Exploring the Synergies of GIS and Participatory 3-D Modeling to Increase Local Communication Capacity[1]

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Summary

This paper focuses on Participatory 3-D Modeling (P3DM), 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. The 3-D modeling process and its output (the scaled relief model) are the foundations upon which participatory GIS can release its full potential increasing the capacity of local stakeholders to interact with national and international institutions. 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 modeling bridges logistical and practical constraints and facilitates public participation in land/resource use planning and management.

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 marginalizes or empowers different groups in society with opposing interests (Poiker T. and Sheppard E., 1995). A workshop on the matter took place in Durham (UK) in 1998. Researchers and practitioners debated the pros and cons of combining participatory research and GIS. The outputs of the event, well summarized in PLA Notes 33, 1998 (Abbot. J et al. 1998), counsel caution in using "community-integrated GIS", especially in terms of final ownership and use of the generated information.

A follow-up workshop held in Santa Barbara (USA) in 1998 reminded us that the use of GIS in a genuine participatory context is still in its infancy. A number of cases presented as "participatory applications" of GIS merely used demographic information or secondary data within a standard GIS environment (Jordan G., 1999). What has formally emerged is (a) the need to define "best practice", allowing for true participation in generating accurate spatial information; (b) the importance of determining the "added value" of using GIS and what the nature of participation should be, (c) the need to place emphasis on detailed monitoring and evaluation of processes, methods, accuracy and outcomes; (d) 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[2], initiated and co-finance the National Integrated Protected Areas Programme (NIPAP). This is a

[1] Adapted from *Adding the fourth dimension to Participatory 3-D Modelling*, by Giacomo Rambaldi, Marlynn Mendoza and Fernando Ramirez, PLA Notes 39, 2000

[2] Protected Areas and Wildlife Bureau, Department of Environment and Natural Resources.

five-year (1995-2000) intervention aimed at establishing eight[1] 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.

While the relevant legislation 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.

● Visualizing 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 transect diagramming and participatory resource mapping were readily adopted, yet with reservations about "translating" sketch maps into more precise, useable information. More importantly, experience has subsequently suggested that formal institutions tend to pay little attention to sketch maps.

In 1997, with the objective of generating durable, true-to-scale and "meaningful-to-all" information, the Programme developed a method, called *Two-Stage Resource Mapping.* Representatives from different local administrative units (barangays), together with local communities, produced resource sketch maps. Thereafter, they transferred the information to blown-up topographical maps. After a final community validation, the outputs were extracted and transferred with minimal distortion to the GIS. Plotted data were then returned to the communities for validation and were used in subsequent consultations on zoning within the protected area.

While the method integrated people's knowledge and perceptions with additional resource management information, and returned the output to the communities for further use, 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 administrative units (65 in the case of Mt. Malindang National Park), the production of a sufficient number of community-specific sketch maps became unrealistic from both practical and financial points of view. Furthermore, the Programme had to acknowledge that a consistent part of the comprehensive analysis was done far from the field. Communities were presented, after several months, with GIS outputs for their comments, 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, but all this was linked to the nature of the areas, covering extensive terrestrial and marine components and diverse ecosystems.

Committed to involving protected area-dependent communities in the planning process, the Programme was faced with the challenge on how to provide <u>all</u> stakeholders the opportunity to

[1] 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 Landscape and Seascape, Taytay and San Vicente (Palawan).

portray their domain as they view and know it and to avail themselves of an accessible medium understood by all.

• Making information tangible through Participatory 3-D Models

An answer suggested itself in the collation and plotting of data on scale relief models through a process 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.

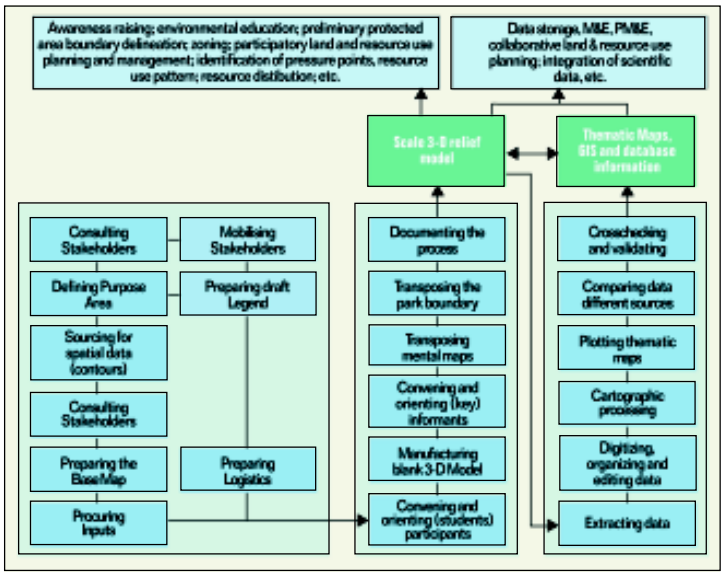

Figure 1 Process and means (P3DM & GIS) for integrating "PeopleTech" and "HighTech"

Stakeholders are consulted on their interest in availing of a locally based 3-D model for planning, management and monitoring purposes. A consensus obtained, mobilization starts: 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. Facilitators procure the necessary inputs and mobilize the community for the phase where research, analysis and diagnosis are done sequentially.

High school students are best involved in assembling the scaled blank relief model where key informants are later assisted in transposing their knowledge (*"mental maps"*). Informants include elders, indigenous people, other community representatives from the various activity sectors (fisherfolk, farmers, forest dwellers, etc.) national and local government officials, non-governmental organizations, etc, all contributing in a voluntary capacity. A legend is prepared according to an array of colours and various media (pushpins, yarn and paint) *(see Table 1).*

Figure 2 Indigenous people transposing their knowledge

Figure 3 Capitalising on women's perspectives

The process facilitates concurrent participation of men and women *(Figures 2 and 3),* people from different neighborhoods, social, educational, cultural and economic backgrounds allowing for *on-the-spot* validation of the displayed information.

	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 l); 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	**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.**

Table 1 "Features" and the means to code and display them

Once completed, 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 purpose. Nonetheless, discussions centered on use of and access to resources located within a protected area can be initiated only after visualizing the protected area's boundary.

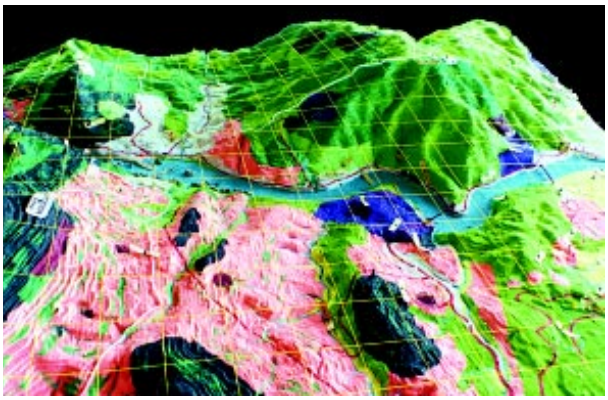

Figure 4 The geo-referenced grid is in place

At this stage, GIS-generated information comes back onto the scene.

Based on the outline of the source map, a geo-referenced scaled grid is placed on the top of the relief *(Figure 4)*. For 1:10,000 scale models, the grid has 10-cm intervals. The resulting squares correspond to 100 hectares. Latitude and longitude co-ordinates of the boundary corners are identified on the source map and reflected on the relief model. The corners are connected by the use of a color-coded yarn. 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.

• Linking People's knowledge to the Geographic Information System

In order to use the 3-D model for Participatory M&E or for combining thematic layers of different sources, the information has to be extracted and stored. In practice, whatever is displayed on the model is transferred to transparent, grid-referenced plastic sheets (Figure 5) in

Figure 5 Information is extracted

the form of points, lines and polygons. Attributes (non-graphic information like names, descriptions of land use or cover, etc.) are consigned to a legend. Plastic sheets and accompanying notes are handed over to the GIS, which digitizes, stores and edits the data. Administrative boundaries are integrated and attributes are assigned to points, lines and polygons.

Colors and symbols are allocated to the different attributes. A legend is prepared and joined to other cartographic information like scale, title, source of information (including date), co-ordinates, directional arrows, etc. Customized thematic maps are produced at the desired scale.

Outputs are then compared with other existing spatial information, like maps produced from satellite-interpreted imagery. In the cases examined by the Programme, maps based on people's knowledge contained many more features and were more detailed than satellites interpreted information.

Inconsistencies among data sets were encountered in almost all sites. Validation has been done in the field by reconvening around the P3-D Models with a sufficient number of residents or through direct on-field investigation.

Experience has shown that "pooled people's knowledge" merged with traditional spatial information (contours) is not only accurate but more detailed and updated than that maintained in official circles.

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.

• The use of P3-D Models in Protected Area Planning and Management

As shown in Table 2, nine relief models have been constructed in the framework of the Programme. Six are confined to inland ecosystems, while those of the El Nido, Malampaya Sound and Mount Guiting-guiting include coastal and marine areas.

Protected Area	Scale	Area (km^2)	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%	27
Mt. Malindang National Park, (Misamis Occidental)	1:10,000	1,176	119	21%	376
Province of Misamis Occidental and portions of Zamboanga del Norte and del Sur (Mt. Malindang National Park)	1:50,000	4,056	27	20%	120
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.

Figure 2 Participatory 3-D models produced in the framework of the Programme

Protected areas listed in the table are distributed throughout the Philippines. Mt. Pulag National Park, the most northern, is located in the Provinces of Benguet, Ifugao and Nueva Vizcaya and is inhabited prevailingly by Indigenous Peoples, the Kalanguya, the Ibaloy and the Kankana-ey. The most southerly, Mt. Malindang National Park, is located in Mindanao and is ancestral land of the Subanen community. Two Palawan sites, El Nido and Malampaya Sound are settled mainly by recent migrants. Mt. Guiting-guiting and Mt. Isarog are based in the provinces Romblon and Camarines Sur respectively and are home of a mix of indigenous groups and contemporary migrants.

Figure 6 1:10,000-scale relief model of Mt. Malindang National Park and environs

Once completed (see Figure 6), 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.

• The P3-D Models and GIS

The 3-D modeling process and its output (the scaled relief model) are the foundations upon which participatory GIS can release its full potential increasing the capacity of local stakeholders to interact with national and international institutions.

In fact the models and derived maps allow local stakeholders to:

- Use geo-referenced cartographic information – based on people's knowledge - in official and legal contexts, to assert rights over land and waters;
- Use the models and the maps as a means to communicate with external agencies, geo-coding their priorities, aspirations, concerns and needs;
- Play an active role in developing management, zoning and resource use plans and lead in delineating boundaries;
- Conserve and reinforce local/traditional knowledge;
- Teach local geography and enhance the interest of younger generations in the conserving and/or restoring natural resources;
- Discuss environmental, land tenure, ancestral rights issues and resolve internal conflicts;
- Monitor changes in settlement pattern, land use and vegetation cover;
- Introduce visitors to the area.

• Lessons learned

- 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. Information portrayed through shape, coded materials and colors is made tangible and meaningful-to-all. It eases communication and language barriers. Two-dimensional maps cannot match their impact and appeal. Compared to data appearing on a planimetric map (e.g. contour lines), a relief model enormously facilitates their assimilation, interpretation and understanding.

- Process and output have proven to fuel self-esteem, awareness of interlocked ecosystems and intellectual ownership of the territory.
- Especially when dealing with relatively extensive and remote areas, P-3D modeling bridges logistical and practical constraints and facilitates public participation in land/resource use planning and management.
- 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.
- P3-D Modeling has many positive edges, but it is a demanding process entailing initial and final services of a Geographic Information System, accurate procurement of supplies, thorough groundwork to mobilize participants, skilled facilitators, space for storage and display, and caretakers. 3-D models are hard to move around. Digitizing the information and plotting it on paper maps, overcome this.
- A P3-D model is never completed. Like any dynamic system, changes are constant and the model (like a GIS) can accommodate regular updating. Unfortunately a relief model cannot memorize past scenarios. This is the context where GIS "adds value" and becomes a vital ingredient for Participatory Monitoring and Evaluation (PM&E).

Updated at regular 2-3 year intervals, a 3-D model allows for actual Participatory Monitoring and Evaluation (PM&E) as shown in Figure 7. This is based on the assumption that data contained in the model are dutifully updated and periodically extracted, digitised and plotted in the form of thematic maps.

Conclusions

In the context of the Philippines, P3DM has gained tremendous interest. It has proved to be an extremely efficient community-based management and communication tool.

With some additional improvements it may be viewed as "best practice" for allowing true participation in generating accurate geo-referenced information. The P3-DM process generates a tremendous and long-lasting enthusiasm among participants and generally among the concerned constituencies.

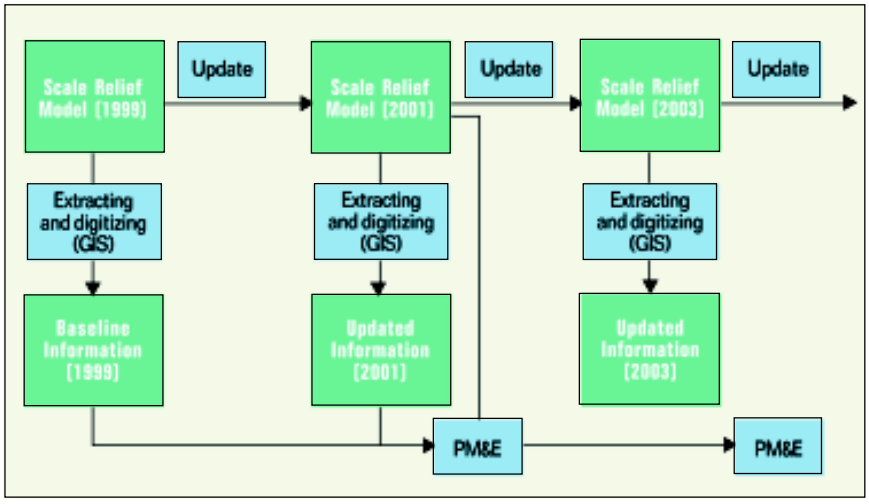

Figure 7 How to combine P3-DM and GIS to implement PM&E

As distinct from sketch maps or sole GIS outputs, a well-displayed and properly stored 3-D model is appealing, fuels community-esteem and sense of intellectual ownership. An enormous amount of information is collated and permanently displayed at community level, where it is readily accessible to local residents and outsiders. A model becomes finally part of the local cultural landscape.
The 3-D modeling process and its output (the relief model) are the foundations upon which participatory GIS can release its full potential. The synergy resulting from combining P3DM and GIS results in a powerful communication medium which increases the capacity of local stakeholders and official policy makers to interact with external agencies and central government.

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NOTES

Additional information and updates on P3-DM are available on the web site **Participatory Avenues** at http://www.iapad.org

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