Adding the fourth dimension to Participatory 3-D Modelling

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Introduction

This article focuses on Participatory 3-D Modelling (P3-DM), a tool which merges Geographic Information System (GIS)-generated data and peoples' knowledge to produce a stand-alone relief model. The model provides stakeholders with an efficient, user-friendly and relatively accurate spatial research, planning and management tool, the information from which can be extracted and further elaborated by the GIS. Regular updating of the model allows for monitoring change and for integrating the fourth dimension, time, into the system. Therefore, by combining 3-D models with GIS, it is possible to implement (participatory) monitoring and evaluation over large areas.

The 3-D modelling process and its output (the scaled relief model) are the foundations upon which participatory GIS can release its full potential.

Background

In recent years there has been a strong drive towards integrating Geographic Information Systems (GIS) into participatory planning, particularly to deal with spatial information gathering and decision-making. A strong debate has sprung out of the concern that the nature of and access to GIS simultaneously marginalises or empowers different groups in society with opposing interests (Poiker T. and Sheppard E., 1995). After much debate and several workshops, what has formally emerged is:

- the need to define 'best practice', allowing for true participation in generating accurate spatial information;
- the importance of determining the 'added value' of using GIS and what the nature of participation should be;
- the need to place emphasis on detailed monitoring and evaluation of processes, methods, accuracy and outcomes;
- the fact that the use of GIS means that accuracy issues become important, which has profound implications for the classic spatial participatory tools such as participatory sketch mapping (Jordan G., 1999).

Context

In line with the 1992 Earth Summit, the European Union and the Government of the Philippines[1], initiated and co-financed the National Integrated Protected Areas Programme (NIPAP). This is a five-year (1995-2000) intervention aimed at establishing eight[2] protected areas within the framework of the Philippine protected area system. The system strongly supports the participation of local communities in planning and implementing policies and actions to conserve biodiversity. 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 protected area management.

Visualising information

NIPAP started participatory research in 1996. Protected area dependent communities were introduced to participatory approaches in data collation, analysis and interpretation. Spatial methods, such as participatory resource mapping, were readily adopted, yet with reservations about 'translating' sketch maps into more precise, useable information. Experience has subsequently suggested that formal institutions tend to pay little attention to sketch maps.

In 1997, the Programme developed a method, called *Two-Stage Resource Mapping*. In this method, local stakeholders produced sketch maps which were transferred to topographical maps. Then, after community validation, the data was transferred to the GIS. Plotted data was then returned to the community for further validation and consultation on zoning within the protected area. While the method integrated people's knowledge with additional resource management information and returned the output to the communities, it was observed that the basic input – the participatory resource maps – was spatially confined to the social,

1 Protected Areas and Wildlife Bureau, Department of Environment and Natural Resources.

2 Mt. Guiting-Guiting Natural Park (Romblon), Mt. Isarog National Park (Camarines Sur), Mt. Malindang National Park (Misamis Occidental), Mt. Pulag National Park (Benguet, Ifugao & Nueva Vizcaya), (Palawan), Mts. Iglit-Baco National Park (Occidental and Oriental Mindoro), El Nido-Taytay Managed Resources Protected Area; Coron Island; Malampaya Sound Protected Land and Seascape, Taytay (Palawan).

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 a number of different administrative units, the production of a sufficient number of community-specific sketch maps became unrealistic in both practical and financial terms. The Programme also acknowledges that the analysis was done far from the field. Communities were presented, after several months, with GIS outputs for their comments, rather than being provided with a tool enabling them to analyse the protected area locally from the onset. Committed to involving protected area-dependent communities in the planning process, the Programme was faced with the challenge of how to provide *all* stakeholders the opportunity to portray their domain as they knew it through an accessible medium.

Making information tangible through participatory 3-D models

A solution was found through the collation and plotting of data on scale relief models through a process as outlined in Figure 1. The methodology is based on the integration of participatory spatial research tools and scaled spatial information (contour lines) provided through a GIS. Stakeholders are consulted on their interest in the construction of a locally based 3-D model for planning, management and monitoring purposes. Then, the GIS produces a contour map at the desired scale (e.g. 1:10,000) including the protected area, buffer zones and other features of economic and ecological relevance. Materials for the model are provided and the community is mobilised for the phase where research, analysis and diagnosis are done sequentially. The first step consists of making the blank relief model. What follows represents the most important part of 3-D modelling and is based on the contribution of key informants and representatives from all stakeholder groups, who are involved in a voluntary capacity.

Women's participation is encouraged to accommodate gender-related knowledge and perceptions. A legend is prepared for the model and participants are briefed on the process of transferring their knowledge ('*mental maps*') to the blank model.

They are given pushpins, yarns and small labels, and asked to identify, locate and name in sequential order water

Figure 1 The participatory 3-D Modelling process

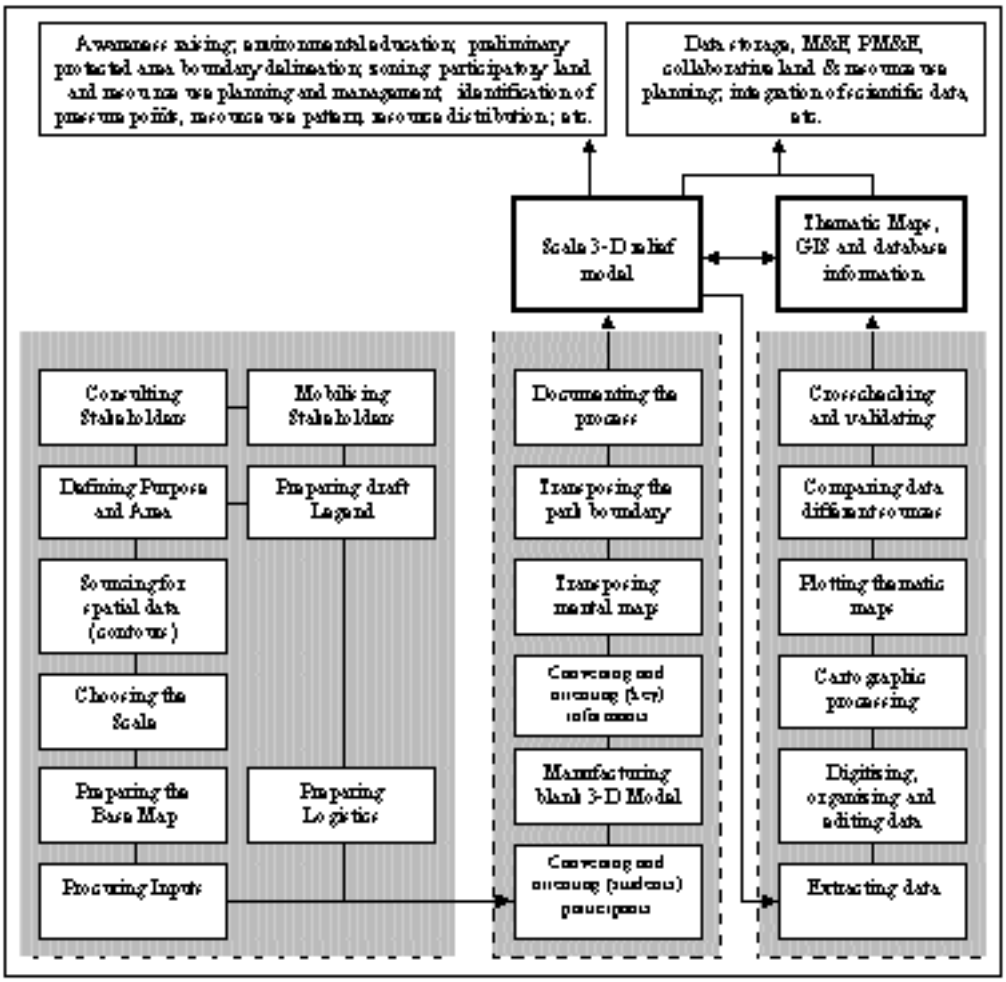
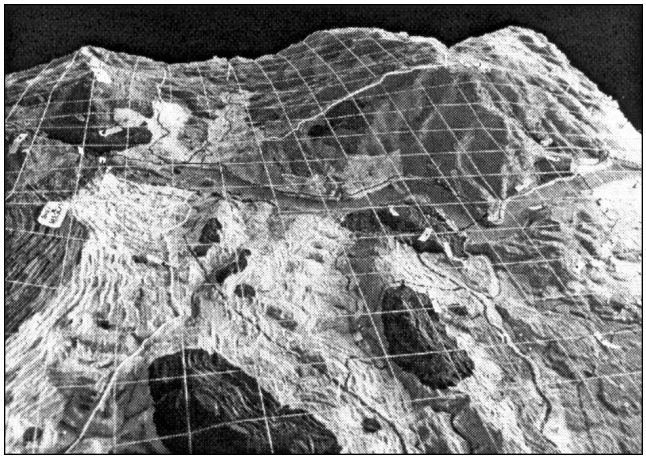


Figure 2 Capitalising on women's perspectives

Figure 3 The geo-referenced grid is in place



courses, roads, mountain peaks, islets, trails, social and cultural features and other landmarks used to orient themselves when moving around their domains. This allows the participants to get a progressively deeper grasp of their whereabouts vis-à-vis the relief model.

Participants are then invited to delineate, using coloured yarns, vegetation types, land uses, and other features (e.g. sacred areas, burial grounds, etc.) that they consider to be relevant.

The initial contouring of areas, by the use of yarns and pushpins instead of direct painting, allows participants to discuss the outlining, modify and mutually agree on single items of data. Once consensus has been reached, coloured paint is applied, appropriately coded. The process generates great momentum and animated discussions.

The process facilitates concurrent participation of men and women (see Figure 2), people from different neighbourhoods, social, educational, cultural and economic backgrounds. It allows for *on-the-spot* validation of the displayed information.

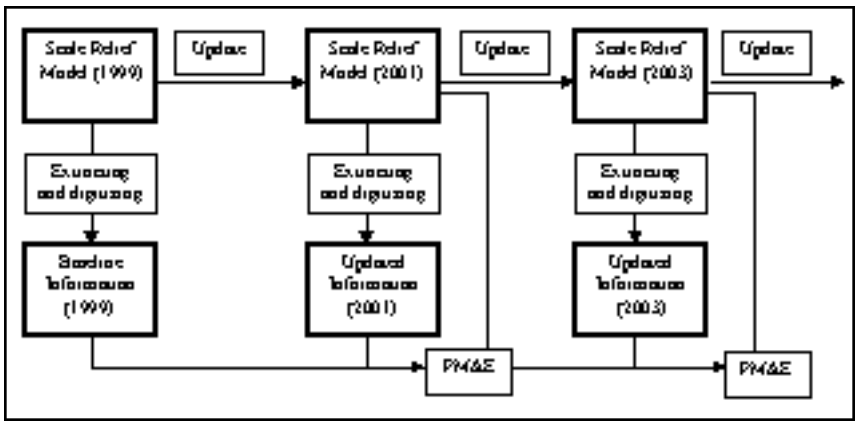
At this stage the relief model contains spatially defined detailed information on land use and land cover, settlements, communications, social infrastructure, sacred places and many other features. The output is self-contained and can be used as it stands for the desired analysis. Nonetheless, within the context of the Programme discussions centred on use of and access to resources located within a protected area could be initiated only after visualising the protected area's boundary. Then, GIS generated information is bought back into the process. Based on the outline of the source map, a geo-referenced scaled grid is placed on the top of the relief (see Figure 3). At the end of the exercise, the outline of the protected area boundary is visible to everybody. The relief model is now ready for being used for any type of discussion on resource use, distribution and access, for participatory problem analysis and for planning. However, the reader should never consider that a P3-D model is ever complete. Like any dynamic system, changes are constant and the model (like a GIS) can accommodate regular updating. Unfortunately a relief model cannot memorise past scenarios. This is the context where GIS 'adds value' and becomes a vital ingredient for Participatory Monitoring and Evaluation (PM&E).

Bringing-in the fourth dimension

Updated at regular two to three year intervals, a 3-D model allows for actual Participatory Monitoring and Evaluation (PM&E) as shown in Figure 4. This is based on the assumption that data contained in the model are updated and periodically extracted, digitised and plotted in the form of thematic maps.

In doing participatory monitoring and evaluation (PM&E), communities usually compare sketch maps, transect diagrams or other conventional spatial tools, produced at different times. However, this is weakened by the outputs

Figure 4 How to combine P3-DM and GIS to implement PM&E



not being geo-referenced and properly coded. 3-D modelling overcomes this weakness, because the basis – the relief model – is constant and the coding is clearly defined in the legend and embedded in the model.

Linking people's knowledge to the Geographic Information System

In order to use the 3-D model for PM&E, the information has to be extracted and stored. In practice, whatever is displayed on the model is transferred to transparent, grid-referenced plastic sheets. Attributes (non-graphic information such as descriptions of land use etc.) are consigned to a legend. Plastic sheets and accompanying notes are handed over to the GIS, which digitises, stores and edits the data. Administrative boundaries are integrated and attributes are assigned to points, lines and polygons.

Experience has shown that 'pooled people's knowledge' merged with traditional spatial information (contours) is not only accurate but more up to date than that maintained in official circles (see Box 1). The physical outputs of the process are therefore two: the relief model and the GIS-generated maps. Both are permanently displayed within the proprietor community.

Box 1 Whose knowledge counts?

During P3-D modelling exercises, participants corrected information already mapped (e.g. 'these roads do not exist anymore', 'there is a road missing here' etc.). Indigenous people rectified the names of important landmarks appearing on official maps. People's knowledge proved to be more accurate and diversified when comparing land use and land cover derived from P3-D models with satellite interpreted imagery. For example:

- In the Cordillera (Luzon) large areas classified as *grassland* by JAFT/NAMRIA (1994), were portrayed as *vegetable gardens* and *rice fields*. Field verification confirmed the people's view.
- Participants in Rizal (Luzon) pointed out that an entire hill portrayed on the source map no longer existed due to rampant quarry activities. The model now reflects the real situation.

All models contain information not detectable through satellite imagery or aerial photography. This relates to all socio-economic and cultural features.

The use of P3-D Models in protected area planning and management

As shown in Table 1, eight relief models have been constructed in the framework of the Programme. Five are confined to inland ecosystems, while those of the El Nido, Malampaya Sound and Mount Guiting-guiting include coastal and marine areas.

Protected areas listed in the table are distributed throughout the Philippines. In the construction of the 3-D models, remarkable differences have been noticed in terms of participation among different sites. Upland, indigenous people proved to be the most committed and knowledgeable in terms of natural resources, names of locations and distribution of traditional use zones. Farmers know the territory at walking distance from their farm, while small-scale fisherfolk would be conversant with coastal and marine areas stretching over tens of kilometres of coastline. Men would be conversant with fishing and hunting grounds, while women with the location of social infrastructure, households and farmland. Except for a few cases of dominant informants, no conflicts emerged between different groups.

Women's participation has been variable (see Table 1), depending mainly on local cultural norms, geographical coverage and location of the Protected Area. In Mount Pulag for example, where we registered the lowest level of female participation, society is typically male-dominated, families are large and women are busy with household chores and their vegetable gardens. To participate in exercises conducted over vast areas such as Mt. Malindang, El Nido and Malampaya Sound frequently requires that participants travel over long distances and are absent from home for some days, which a mother of young children can hardly afford. Urban centres located close to Protected Areas (Mt. Guiting-guiting and Mt. Isarog National Park), produced higher percentages of female participants, probably due to the greater freedom enjoyed by urban women.

Once completed, the models (and the GIS-generated maps) have been entrusted to the Protected Area Management Boards (care of one municipality) or to the concerned Protected Area Offices. All are used for the following:

- involving communities in developing management, zoning and resource use plans, and in geo-referencing their priorities, aspirations, concerns and needs;
- overall protected area planning, management and monitoring;
- conducting preliminary consultations on boundary delineation;
- monitoring the dynamics of settlements, infrastructures and access points vis-à-vis the protected areas;

- substantiating public hearings and planning workshops;
- introducing visitors to the area;
- teaching local geography and enhancing the interest of students and residents in the conservation and/or restoration of natural resources; and,
- identifying the distribution of selected species within the protected areas and their buffer zones.

Box 2 A call for caution

P3-D models facilitate the selective pin-pointing of resources, households and other features. This feature can have positive and negative effects. Because of their accuracy, P3-D Models, alone or combined with GIS, turn local knowledge into public knowledge and conceivably out of local control. This can be used by outsiders to locate resources and development needs, or merely, to extract more resources, or to increase control from the outside. (J. Abbot *et al.* 1999).

Planners should be aware of these realities and be careful in applying this process. Thus, plotting endangered species, hardwoods, and other resources in demand on the black market, should be done with caution and invariably behind closed doors in the course of focus groups discussions. This sensitive information should be removed from the model before displaying it to the public.

It follows that maps produced on the basis of "pooled community knowledge" should be filtered in the interest of the community, by the people and with the people to fit a specific purpose and a selected audience.

Lessons learned

Relief models are excellent visual aids capturing the ruggedness and details of the territory. Compared to data appearing on a planimetric map (e.g. contour lines), a relief model facilitates interpretation and understanding.

P3-D Models provide local stakeholders and official policy makers with a powerful medium for negotiation, easing communication and language barriers. Especially when dealing with relatively extensive and remote areas, P-3D modelling bridges logistical and practical constraints and facilitates public participation in land/resource use planning and management.

Considering that in most protected areas of the Philippines no boundary has yet been demarcated, relief models allow stakeholders to get a first time understanding of their location. This certainly facilitates the processes of boundary delineation and zoning, both activities otherwise characterised by heavy logistics and lengthy negotiations. In most cases Local Government Units (LGUs) become custodians of the models and the driving force for their regular updating. LGUs' interest in P3-D models is not limited to environmental issues. They see their use for infrastructure and tourism development, water delivery, land tenure, tax mapping and delineation of political boundaries.

Table 1 Participatory 3-D models produced in the framework of the Programme

Protected Area	Scale	Area (km2)	Active participants (no.)	Women's participation (%)	Working days (no.)
Mt. Pulag National Park (Benguet, Nueva Vizcaya and Ifugao)	1:10,000	360	75	19%	270
Mt. Isarog National Park (Camarines Sur)	1:10,000	480	101	28%	277
Mt. Malindang National Park, (Misamis Occidental)	1:10,000	1,176	119	21%	376
Pamitinan Protected Landscape (Rizal)	1: 2,000	17	93	52%	300
Mt. Guiting-guiting Natural Park (Romblon)	1:10,000	896	101	31%	261
Community-based Forest Management Area in the Buffer Zone of Mt. Guiting-guiting Natural Park	1: 5,000	10	10	30%	40
El Nido-Taytay Managed Resources Protected Area (Palawan)	1:20,000	1,968	70	23%	190
Malampaya Sound Protected Land and Seascape (Palawan)	1:20,000 (*)	3,016	87	23%	246

(*) Differentiated scaling (1:20,000 horizontal; 1:10,000 vertical) has been adopted in Malampaya Sound to enhance the perception of slope.

P3-D Modelling has many positive edges, but it is a demanding process entailing initial (mandatory) and final (optional) services of a Geographic Information System, accurate procurement of supplies, thorough groundwork to mobilise participants, skilled facilitators, space for storage and display and caretakers.

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 internalise the model and to transpose their knowledge. A solution could be 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.

Lastly, relief models are hard to move around. Digitising the information and plotting it on paper maps, which are easy to store and carry around, partially overcome this.

Conclusion

In the context of the Philippines, Participatory 3-D modelling proved to be an extremely efficient community-based planning and management tool. With some additional improvements it may be viewed as 'best practice' for allowing true participation in generating accurate geo-referenced information. Combined with GIS, it opens the doors to collaborative planning and effective Participatory Monitoring and Evaluation.

Furthermore, the NIPAP experience illustrates that 3-D models produced through collaborative processes generate a long-lasting enthusiasm among participants and an enormous amount of information is collated and permanently displayed at community level, where it is readily accessible to all stakeholders, local residents and outsiders.

Participants and users get a '*bird's eye view*' of their environment. This enhances analytical skills, broadens perspectives on interlocked ecosystems and helps in dealing with issues and conflicts associated with the territory and resource use. Because all stakeholders play an active role in the realisation of the models, both administrators and communities easily understand the medium. A relief model makes information tangible, eases communication, helps bridge language barriers and increases the potential of all stakeholders to deal with their constituencies, central government and outsider institutions that are part of the concerned area. In the Philippines the integration of P3-DM and GIS is proving to be useful in the process of establishing and managing natural resources through a genuine participatory approach.

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