natural Park
MPNP	Mount Pulag National Park
MSPLS	Malampaya Sound Protected Landscape and Seascape
NAMRIA	National Mapping and Resource Information Authority
NGO	Non-governmental Organization
NIPAP	National Integrated Protected Areas Programme
NIPAS	National Integrated Protected Areas System
P3-DM	Participatory 3-Dimensional Modeling
PA	Protected Area
PAMB	Protected Area Management Board
PAWB	Protected Areas and Wildlife Bureau
PASu	Protected Area Superintendent
PLA	Participatory Learning and Action



WHY 3-D?

NIPAP introduced participatory action research to selected protected areas in 1996. Communities dependent upon these areas for their livelihoods were introduced to data collection, basic analysis and interpretation using participatory mapping techniques.

Transect diagramming and plotting natural and other resources onto sketch maps were readily adopted methods, but reservations remained about how to “translate” these sketch maps into more precisely scaled authoritative information that could be used officially for management purposes.

Experience has shown that bureaucracies tend to pay little attention to informal documents, including sketch maps.

By 1997, NIPAP, guided by this principle and with the objective of generating durable, accurately scaled and “meaningful-to-all” information, developed a method, called Two-Stage Resource Mapping (Rambaldi G. et al. 1998). This approach was adopted initially in the planning of the El Nido Marine Protected Area in Palawan (Figure 1).



Fig. 1
Fisherman
presenting
the results of
two-stage
resource
mapping



Fig. 2 Information is transferred from the sketch to the topo map

Basically, the system worked as follows:

- Local communities together with representatives from the local barangays (local administrative units), produced sketch maps portraying their economic domains and transferred the information to blown-up topographical maps as shown in **Figure 2**.
- Following validation by all parties involved, information from the topographical map was transposed with minimal distortion to a GIS-generated map and returned to the communities for re-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 kilometers and a number of different administrations (65 in Mt. Malindang Natural Park), the production of a sufficient number of community-specific sketch maps became unrealistic from both practical and financial points of view.

Furthermore, the Program had to acknowledge that a consistent part of the comprehensive analysis was carried out away from the field. Communities had to wait 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 we 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 Two-Stage Resource Mapping process by using scaled relief models, as outlined in **Figure 6** on page 4.

MAKING INFORMATION TANGIBLE

Participatory 3-Dimensional Modeling (P3-DM) integrates participatory resource mapping, and spatial information (contour lines) to produce a stand-alone scaled relief model (**Figure 3**), which has proved to be a user-friendly and relatively accurate research, planning and management tool.



Fig. 3 The model: a focus for discussion

Relief models are excellent visual aids capturing the ruggedness and details of the territory. Users can see and feel the contours of every mountain range and river valley (Figure 4). Two-dimensional maps cannot match their impact and appeal.

A relief model enormously facilitates the interpretation, assimilation and understanding of cartographic information. Pressure points and “hot-spots” are highlighted (forest cover, household concentrations, industry, access ways, etc.) making them visible and tangible to everyone (Figure 5).



Fig. 4 Information is made tangible



Fig. 5 There we are!

Here are some noted advantages of P3-DM:

- Both process and output fuel self-esteem, raise local awareness of interlocked ecosystems and delineate intellectual ownership of the territory.
- Relief models provide stakeholders and local authorities with a powerful medium for easing communication and language barriers and create common grounds for discussion.
- The method is especially effective in portraying relatively extensive and remote areas, overcoming logistical and practical constraints to public participation in land/resource use planning and management.
- 3-D modeling is an efficient community-organizing tool because it gathers people to share information and concerns. Old people share history with young people, passing on legends and religious beliefs, sacred rites and places so essential to conserving tradition.
- In Participatory Monitoring and Evaluation (PM&E) sketch maps, transect diagrams or other conventional spatial tools, produced at different times are compared. There is an inherent weakness in the fact that the outputs are not properly geo-referenced and consistently coded. P3-DM overcomes this weakness, because the relief model is a constant with its legend and coding embedded.
- Most protected areas in the Philippines do not have demarcated boundaries. Relief modeling can give communities and local authorities a clear first time factual understanding of their perimeter. This facilitates a bottom-up approach to boundary delineation and zoning, both of which activities tend to otherwise be characterized by bureaucratic logistics and lengthy negotiations.
- Thanks to the use of differentiated coding systems and materials, 3-D models, similarly GIS, accommodate overlapping information layers, thus facilitating community-based analysis and decision-making.

P3-DM is designed 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 in a similar context, they must fulfill 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 followup the P3-DM process.

THE PROCESS

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

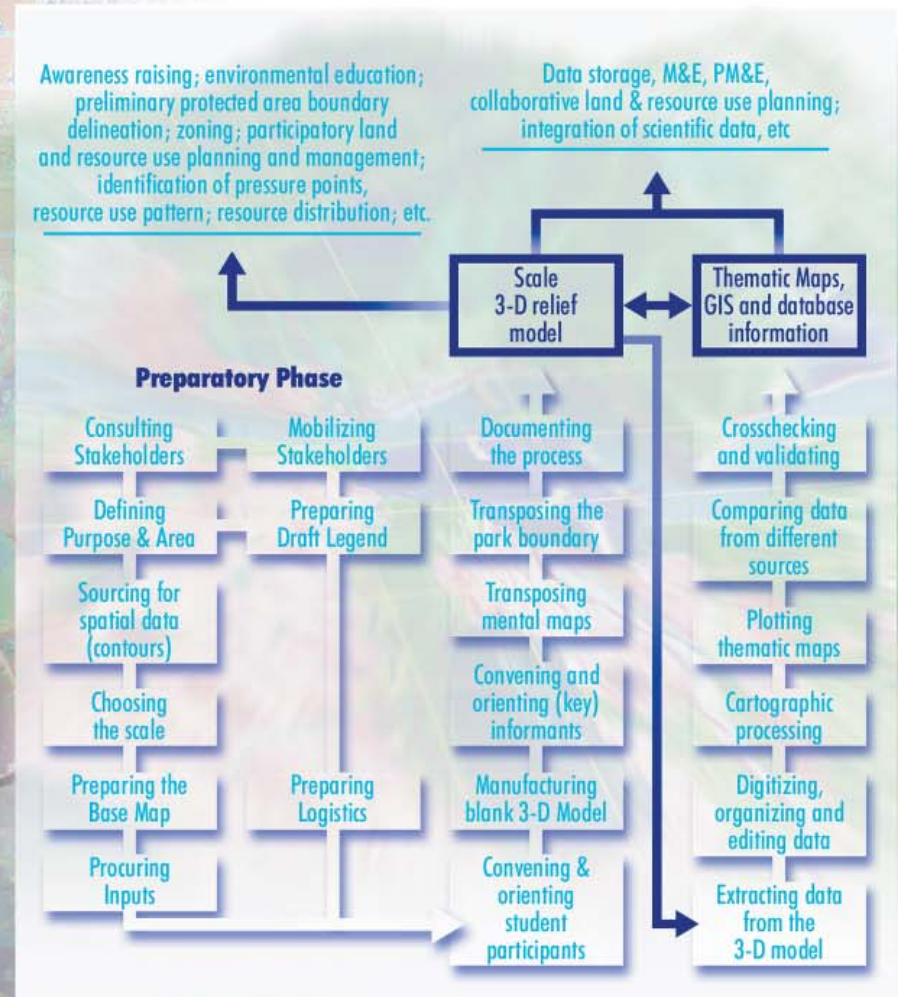


Fig. 6 The 3-D Modeling process and its GIS generated outputs

There are seven basic phases in producing a 3-D model, as follows:

1. **Preparatory work**
2. **Assembling the blank model**
3. **Transposing information**
4. **Model handing over**
5. **Extracting information**
6. **Digitizing and manipulating data**
7. **Field verification**

Each Phase is described in the following sections.

P3-DM's main function is to generate spatially defined, geo-referenced and scaled information which is not the case in other informal mapping techniques. Its adoption needs thorough preparation in the procurement of supplies, discipline in adhering to color-coding and precision in the construction, transposition, extraction and digitization phases.



Selecting the Area

The area to be reproduced has to be precisely defined from existing topographic or administrative maps. This allows for the preliminary identification of the constituency to be made.

Defining the Constituency

As previously stated, the facilitator has to have a thorough understanding of the social dynamics of the area. A stakeholders' analysis or even better, a stakeholders' map would be of great advantage in identifying those having vested interests in the area.

In Philippine protected areas these interests would already be represented on the Protected Area Management Board (PAMB).

Groundwork at Community Level

The next step in the Preparatory Phase is to introduce the concept of participatory modeling to community representatives, indigenous peoples' groups, local government and non-governmental organizations, reaching agreement and consensus on the use to which the process is to be put.

Organizing the Logistics

Logistical organization includes finding a spacious venue where the community will be able to manufacture the model. It may be necessary also to organize transport, accommodation and catering.

Drawing up the Participant List

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

The first group 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.

The second group¹ is made up of "custodians of local knowledge", comprising indigenous groups, various economic sectors (farmers, fishers, etc.), governmental and non-governmental organizations, and the private sector. They will create the landscape of the model by merging their mental maps into collective knowledge.

Cluster the informants into focus groups on the basis of residence, economic endeavor, cultural affinity, advocacy and other criteria. Always ensure that women² and elders³ are adequately represented.

In order to maximize objectivity of the sessions and validity of the output, schedule overlapping sessions and focus groups.

Gathering Secondary Information

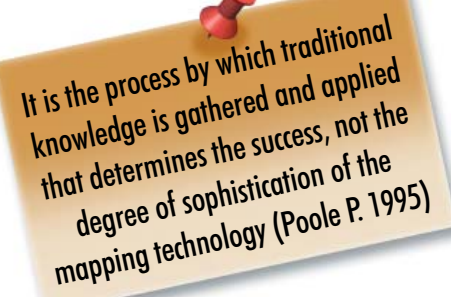
Cheap and easy access to digital contour lines is a prerequisite for cost-effective Participatory 3-D Modeling.

In the absence of data in this format, contour lines can be digitized from existing maps, but the costs are relatively high.

Without topographic maps or digital contour intervals it is impossible to produce *scaled* relief models, without substantial financial investments.

Additional information needing to be gathered includes demographic, land use, vegetation cover, resource tenure, ancestral domains, and whatever else might be of relevance to the facilitators for understanding the physical, social and economic characteristics of the area.

PHASE ONE: PREPARATORY WORK



It is the process by which traditional knowledge is gathered and applied that determines the success, not the degree of sophistication of the mapping technology (Poole P. 1995)

¹ Advocacy groups may wish to limit local participation to minorities asserting rights to resources, or struggling for the preservation of cultural identity, all of which can be linked on the model to territory and domain.

² Women's participation may vary, depending on the cultural background of the participating communities. In our experience we considered as satisfactory 30% participation.

³ Old people share history with young people, passing on legends and religious beliefs, sacred rites and places so essential to conserving tradition. (Alcorn J.B., 2000)

The Base Map⁴

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 map⁴ or model (land area, distances, rivers, lakes, roads, and so on) must be shown proportionately to its actual size. The proportion chosen for a particular map is its scale (Figure 7).

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

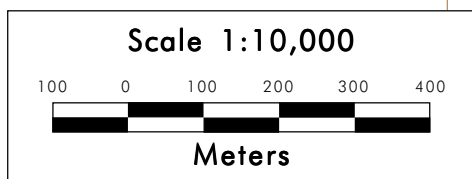


Fig. 7 1:10,000 scale reference

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 models aim at providing a visual aid capturing the details of the territory, the larger⁵ the scale the better.

Conversions

0.001 km	=	1 m	=	100 cm
0.1 km	=	100 m	=	10,000 cm
1 km	=	1,000 m	=	100,000 cm
1 km ²	=	100 ha	=	1,000,000 m ²
1 ha	=	10,000 m ²		

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 physically to construct and store the model.

The ideal scale for 3-D modeling is 1:10,000 or larger⁵. 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 3-D modeling. At 1:10,000, one centimeter on the model corresponds to 100 meters on the ground - a pretty comfortable scale for people to pin-point salient features.

Table 1 Choice of scale: some examples

Scale of the reference map	Size (cm) of the selected area on the reference map to be reproduced as a P3-D Model	Selected scale for the P 3-D Model	Size of P 3-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

⁴References on “map reading” are provided in Appendix 1.

⁵Note that 1:10,000 is a larger scale than 1:50,000.

Table 1 demonstrates the simple arithmetic of re-scaling smaller scale maps (1:50,000, for example), to more detailed 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 influence 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 including the core area (e.g. protected area, watershed, ancestral domain, or other) and its environs of ecological, cultural and economic significance.

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 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 do assess *causes* and *effects*.

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 manageably sized.

At a 1:10,000 scale, households and other point-form features can be individually located. A 1:20,000-scale model accommodates less information, but settlement details can still be represented.

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 organization or other.

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) needed to be mobilized.

The Vertical Scale

For relief models scaling has to be applied both horizontally and vertically. Measured vertically, 1 cm on a 1:10,000 scale map corresponds to 100 m elevation. 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 horizontally scaled 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 should 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 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!*

Obviously the intervals of the contours that are shown on the maps depend also on the process used to generate them. The closer the intervals, the process used to generate them has to be more accurate.

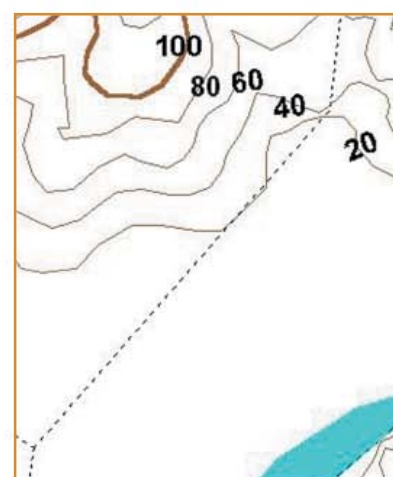
Make sure that the inter-locked ecosystems are visible on the model (e.g. upland and lowland tropical forest, mangroves and coral reefs, etc.)



1:50,000 scale



1:25,000 scale



1:10,000 scale

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.

Considering the scope of this manual, the discussion will be limited to how to define the interval of the contours for the purpose of manufacturing a scaled relief model.

What contour intervals should we use?

Assuming a 1:10,000 scale (horizontal and vertical), it needs to be decided what contour interval to use.

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

We will assume that the target is the production of the relief of an island, the lowest elevation of which is the seabed, at -40 m, the highest the mountain peak at 2,400 m above sea-level.

Reproducing a gradient of 2,440 meters by the use of 20-m contours implies the preparation of 122 layers. $[(2,440/20)=122]$. This would be a demanding task. A workgroup of 12 people can trace, cut and paste approximately 15 layers per day. It would therefore take 7-8 days to complete.

Using 40-meter contour lines, 61 layers $[(2,440/40)=61]$ can be prepared and assembled in 3-4 days.

Table 2 illustrates the relationship between scale and contour interval.

Table 2 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

Often, the choice of vertical scale to apply is dictated by the availability of the materials employed in the construction of the model. In the Philippines for instance, corrugated carton rolls are available only in 3 mm and 4 mm thicknesses.

Preparing the Base Map

GIS technology is becoming more and more widespread for storing and manipulating georeferenced information. It is an essential tool in both the construction of P3-DM and in optimizing data interpretation.

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

Basic data needed by the GIS office includes:

- Desired scale.
- Contour interval.
- Desired grid.
- 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 four different colors (Figure 8) to facilitate the work of the tracers as discussed on page 11.

Fig. 8 Example of contours drawn in different colors

Materials' Procurement

The procurement of inputs in 3-D modeling is one of the most critical tasks you will face during the preparatory phase.

A supply inventory of materials needed in the construction of the model is presented in Appendix 2.

Various items should be available in sufficient quantity and able to accommodate as many variables as people may want to impose onto the model.

Different colored map pins of various shapes, a rich choice of acrylic colors and matching yarns are vital to the exercise (Figure 9 and Figure 20).

In procuring the inputs relate the number and shape of pins and other items to the number of features that need to be plotted. For example, you should be aware of the approximate number of households found in the area. This will guide you in determining the number of e.g. white bullet-headed pins. In the same area you may expect to find a certain number of schools and day care centers. Make sure that you have enough color-coded pins to identify these two items independently.

It follows that procurement is done after making a first assessment of the features you may encounter in the area.

Draft a preliminary legend which can be expanded during the conduct of the exercise. This will guide the compilation of the procurement inventory.



Fig. 9 P3-DM coding items

Table 3 "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 halls, barangay centers, day-care centers, schools, rural health centers, hospitals, bus stops); cultural places (churches, burial caves, cemeteries, sacred areas, etc); tourist establishments; human settlements (households I); scenic spots, turtle nesting sites; diving spots; docking sites, and other.	Map and push pins of diverse color, shape and size.
Lines	Water bodies (rivers, lakes); communication ways (roads, bridges, trails); social infrastructures (rural water supplies), boundaries (administrative units, protected area, Ancestral Domains, land status, etc); coordinates (grid)	Yarns of different colors.
Polygons	Water bodies (rivers, creeks, lakes, springs and waterfalls); cultural places (cemeteries, sacred areas, etc); tourist establishments; land use (rice fields, swidden, vegetable gardens, sugarcane and coconut plantations, orchards, reforestation sites, residential areas, etc.); land covers (mossy, dipterocarp and pine forest, grassland, brushland, mangrove, etc.); land slides and bare land; fish breeding and spawning areas; feeding grounds of endangered species; fishing grounds (differentiated as squid and pelagic fisheries); areas where destructive methods are employed, coral reefs (differentiated into "intact" and "damaged");	Acrylic paint - different colors.
Attributes	Names, annotations	Text on labels.

PHASE TWO: ASSEMBLING THE MODEL

The Base Table

A purposely-constructed wooden base should be made available (Figure 10). The table(s), 60-70 cm high, has to match exactly the base map, be strong to support the weight of the model and reinforced 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 tables rather than one, joining them on completion of the exercise.

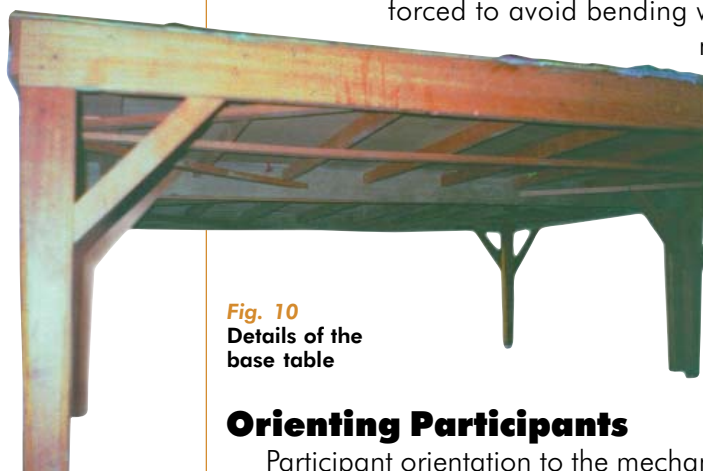


Fig. 10
Details of the
base table

Orienting Participants

Participant orientation to the mechanics of construction (Figure 11) should be accompanied by some rudiments on map reading (Appendix 1) related to the materials being used: “We are going to use a four millimeter thick carton for each layer, because - at a 1:10,000 scale - 4 mm represent a 40 meter contour interval, or 40 meters difference in altitude”.

Fig. 11
Prepare visual
aids to
support your
presentation



Organizing Work

Organize four distinct workgroups, as disclosed in Table 4, each of which is allocated and coached on a specific task by one facilitator.

Table 4 Workgroups & facilitators

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

For example, a team of fifteen students guided by three facilitators, constructing a 1:10,000-scale model measuring five square meters (500 km² on the ground) can complete the “blank” model in three to four days.

Tracing, Cutting and Pasting

The first group, “the Assemblers”, prepares carton sheets, exactly corresponding to the size of the wooden table and to the base map.

A second group, “the Tracers”, makes a sheet of carbon paper of exactly the same dimensions (Figure 12).

Using the source map and the carbon paper, “the Tracers” outline each contour (Figure 13) onto a separate corrugated carton sheet, selecting one corner of the map as a reference⁶. To clearly identify each layer, a directional arrow indicating North is drawn on each carton layer together with an annotation on the elevation.

“The Carvers” cut out each single contour (Figure 14), passing it on to the fourth group.

“The Gluers” paste each layer on the top of the previous one maintaining appropriate geo-references.

From the outset, each and every layer is geo-referenced. Prominent landmarks (mountain peaks) or other topographical features are identified on the base map and marked on the base table. Nails are hammered into the plywood to correspond to their location.

Once the contour lines have been traced onto the appropriate carton layer, all reference marks are transposed from the base map. In essence the carton layer is perforated to correspond to the landmarks.



Fig.12 The carbon paper is assembled



Fig.13 Each contour line is traced on a separate carton board



Fig. 14 Contour layers are cut



⁶ You have to refer to the reference corner whenever you overlap or relate layers of information.

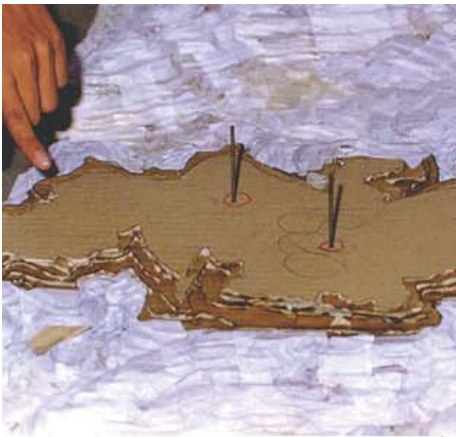


Fig. 15 Geo-referenced nails are used to properly locate the layers



Fig. 16
The single layer is pasted



Fig. 17 Layers are consolidated

Thereafter, each perforation becomes matched to the corresponding nail (Figure 15 and Figure 16), thus making sure that each layer is correctly placed on the top of its predecessor.

The various layers are then consolidated by the use of crêpe paper and water-based glue (Figure 17). Crêpe paper cut into small squares measuring 5 cm x 5 cm works best, resulting in a strong and resistant papier-mâché.

The “Blank” Relief Model

The outcome of the first phase is a scale relief model following the bare contours of the landscape (Figure 18).



Fig. 18
The “blank”

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 is a reflection of the “mental maps” of the community informants.

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 your venue is not overcrowded.

A model measuring 2.4 m x 1.6 m can accommodate approximately 20-25 participants at a time. If 100 key informants have been invited, they should be convened into groups as discussed on page 5. The exercise should last for 5-6 days. Informants' sessions should overlap to encourage "cross fertilization" in order to maximize the veracity of plotted data.

Orienting Key Informants

In front of the blank model, refresh informants on the objectives of the exercise, explain the process of plotting "mental maps" and remind them of the importance of making reference to the legend in choosing colors and symbols.

Use this re-briefing opportunity to refine the legend (Figure 19) to include additional features relevant to the participants and also to ensure that all understands the legend and definitions.

It is imperative that the informants and all other participants clearly understand the legend.

"Primary forest" is a precise ecological term that may have a different meaning for a scientist, a farmer, or mean nothing at all. Common ground and common understanding need to be established. Use of vernacular definitely helps.

Informants and others can now finalize the legend, matching the range of features to be plotted with the array of different colors and media (pushpins, yarn and acrylic paint).

Transferring Mental Maps

Using a compass, orient the relief model North-South. Display the coding tools (Figure 20).



Fig.21 Landmarks are identified

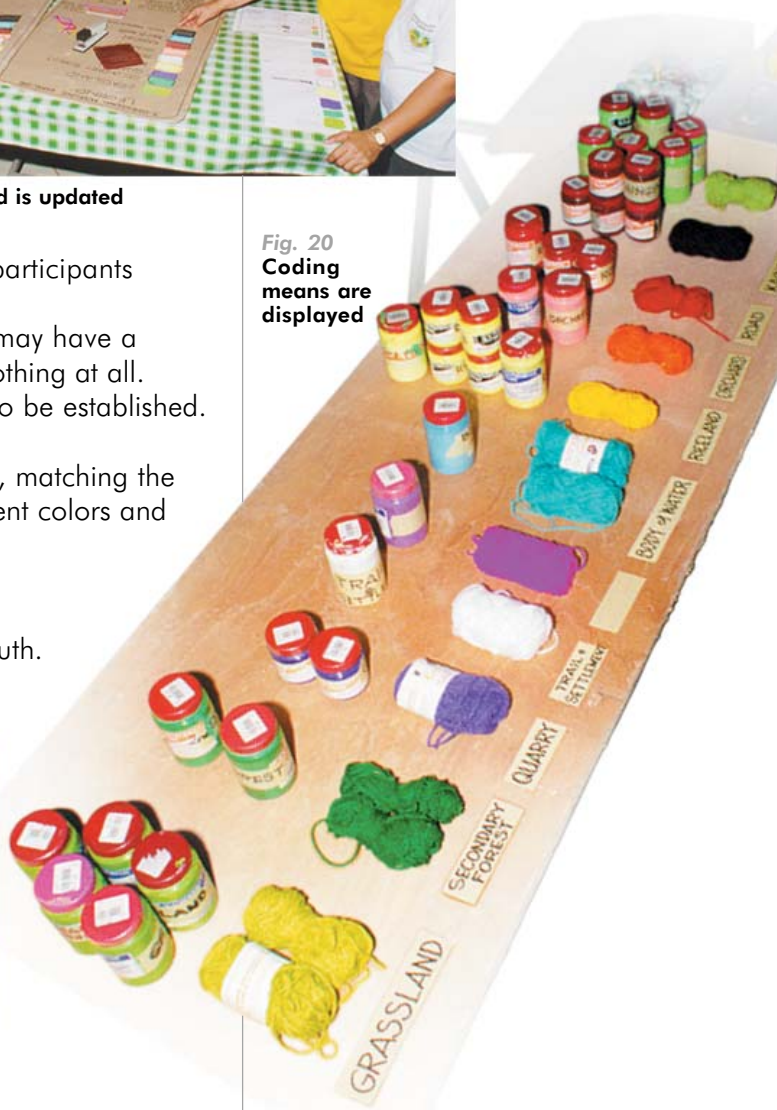
Invite informants to locate and name in sequential order: water courses, mountain peaks, islets, roads, trails, social infrastructures and other landmarks they use to orient themselves when moving around within their domains (Figure 21).

PHASE THREE: TRANSPOSING INFORMATION



Fig. 19 The legend is updated

Fig. 20
Coding
means are
displayed



In choosing colors,
be aware of
cultural implications

This is a critical process that follows people's natural orientation mechanisms and allows the informants to get a progressively deeper grasp of their whereabouts vis-à-vis the model.

Invite them to delineate by the use of colored yarns vegetation types, land use, and other aspects that they consider relevant to their domains (Figure 22).

Fig. 22
Land uses
and land
cover are
identified



Fig. 23
Acrylic colors
are applied
after validation



Initial contouring of areas using yarn and dressmaker's pins instead of immediate painting or drawing allows informants to discuss and arrive at consensus on any particular feature or item of information, on its distribution, location and extent.

Once the individual features are validated, colored paint (acrylic is best) is applied (Figure 23), according to the coding system and the corresponding yarns removed.

After the paint has dried, participants are invited to locate with the use of color-coded pushpins and paper-tags, (Figure 24) the names of locations and administrative units, households and whatever "point form information" they consider to be important within their communities.

Fig. 24
Point form data
are located
by the use of
color-coded pins





The nature of the process, which assures the concurrent participation (Figure 25) of groups of people from neighboring locations and having different social, educational, cultural and economic backgrounds, allows for on-the-job data validation. Thus, compared to other participatory community mapping tools, there is lesser need for a *final* validation of the output.

In the course of transposing mental maps you should call the attention on the scale of the model. This is best done by displaying a reference showing scaled lengths and areas.

During the process, participants may want to add features not included in the legend. Select the appropriate medium (pin, yarn or paint) and color-code, add the description and the corresponding symbol on the legend.

The use of differentiated coding systems and materials (colored paints, pins and yarns) allows 3-D models - like in a GIS - to accommodate overlapping layers of information. Over a given territory, painted areas describe different land cover and use. Color-coded yarns identify land status, zoning, tenure and administration.

Secondary Information

After the informants have completed transposing their mental maps and cross-checking the information, other features can be added to the model (administrative boundaries, protected area boundaries, etc.), obtained from official and other sources in order to broaden the basis for participatory analysis and planning.

To do this, you have to establish a spatial relation between the base map and relief model. This is done by super-imposing a geo-referenced grid on the top of the model.

Placing the Grid

A 1:10,000-scale has 10-cm grid intervals. Each grid square corresponds to 100 hectares (one square kilometer). Grid placement on the model should match the grid on the base map. To place the grid you have to start measuring starting from the *reference corner* shown in [Figure 26](#).

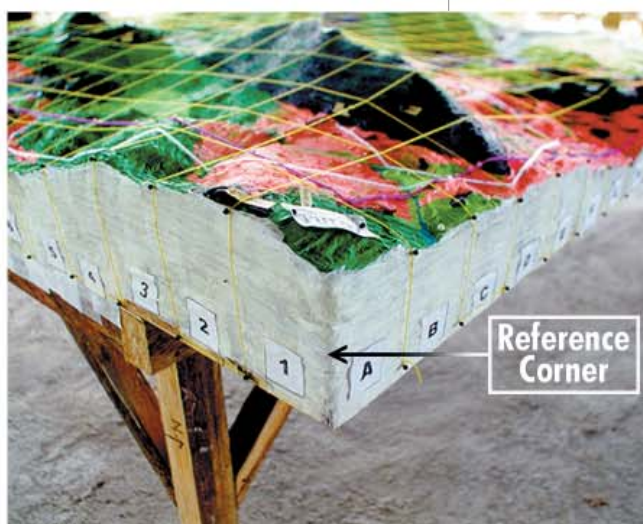
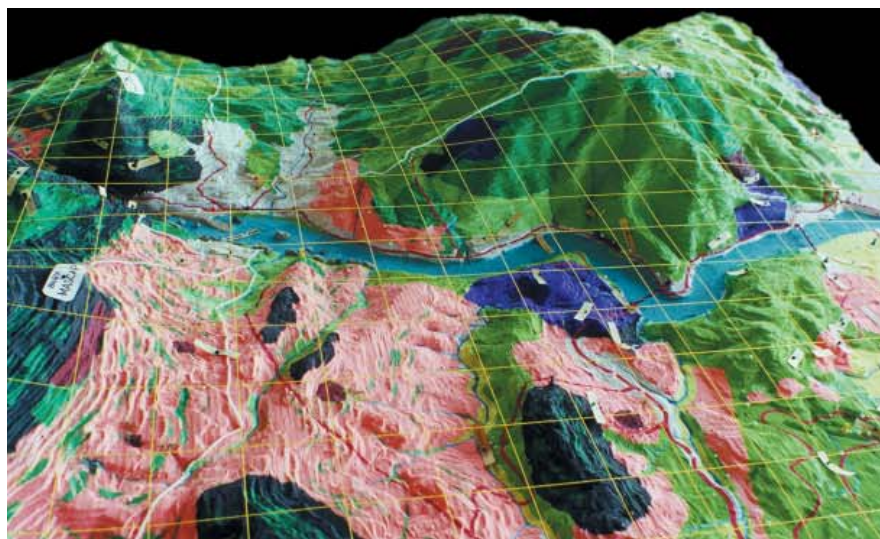


Fig. 26
The grid is placed
by the use of
letter/figures
coordinates

Fig. 27
Model with
10-cm grid



Once the grid has been placed (Figure 27), you can start transposing information from the base map, making use of its corresponding grid.

Latitude and longitude co-ordinates of the boundary corners are identified on the source map (Figure 28) and transposed on the relief model (Figure 29).

Each corner is then connected to the next using a colored yarn (Figure 29).

Fig. 28
Coordinates
are identified on
the base map

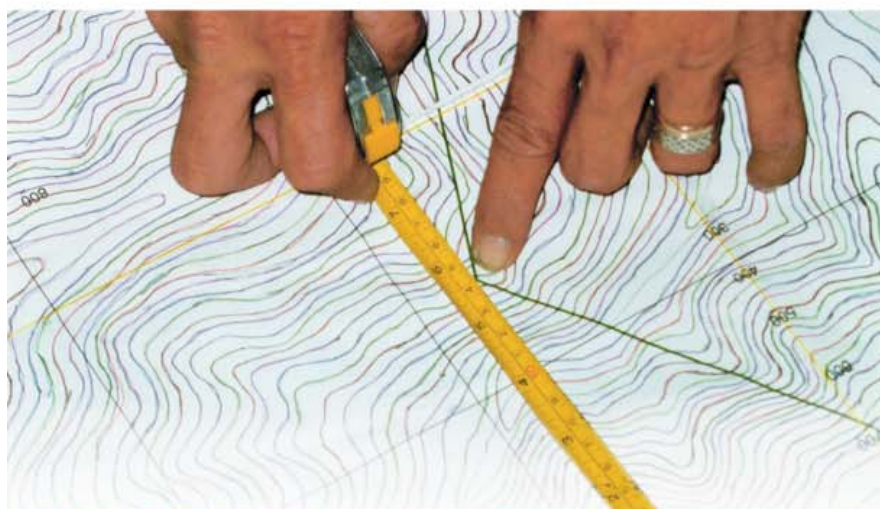


Fig. 29
Coordinates
are reflected
on the relief
model





Fig. 30
The boundary
is outlined

At the end of this exercise the boundary is visible to everyone (Figure 30). Thereafter the grid can be removed.

Finishing Touches

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

Therefore once the model is complete, you have to prepare a more detailed legend, including information on scale, a North-labeled arrow and an acknowledgement plate (see Appendix 3). These can be printed in color and laminated. These essential bits of key information are best embedded into the model. (Figure 31)

Fig. 31
Legend,
plate and
directional
arrow are
placed



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 P3-D model never gets completed. Like a living organism it needs to be nurtured by regularly updating and enriching its information.

The model has to be entrusted to an entity having 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 information. P3-D Models assure that accurate, to-all-meaningful information is kept among the people who generated it.

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

In NIPAP's case, models have been entrusted to Protected Area Management Boards and to People's Organizations. In other cases in the Philippines, custodians are organized groups of Indigenous Peoples.

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

PHASE FIVE: EXTRACTING INFORMATION

Information can now be extracted and transferred to a Geographic Information System.

Pre-extraction Stage

Supplies listed in Appendix 3 include transparent plastic sheets which are generally bought in rolls. These need to be cut at manageable size (say 1-m x 0.8-m). Ahead of actual fieldwork, a matching grid to the one on the base map needs to be drawn on each sheet using a permanent marker.

GIS technicians or cartographers who will be extracting the information should familiarize themselves with the background to the model as annotated in the process documentation. They should be fully familiar with the model's legend, its symbols and the definitions used.

Stakeholder representatives should participate in the extraction process.

Extraction Stage

Extraction can now 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.

The plastic sheets are placed on top of the model as shown in Figure 32.

Where islands are concerned, the coastline can be traced on the plastic sheets directly from the base map (Figure 33). This eases geo-referencing.

Three people at least are needed for a period of 2-3 days to extract information from a 6-7 m² model.

Extraction should be done systematically.

Point, line and polygon are the three features representing the data. These should be separately transferred to the plastic sheets.



Fig. 32 Matching grids



Fig. 33 Tracing the coastline

Accurate documentation is essential. Attributes (non-graphic information like names, descriptions of land use and cover, demographic characteristics, etc.) are associated with the single feature. 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 34](#).

Fig. 34 Looking straight



Fig. 35 Information is digitized

The transparent plastic sheets and the accompanying legend are then handed over to the GIS for editing, digitization ([Figure 35](#)) and data storage.

Information from official and other sources can be integrated (administrative boundaries, etc.).

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

Customized thematic maps are produced at pre-determined scales ([Appendices 5, 7, 9, 10, 11 and 12](#)).

A legend is prepared and joined to other cartographic information like scale, title, source of information (including date), co-ordinates, directional arrow, and others ([Appendix 4](#)).

In the absence of a sufficiently diversified standardized coding system⁷ in the Philippines, the program developed its own.

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)

GIS translation of the Model data can be compared with other existing spatial information, like maps produced from satellite-interpreted imagery.

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 peoples' "pooled knowledge", supplemented by conventional spatial information (contours) is not only accurate but more detailed and more current than information maintained in official circles as discussed in [Appendix 13](#).

PHASE SIX: DIGITIZING AND MANIPULATION

PHASE SEVEN: FIELD VERIFICATION

⁷ A few color codes on land use zoning have been put forward by the Housing and Land Use Regulatory Board (HLURB, 1997). Additional symbols are in use at NAMRIA.

RELIEF MODELS IN PRACTICE

EXAMPLES FROM THE FIELD

Fig. 36
Mt. Pulag National Park
Benguet, Nueva Vizcaya and Ifugao,
Philippines
Scale: 1:10,000,
Area covered: 360 km²



Fig. 37
Mt. Malindang Natural Park,
Misamis Occidental, Philippines
Scale: 1:10,000.
Area covered: 1,176 km²



Fig. 38
Malampaya Sound Protected Landscape and Seascape
Palawan, Philippines
Horizontal scale: 1:20,000;
Vertical scale: 1:10,000.
Total area covered: 3,016 km²





Fig. 39
El Nido-Taytay Managed Resource Protected Area
 Palawan, Philippines
 Scale: 1:20,000
 Area covered: 1,968 km²



Fig. 40
Mt. Isarog Natural Park
 Camarines Sur, Philippines
 Scale: 1: 10,000
 Area covered: 480 km²



Fig. 41
Mt. Guiting-guiting Natural Park
 Romblon, Philippines
 Scale: 1:10,000.
 Area covered: 896 km²

Fig. 42
Pamitinan Protected Landscape
 Rizal, Philippines
 Scale: 1: 2,000.
 Area covered: 17 km²



Fig. 43
Ayta Ancestral Domain
 Cabangon, Zambales, Philippines
 Scale: 1: 5,000.
 Area covered: 107 km²



Photo by Manny Rara, Pafid

Fig. 44
Kakanaey Ancestral Domain
 Palina, Kibungan, Benguet, Philippines
 Scale: 1: 5,000.
 Area covered: 142 km²



Photo by Willy Tolentino, Pafid

For Awareness Raising and Education

NIPAP experience has proved that collaboratively produced 3-D models generate a tremendous, long-lasting enthusiasm not only among participants in the process but generally among a large proportion of local residents.

An enormous amount of information is collated, gets on permanent display and is readily accessible to all stakeholders, local residents and outsiders.

Relief models are useful for teaching local geography and to enhance people's interest in conserving and restoring natural resources.



A MULTIPURPOSE TOOL

"I was born here seventy years ago, and this is the first time in my life that I can see and understand Mount Malindang".

— Words from an elder attending the handing-over ceremony

For Community Cohesion and Self-actualization

Much more so than sketch maps or GIS outputs, a well displayed 3-D model is appealing, fuels community esteem and sense of intellectual ownership, becoming part of the local cultural landscape.

For Collaborative Planning

Relief models are excellent visual aids capturing the ruggedness and details of a territory. Users can see and feel the contours of every mountain range and river valley. Two-dimensional maps cannot match their impact and appeal.

Compared to data appearing on a planimetric map, a relief model facilitates assimilation, interpretation and understanding. People get a "bird's eye view" of their environment. This enhances analytical skills, broadens perspectives, especially on interlocked ecosystems, and helps to deal with issues and conflicts associated with the territory and resource use.

A relief model highlights pressure points (household concentrations, converted forest, access ways, etc.) making them visible and tangible to everyone.

When dealing with more remote and extensive areas, P3-D models remove logistical constraints to public participation in land and resource use planning and management.

In the Philippines few protected area boundaries have yet been demarcated. Relief models allow stakeholders to get a first time factual perception of their location. This facilitates a bottom-up approach to boundary delineation and zoning, activities otherwise characterized by a top-down process, heavy logistics and lengthy negotiations.

As discussed on page 14, the use of a coding system based on a rich assortment of different materials and colors allows a 3-D model to function like a rudimentary community-based GIS accommodating overlapping layers of information. This is extremely useful to establishing visual relations between resources, tenure, their use and jurisdiction.

For Collaborative Research

P3-D models facilitate selective pinpointing of resources, households and other features.

Because of their accuracy, P3-D Models can have positive and negative effects.

Alone or combined with GIS, they 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]. (J. Abbot et al. 1999).

Some groups have expressed concern that the mapping process enables outsiders to control information previously controlled by communities (Pole P. 1995),

Planners should be aware of these possible drawbacks and be careful in the application of the process. Plotting the habitats of endangered species, or the location of hardwoods, or other resources in demand on the black market, should be done with caution and behind closed doors in the course of focus groups discussions. Sensitive information should be removed thereafter.

For Increasing Local Communications Capacity

Because all stakeholders have played an active role in the realization of a 3-D Model, communities and administrators both understand it easily.

A relief model makes information tangible, eases communication, helps bridge language barriers and increases the potential of all stakeholders to deal within their constituencies as well as with central government and outsider institutions. 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. In the Philippines, maps and models produced for establishing Ancestral Domain Claims built public support for the passage of the Indigenous People's Rights Act in 1997. (Alcorn J.B., 2000)



For Protected Area Management

P3-D models serve the following purposes in protected area management:

- Involving communities in developing management, zoning and resource use plans, geo-referencing their priorities, aspirations, concerns and needs.
- Monitoring the dynamics of settlements, infrastructures and access points vis-à-vis a protected area.
- Substantiating public hearings and planning workshops.
- Introducing visitors to the area.

For Self-determination

In the Philippines, NGOs like PAFID (Philippine Association for Inter-Cultural Development) led the way towards national recognition of ancestral rights by combining the use of P3-D models, Global Positioning Systems (GPS) and GIS to provide the evidence required by law substantiating applications filed by Indigenous Peoples. (Figures 43 and 44)

For Participatory Monitoring and Evaluation

A working P3-D model is never completed. Like in any dynamic system, change is a constant.

Although a relief model, like GIS, can accommodate regular updating, it cannot memorize past scenarios. This is where GIS “adds value” and becomes a vital ingredient for monitoring change.

A P3-D model can be instrumental to conducting Participatory Monitoring and Evaluation (PM&E) (Figure 45), provided the data are updated at given intervals, periodically extracted, digitized, plotted in GIS thematic maps and finally returned to the community for assessing change, and identifying its causes and effects.

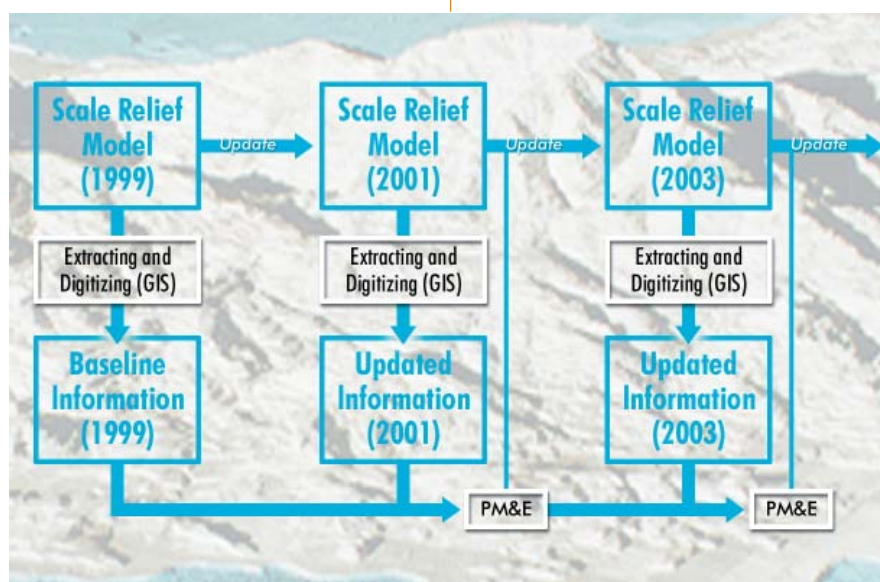


Fig. 45 The function of P3-DM in a participatory M&E context

For Conflict Resolution

Conflict resolution involves area-based mechanisms to prevent, mediate and resolve local conflicts and to strengthen communities in dealing with their management. Disputes over boundary issues, resource use and tenure are often contributory causes for century-long inter-tribal conflicts.

The strategies and processes leading to conflict resolution are complex and articulated and need the backing of appropriate institutional and legal mechanisms.

At grassroots level, participatory approaches and particularly 3-D modeling can help in settling boundary disputes through the visualization of the landscape associated land uses and settlement pattern. Initiatives making use of 3-D modeling for conflict resolution are currently on-going in the Philippines under the auspices of the Office of the Presidential Adviser on the Peace Process (OPAPP).

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 is cause of distraction and demotivation of participants. Splitting participants in groups of 20-25 and making provisions for brief overlapping of groups to allow cross-fertilization and crosschecking is the best way to go.

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.

In the Philippines P3DM has been used in the contexts of protected area management and self-determination. Are there any other situations where relief modeling has been adopted?

Community-based relief models have been used for watershed management in Thailand and for negotiating access to resources in Indonesia. The technique is fast spreading. Updates are available on the internet at <http://www.iapad.org>

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 for generating 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?

Depending on the number of models concurrently constructed. For one model there is the need of one coordinator/head facilitator, two facilitators and a GIS operator.

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 P3-DM process.
Digitize	To encode map features as x, y coordinates in digital form.
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 co-ordinates.
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).
Modeling	The act or art of making a model of something; rendering into solid form.
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.

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APPENDICES

Appendix 1 Reading maps

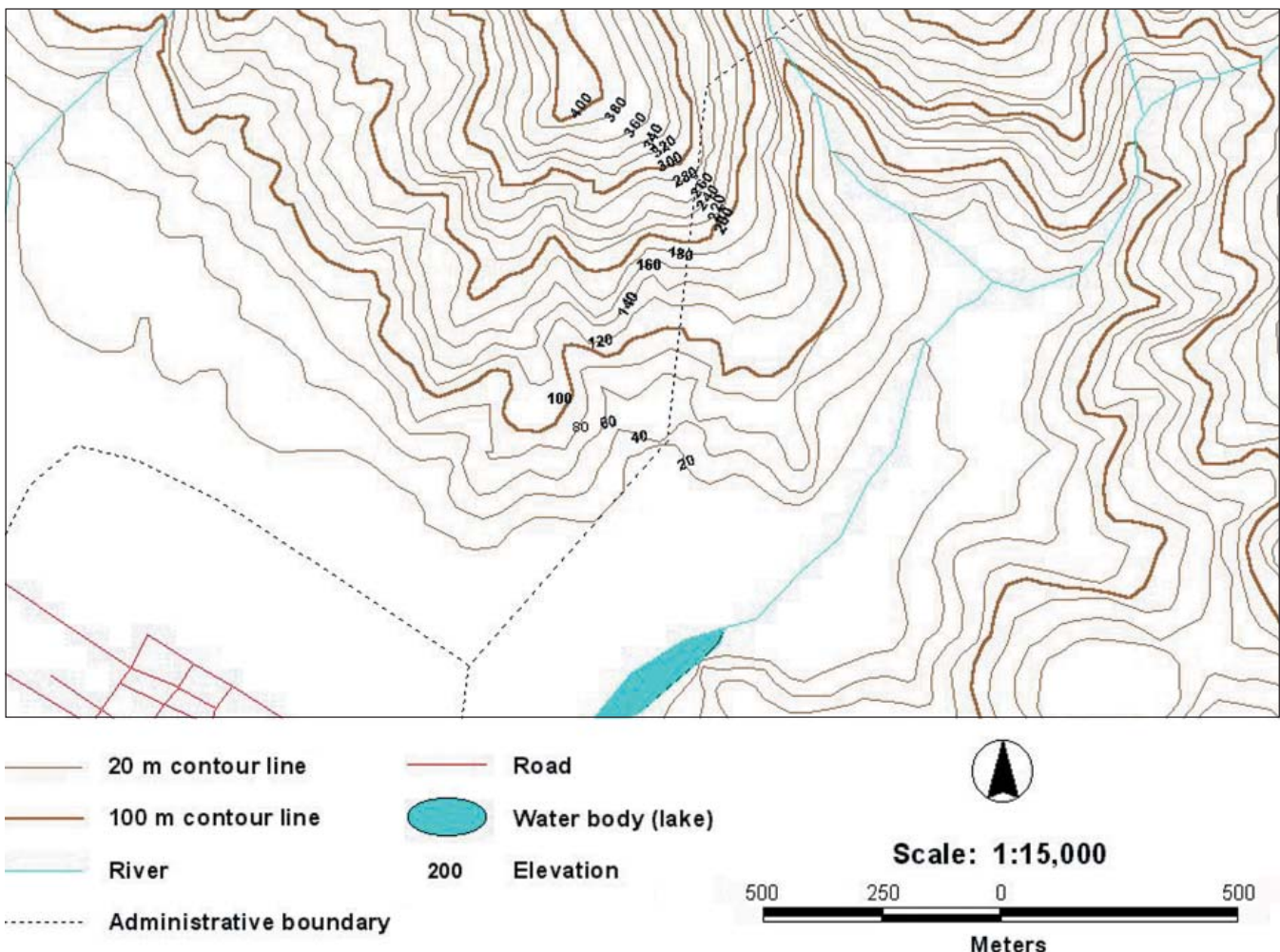
A map is a representation of the Earth, or part of it. Traditionally, maps have been printed on paper. When a printed map is scanned, the computer file that is created may be called a digital raster graphic.

The distinctive characteristic of a topographic map 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. 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 other natural and man-made features, each represented by colors and symbols.

Colors 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 the appearance and readability of a map.



Appendix 2 Supply list for the manufacture of the 1:10,000 scale model of Sibuyan Island, Romblon, Philippines. Area coverage 896 km² (terrestrial: 453 km², marine: 443 km²)

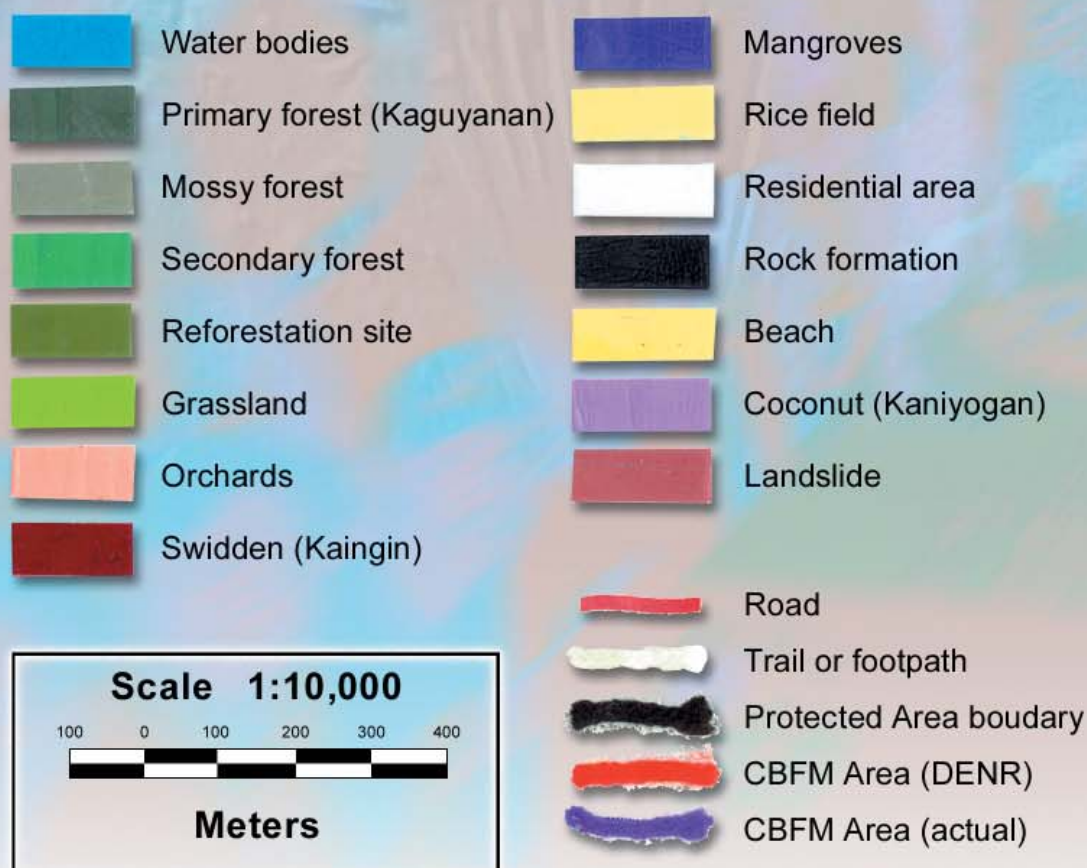
QTY	Unit of measure	Article Specification		Unit Cost estimate (PHP)	Cost estimate (PHP)	Unit Cost estimate (USD)	Cost estimate (USD)
3	Roll	Carton, corrugated (48"x300ftx4mm) STRONG		1,000.00	3,000.00	25.00	75.00
5	Bottles	Office glue (white) 2 kg		249.50	1,247.50	6.24	31.19
8	Pc	Scissors		195.50	1,564.00	4.89	39.10
2	Box	Carbon paper (handwriting) blue diamond legal size		233.75	467.50	5.84	11.69
40	Pc	Crepe paper (white)		12.00	480.00	0.30	12.00
10	Pc	Cutter (small size)		16.50	165.00	0.41	4.13
60	Pc	Blades for above cutters		10.00	600.00	0.25	15.00
3	Unit	Reinforced Plywood (1/4")		450.00	1,350.00	11.25	33.75
8	Pc	Brush # 1		50.00	400.00	1.25	10.00
4	Pc	Brush # 2		44.75	179.00	1.12	4.48
6	Pc	Brush # 9		24.25	145.50	0.61	3.64
6	Pc	Brush # 12		30.25	181.50	0.76	4.54
8	pc	Bucket (1 litter)		65.00	520.00	1.63	13.00
2	1/2 kg jar	Acrylic color	White	88.00	176.00	2.20	4.40
3	1/2 kg jar	Acrylic color	Yellow	88.00	264.00	2.20	6.60
2	1/2 kg jar	Acrylic color	Blue	88.00	176.00	2.20	4.40
1	1/2 kg jar	Acrylic color	Black	88.00	88.00	2.20	2.20
1	1/2 kg jar	Acrylic color	Red	88.00	88.00	2.20	2.20
4	1/2 kg jar	Acrylic color	Apple green	88.00	352.00	2.20	8.80
4	1/2 kg jar	Acrylic color	Emerald green	88.00	352.00	2.20	8.80
4	1/2 kg jar	Acrylic color	Green	88.00	352.00	2.20	8.80
2	1/2 kg jar	Acrylic color	Brown	88.00	176.00	2.20	4.40
1	1/2 kg jar	Acrylic color	Violet	120.00	120.00	3.00	3.00
1	1/2 kg jar	Acrylic color	Orange	120.00	120.00	3.00	3.00
30	Boxes	Map pins (100 pc/ box)	White	45.00	1,350.00	1.13	33.75
10	Boxes	Map pins (100 pc/ box)	Yellow	45.00	450.00	1.13	11.25
10	Boxes	Map pins (100 pc/ box)	Blue	45.00	450.00	1.13	11.25
10	Boxes	Map pins (100 pc/ box)	Black	45.00	450.00	1.13	11.25
10	Boxes	Map pins (100 pc/ box)	Red	45.00	450.00	1.13	11.25
10	Boxes	Map pins (100 pc/ box)	Green	45.00	450.00	1.13	11.25
10	Boxes	Map pins (100 pc/ box)	Violet	45.00	450.00	1.13	11.25
10	Boxes	Map pins (100 pc/ box)	Orange	45.00	450.00	1.13	11.25
10	Boxes	Pushpin flat heads	White	45.00	450.00	1.13	11.25
10	Boxes	Pushpin flat heads	Yellow	45.00	450.00	1.13	11.25
10	Boxes	Pushpin flat heads	Blue	45.00	450.00	1.13	11.25
10	Boxes	Pushpin flat heads	Black	45.00	450.00	1.13	11.25
10	Boxes	Pushpin flat heads	Red	45.00	450.00	1.13	11.25
10	Boxes	Pushpin flat heads	Green	45.00	450.00	1.13	11.25
2	Pc	Hand-knitting yarn no. 8	White	12.50	25.00	0.31	0.63
2	Pc	Hand-knitting yarn no. 8	Yellow	12.50	25.00	0.31	0.63
2	Pc	Hand-knitting yarn no. 8	Blue	12.50	25.00	0.31	0.63
2	Pc	Hand-knitting yarn no. 8	Black	12.50	25.00	0.31	0.63
2	Pc	Hand-knitting yarn no. 8	Red	12.50	25.00	0.31	0.63
2	Pc	Hand-knitting yarn no. 8	A green	12.50	25.00	0.31	0.63
2	Pc	Hand-knitting yarn no. 8	B green	12.50	25.00	0.31	0.63
2	Pc	Hand-knitting yarn no. 8	C green	12.50	25.00	0.31	0.63
2	Pc	Hand-knitting yarn no. 8	Brown	12.50	25.00	0.31	0.63
2	Pc	Hand-knitting yarn no. 8	Violet	12.50	25.00	0.31	0.63
2	Pc	Hand-knitting yarn no. 8	Orange	12.50	25.00	0.31	0.63
4	Rolls	Film Kodak ASA 200 (362)		135.00	540.00	3.38	13.50
1	Pc	Stapler		150.00	150.00	3.75	3.75
1	Box	Staple wire #35		25.00	25.00	0.63	0.63
1	Pc	Clipboard		29.00	29.00	0.73	0.73
8	Pc	Masking tape (2")		30.00	120.00	0.75	3.00
2	Roll	Cotton thread	Yellow	20.00	40.00	0.50	

Appendix 3 Supply list for the extraction phase - 1:10,000 scale model of Sibuyan Island, Romblon, Philippines. Area coverage 896 km² (terrestrial 453 km², marine: 443 km²)

QTY	Unit of measure	Article Specification		Unit Cost estimate (PHP)	Cost estimate (PHP)	Unit Cost estimate (USD)	Cost estimate (USD)
		Transparent plastic sheet					
3	Pc	Overhead projection markers	Yellow	23.00	69.00	US\$ 0.52	US\$ 1.56
3	Pc		Blue	23.00	69.00	US\$ 0.52	US\$ 1.56
3	Pc		Black	23.00	69.00	US\$ 0.52	US\$ 1.56
3	Pc		Red	23.00	69.00	US\$ 0.52	US\$ 1.56
3	Pc		Green	23.00	69.00	US\$ 0.52	US\$ 1.56
3	Pc		Orange	23.00	69.00	US\$ 0.52	US\$ 1.56
2	Pc	Scaled ruler		380.00	760.00	US\$ 8.50	US\$ 17.00
2	Pc	Measuring tape		20.00	40.00	US\$ 0.48	US\$ 0.96
2	Roll	Cotton string	Yellow	27.00	54.00	US\$ 0.55	US\$ 1.10
1	Pc	Base map		265.00	265.00	US\$ 5.96	US\$ 5.96
3	Box	Push pins (100 pcs. Box)	any	35.00	105.00	US\$ 0.84	US\$ 2.52
3	Roll	Masking tape (1.5")		18.00	54.00	US\$ 0.45	US\$ 1.35
1	Pack	Cotton thread		32.00	32.00	US\$ 0.82	US\$ 0.82
1	Flask	Alcohol		45.00	45.00	US\$ 1.00	US\$ 1.00

Appendix 4 Legend and directional arrow (3-D model)

LEGEND
(Relief Model of Sibuyan Island and Mt. Guiting-Guiting Natural Park)





National Integrated Protected Areas Programme

A special project of the DENR supported by the European Commission



Participatory 3-D Model of Mt. Guiting-Guiting Natural Park and environs

November 12-17, 1999

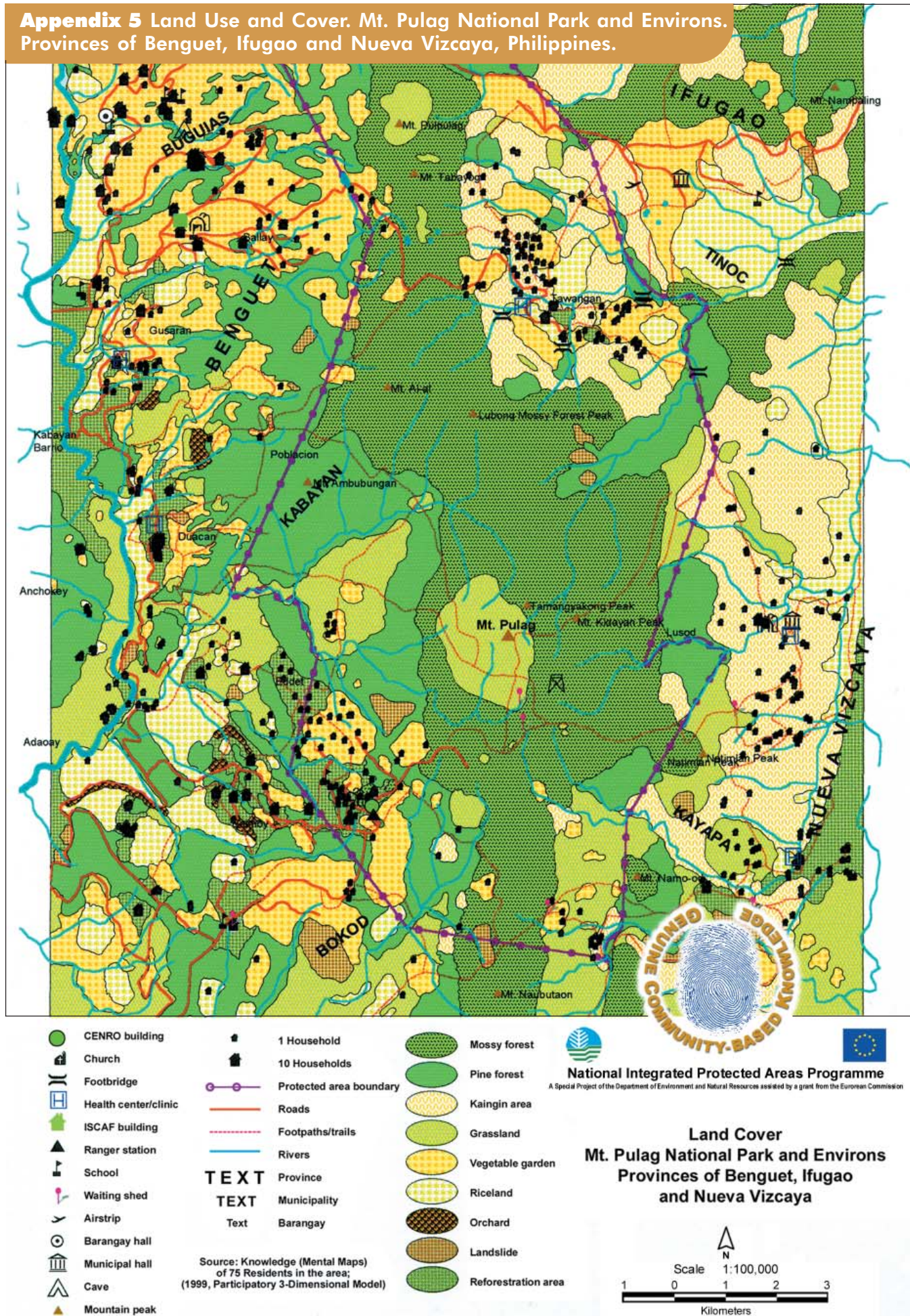
Cajidiocan Multipurpose Hall, Cajidiocan, Sibuyan Island, Romblon

1:10,000 scale relief model resulting from an exercise organised and facilitated by the "Protected Area Office" in collaboration with the "NIPAP Livelihood, Resource Utilisation and Community Development Section" and with the active participation of representatives of the following:

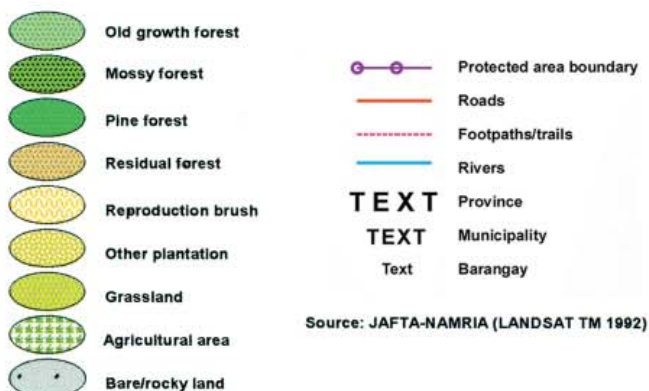
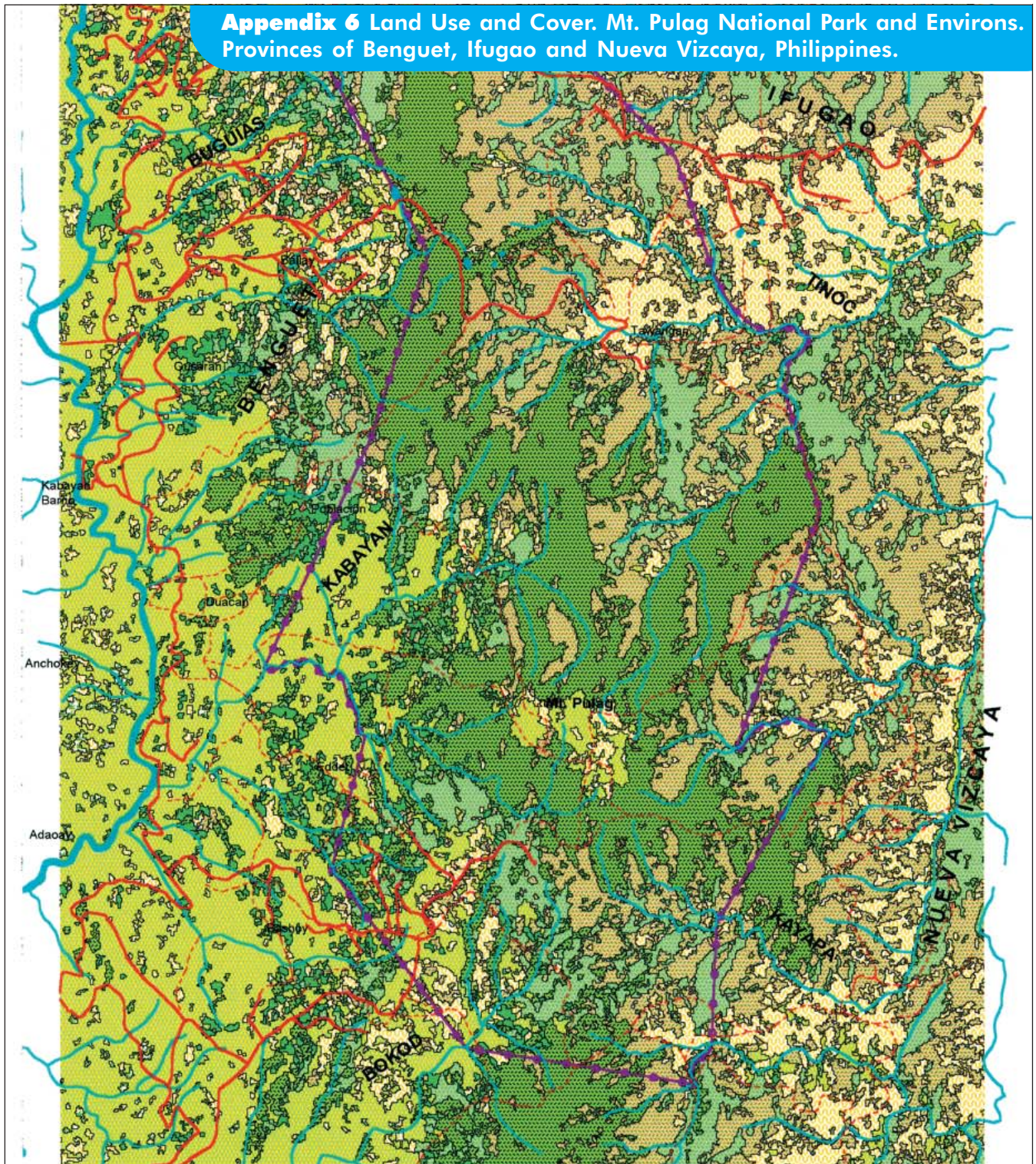
DENR PENRO-CENRO
Local Government Units (Cajidiocan, Magdiwang and San Fernando)
all Barangays, Indigenous Cultural Community, PAMB members,
Magdiwang National High School, Cajidiocan National High School,
Danao National High School, España National High School,
Sibuyan Polytechnic College, Kabang Kalikasan Ng Pilipinas (KKP)
and the Department of Agrarian Reform



Appendix 5 Land Use and Cover. Mt. Pulag National Park and Environs.
Provinces of Benguet, Ifugao and Nueva Vizcaya, Philippines.

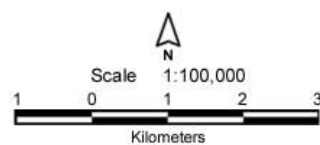


Appendix 6 Land Use and Cover. Mt. Pulag National Park and Environs. Provinces of Benguet, Ifugao and Nueva Vizcaya, Philippines.

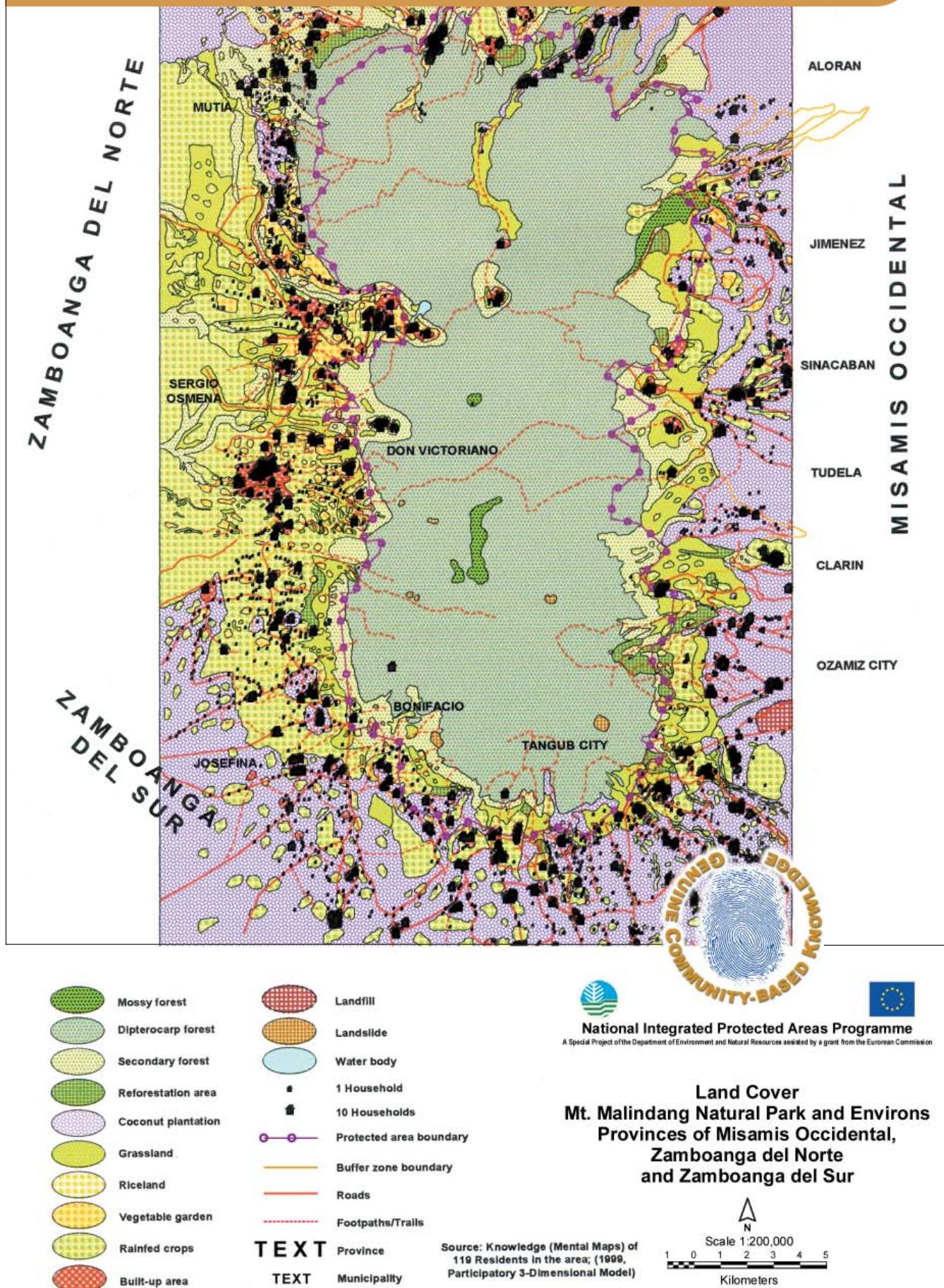


National Integrated Protected Areas Programme
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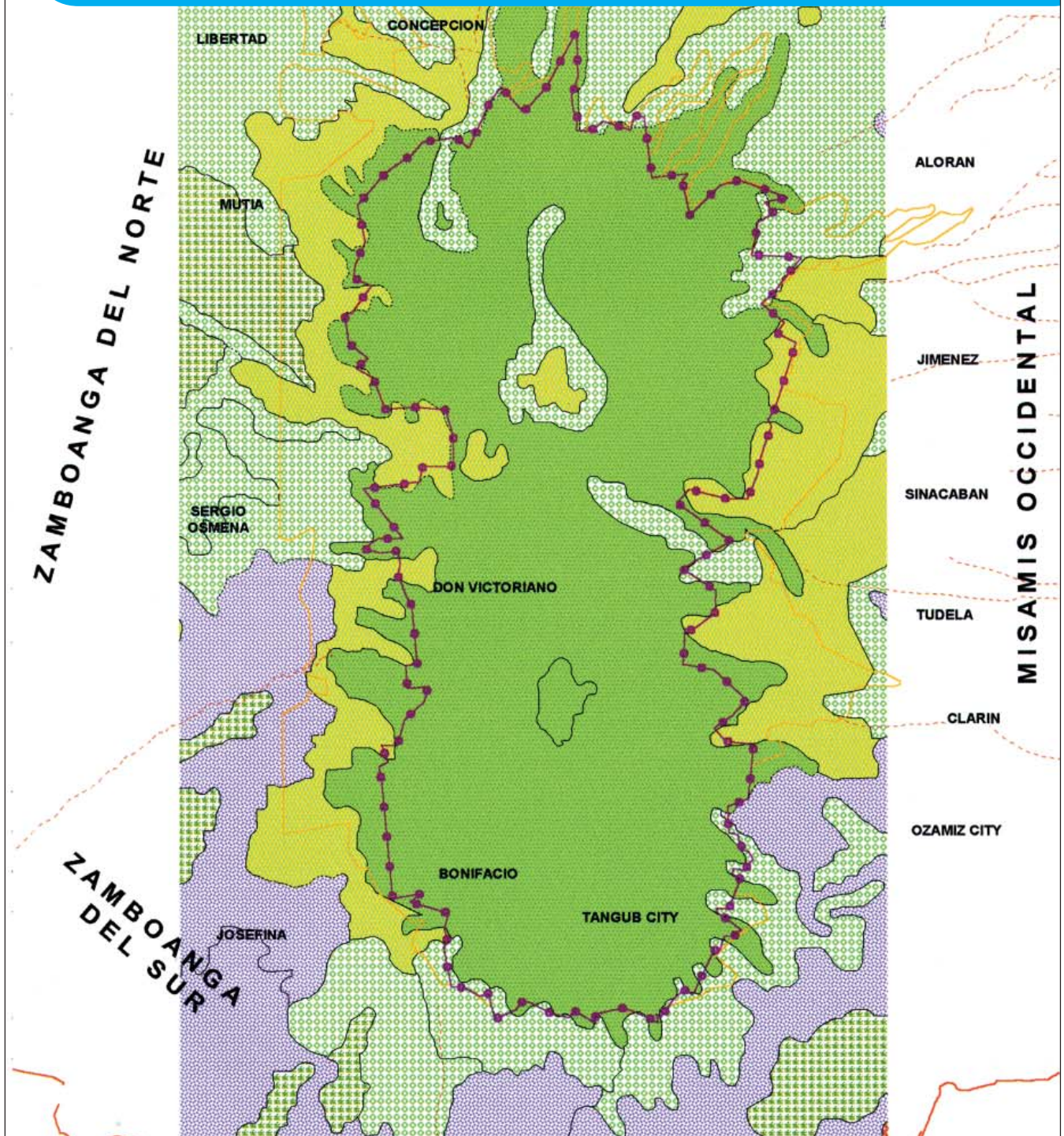
Land Cover Mt. Pulag National Park and Environs Provinces of Benguet, Ifugao and Nueva Vizcaya



Appendix 7 Land Use and Cover. Mt. Malindang Natural Park and Environs. Provinces of Misamis Occidental, Zamboanga del Norte and Zamboanga del Sur, Philippines.



Appendix 8 Land Use and Cover. Mt. Malindang Natural Park and Environs.
Provinces of Misamis Occidental, Zamboanga del Norte and Zamboanga del Sur, Philippines.



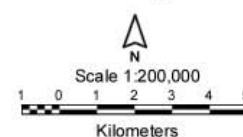
- Forest
- Coconut plantation
- Grassland
- Shrubs
- Agricultural area
- Built-up area

- Protected area boundary
- Buffer zone boundary
- Roads
- Footpaths/trails
- TEXT** Province
- TEXT** Municipality

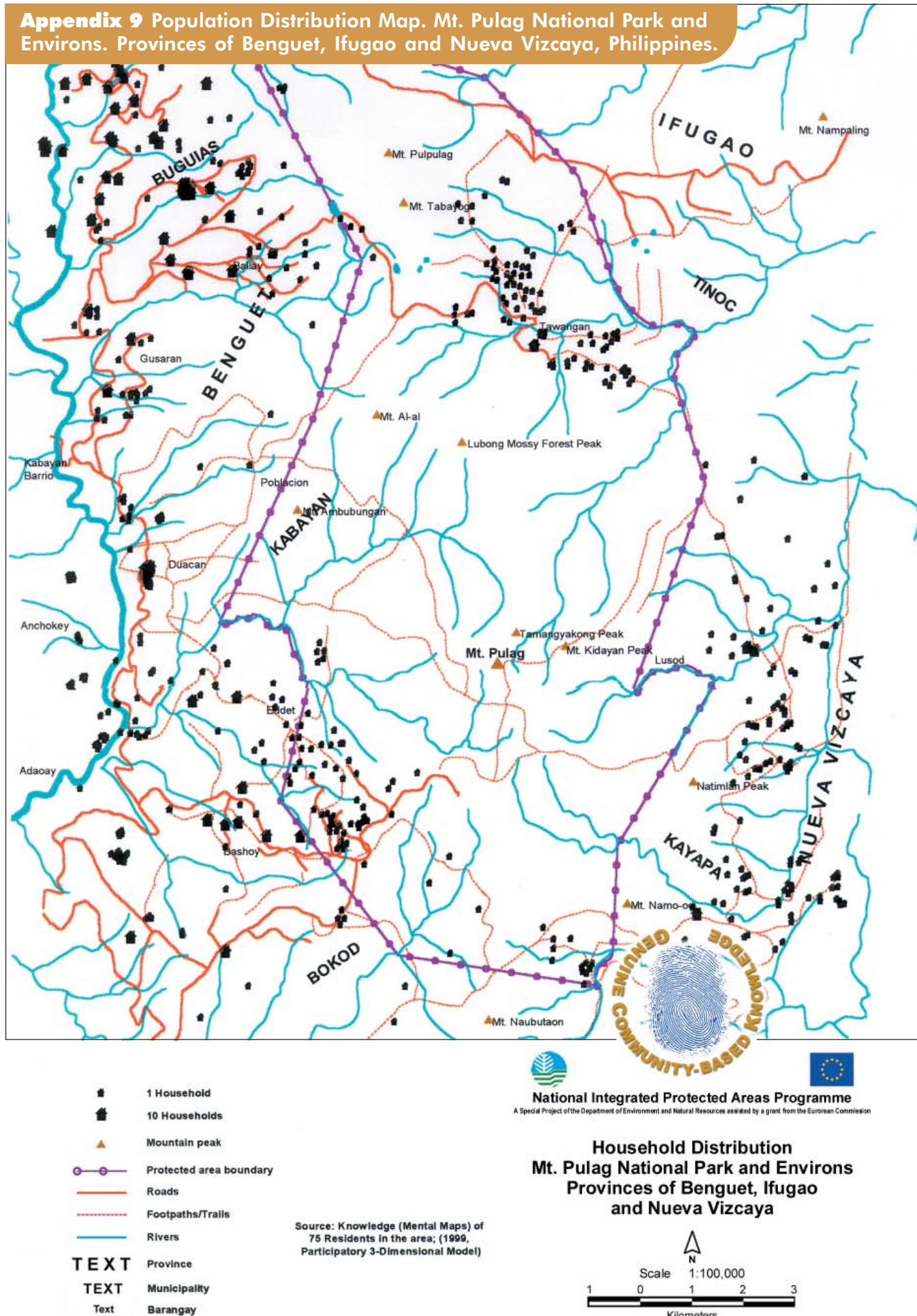
Source: Unknown

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A Special Project of the Department of Environment and Natural Resources assisted by a grant from the European Commission

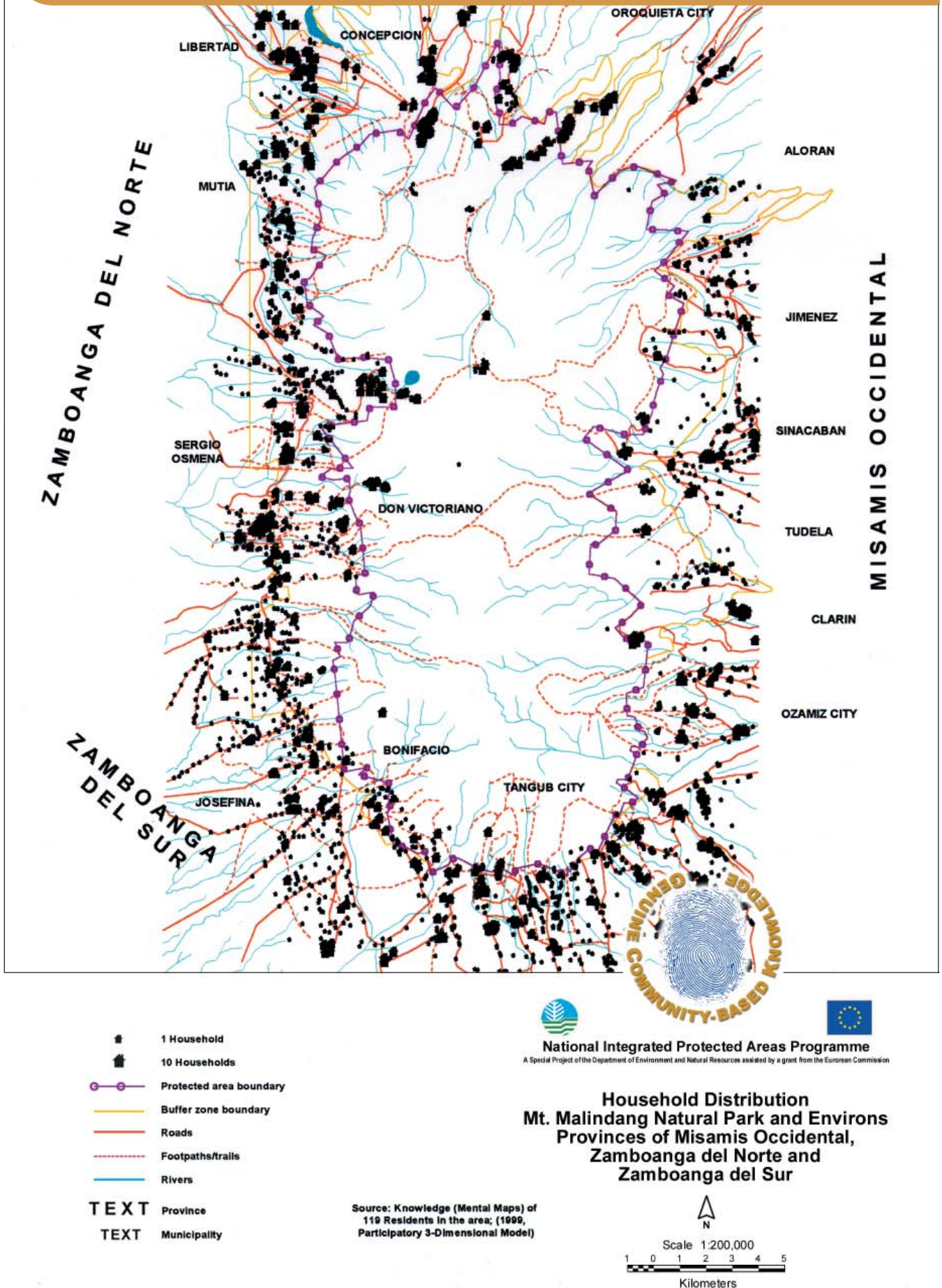
Land Cover
Mt. Malindang Natural Park and Environs
Provinces of Misamis Occidental,
Zamboanga del Norte
and Zamboanga del Sur



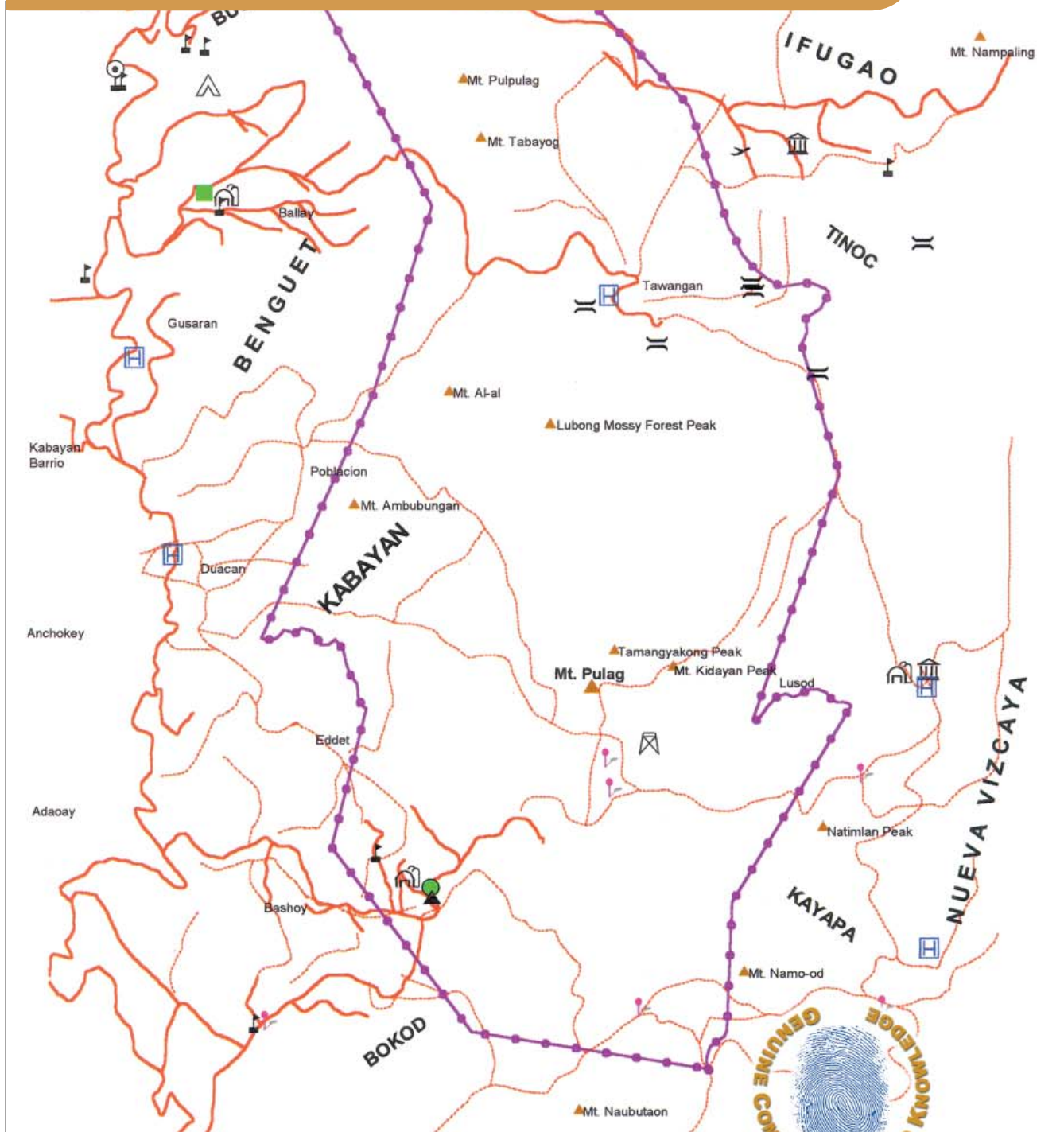
Appendix 9 Population Distribution Map. Mt. Pulag National Park and Environs. Provinces of Benguet, Ifugao and Nueva Vizcaya, Philippines.



Appendix 10 Population Distribution Map. Mt. Malindang Natural Park and Environs. Provinces of Misamis Occidental, Zamboanga del Norte and Zamboanga del Sur, Philippines.



Appendix 11 Social Infrastructure Distribution Map. Mt. Pulag National Park and Environs. Provinces of Benguet, Ifugao and Nueva Vizcaya, Philippines.



- | | | | |
|--|--------------------------|--|-------------------------|
| | CENRO building | | Airstrip |
| | Church | | Barangay center |
| | Health center/clinic | | Municipal hall |
| | Multi-purpose center | | Cave |
| | NPC tower | | Mountain peak |
| | Peace and Order barracks | | Protected area boundary |
| | Ranger station | | Roads |
| | School | | Footpaths/Trails |
| | Storage | | |
- TEXT** Province
TEXT Municipality
TEXT Barangay

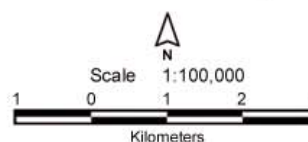


National Integrated Protected Areas Programme
 A Special Project of the Department of Environment and Natural Resources assisted by a grant from the European Commission

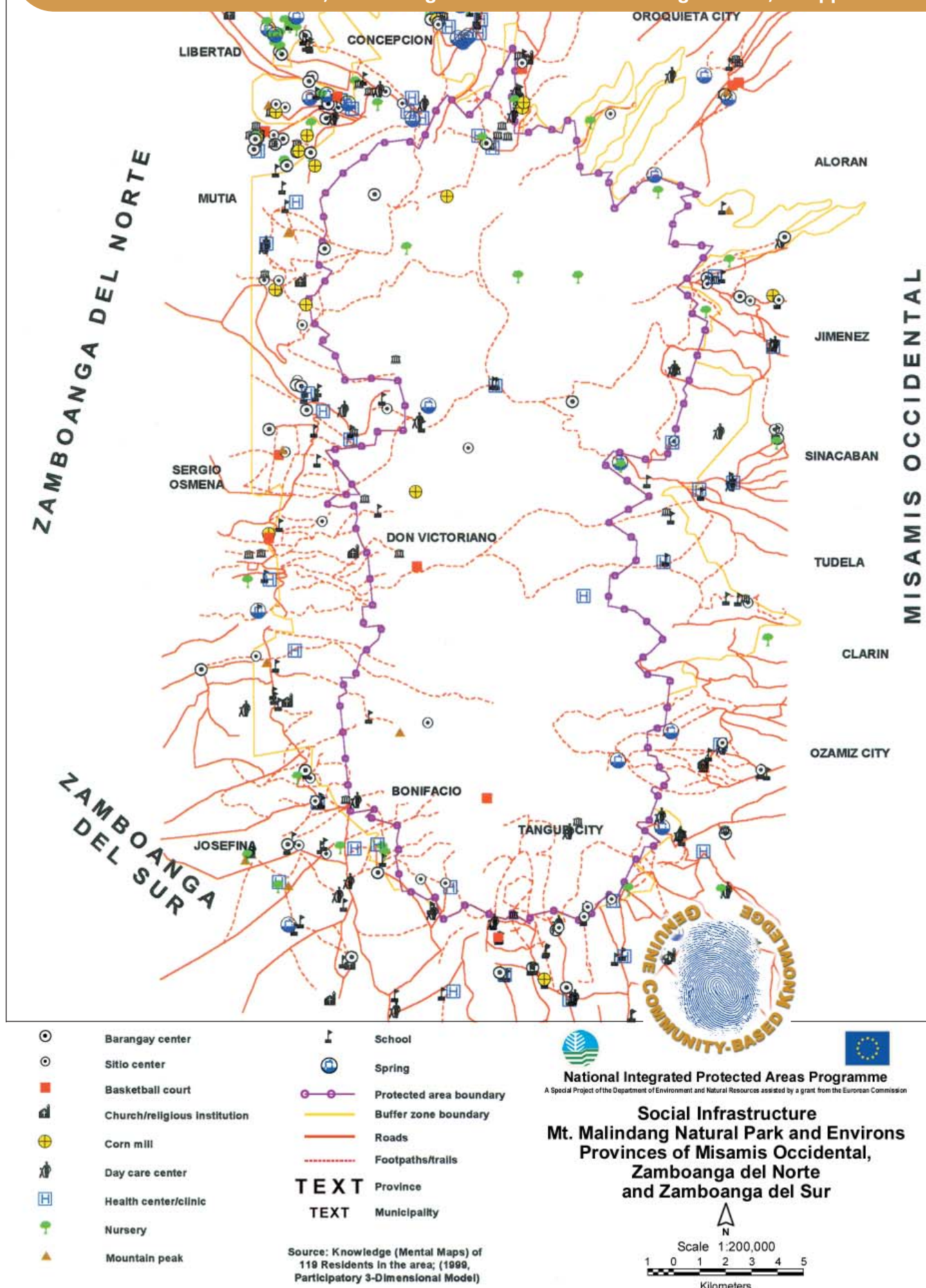


Social Infrastructure Mt. Pulag National Park and Environs Provinces of Benguet, Ifugao and Nueva Vizcaya

Source: Knowledge (Mental Maps) of
 75 Residents in the area; (1999,
 Participatory 3-Dimensional Model)



Appendix 12 Social Infrastructure Distribution Map. Mt. Malindang Natural Park and Environs. Provinces of Misamis Occidental, Zamboanga del Norte and Zamboanga del Sur, Philippines.

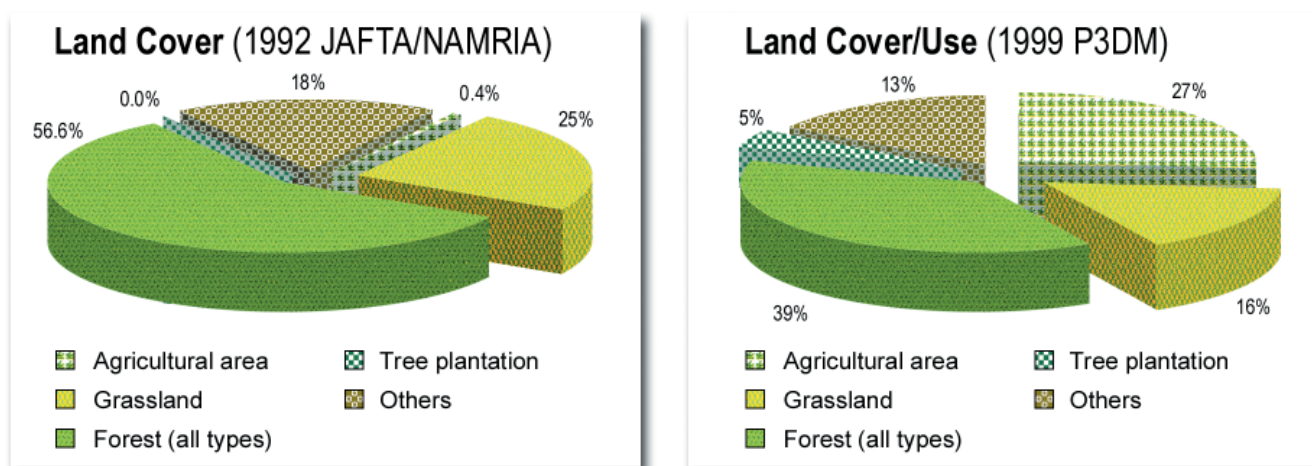


Appendix 13 Discussion of discrepancies encountered in comparing collective people's knowledge with interpreted satellite imagery and other secondary information

Appendixes 5-12 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 5, 9 and 11 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 km² or 36,000 hectares. Appendix 6 is a land cover map of the same area based on 1992 interpreted satellite imagery.

Case 2: Appendix 7, 10 and 12 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 km² or 117,600 hectares, including Mt. Malindang Natural Park. Appendix 8 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 km²), 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 peoples' 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, JAFTA/NAMRIA (Appendix 6) shows a total forest cover (mossy, pine, old growth, residual forests) of 56%, compared to a lower percentage (40% including mossy and pine forests) portrayed by key informants (Appendix 5). 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 5) instead of land cover (Appendix 6) 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 (kaingin) appears to be prevailing, representing 11.7% of the whole area (see chart no. 2 "other"). According to people's knowledge aside from kaingin, "other" land uses (17.2%) include landslides (1.1%), orchards (0.3%) and reforestation areas (4.3%).

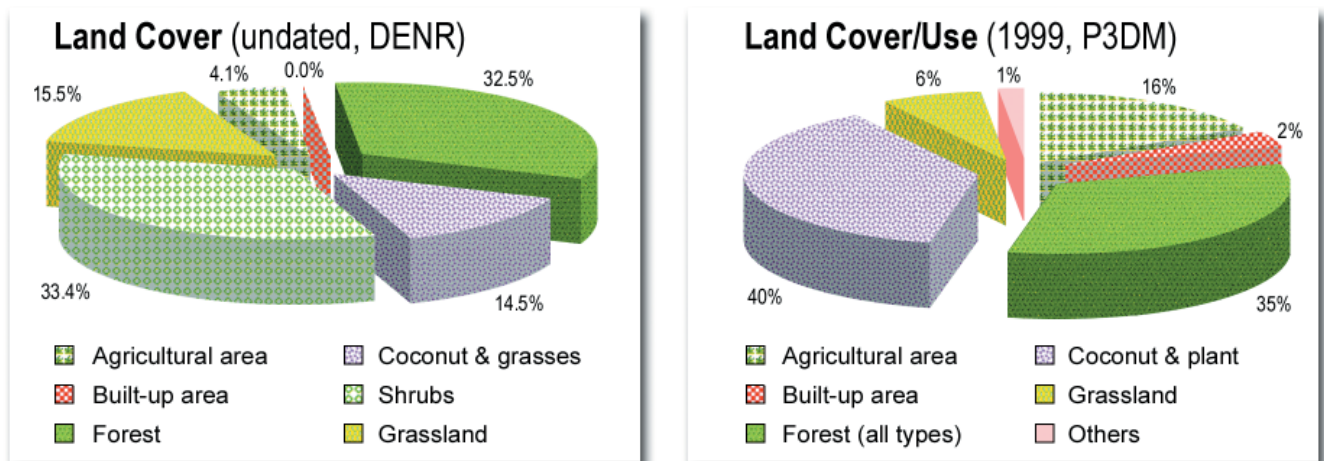
JAFTA/NAMRIA attributes 17.6% of the total area to "reproduction brush", a land cover classification comparable to kaingin in terms of land use.

Comments to Case 1: People's knowledge appears to be more accurate and useful for planning purposes, because it portrays land use rather than land cover. JAFTA/NAMRIA interpretation of satellite imagery definitely lacked ground truthing. 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 (Appendices 5, 7 and 11) 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 5, simply taking into account the protected area boundary, communication ways, land use and household distribution. The first hot spot is located in the southwestern and the second in the northeastern 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 8) contains six categories of land cover, half of those (12) contained in the map produced on the basis of the 3-D model (Appendix 7). 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 uses/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).

Again, the 3-D model has been useful in identifying possible hotspots.

Appendices 10 and 7 describe the distribution of households. Appendix 7 combines different layers of information and shows an on-going settlement trend (i.e. trail and households) in the northwestern portion of the protected area. This could lead, in the short term, to the "ecological" separation of approximately 20% of the territory from the main body of the protected area. This hot spot is by no means detectable from the map shown in Appendix 8.

The map shown in Appendix 12 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.

Essentials of Protected Area Management in the Philippines



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