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for
Environmental Mainstreaming

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PARTICIPATORY GEOGRAPHICAL INFORMATION SYSTEM

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PARTICIPATORY GEOGRAPHIC INFORMATION SYSTEMS (PGIS)

Note: We are grateful for review comments provided by Michael McCall (International Institute for GeoInformation Science and Earth Observation (ITC), Enschede, The Netherlands), and Jon Corbett (University of British Columbia, Canada).

What is PGIS for?

Policy development	√	
Planning	√	
Field work	√	
Investment	√	
Assessment	√	
Monitoring	√	
Campaigning		

What issues does PGIS focus on?

Environmental	√
Social	√
Economic	√
Institutional	√

Purpose

Participatory GIS (Geographic Information Systems), PGIS, is an umbrella term that described the community application of a diverse range of geographic information technologies and systems (GIT&S). PGIS practice is based on using geo-spatial information management tools to represent peoples' local spatial knowledge in the forms of virtual or physical, 2 or 3 dimensional maps. Many tools and approaches can be used (see Annex 1), eg: ephemeral maps (drawn on the ground, in sand, etc.) and sketch maps (including drawing mental maps); scale mapping (overlay drawing of spatial information onto existing topographic base maps), and similarly adding spatial information via overlays onto aerial photographs; satellite imagery; community surveying of new information using global positioning systems (GPS); incorporating this spatial information into GIS format; dynamic and web-based mapping; participatory 3-D models (P3DM); photography and video, etc.

These can be used as interactive vehicles for discussion, information exchange, analysis and support (adding authority to local knowledge and community confidence) in advocacy, decision-making and action-taking. GIS is used mainly as computer cartography with limited GIS analytical functionality. Users employ the outputs mainly as media (re: the power of the map!) to support their arguments.

McCall (2004) notes that PGIS practice has been most widely applied to natural resource management and to land and resource claims in developing countries (with some examples in developed countries). The rural applications are mainly in natural resource identification and management (especially for forests), or environmental hazard mapping. Native (indigenous) peoples in both North and South utilise PGIS for legitimising customary land and resource claims, e.g. Canada, USA, Australia, NZ, Philippines, Indonesia, South Africa, Brazil, and Peru. Applications to urban issues - community neighbourhood identification, problem prioritisation, and participatory planning, environmental and security risk assessment, etc are mainly found in North societies (with a few South examples).

Participatory Mapping and PGIS is Special

The most significant and valuable contribution of PMapping/PGIS is that it elicits, represents and validates local (including indigenous) spatial knowledge (but is rarely available on official maps/GIS). It provides:

- *Spatial specificity*: information about local interests & priorities, values and perceptions.
- *Social Inclusivity*: it can be representative of communities, as well as individuals.

- *Local and external knowledge* - local, indigenous knowledge, sacred knowledge, gendered knowledge - knowledge that doesn't necessarily conform to state visions of place; integrated with scientific knowledge of e.g. implications of global climate change, globalization and urbanization.
- *Visual images as "spatial narratives"*. Pictures are rich in information and shared understanding, and increase information both quantitatively and qualitatively. Visual images often provide the conviction' factor, though this may have negative as well as positive implications.
- *Multi-sourcing*: involves multiple processes of people's participation in knowledge identification and selection. There are many opportunities for cross-checking and alternative validations.
- *Capacity-enhancement*: communities / groups can be empowered by involvement in PGIS processes – improving self–confidence and technical/ political capacities.

Background facts

The1990s saw the diffusion of modern spatial information technologies including GIS, low-cost global positioning systems (GPS), remote sensing image analysis software, open access to data via the Internet and steadily decreasing cost of computer hardware. Spatial data, previously controlled by government institutions became progressively more accessible to and mastered by non-governmental and community-based organizations, minority groups and sectors of society traditionally disenfranchised by maps and marginalized from decision making processes. This new environment facilitated the integration of geographic information technologies and systems (GIT&S) into community-centred initiatives.

Standard GIS creates much value-added to conventional mapping on paper, providing the ability to:
- handle multiple data layers (overlays) for analysis and presentation;
- work across multiple scales and topographies (scale comparisons, zooming-in);
- combine data on different issues (eg transportation, hazards, socio-economic), and from different formats (eg satellite, paper) and sources (local, external, scientific);
- undertake spatial analysis of e.g. proximity, buffer zones, threshold distances overlaying different types of land use, efficient routes and networks (e.g. of people, or roads etc.);
- view time series - for temporal comparisons,
- visualise –spatial visualisations (maps, GIS) are particularly valuable in scenario development and exploration. e.g. to consider alternative futures;
- handle spatial queries (where is …?, what is at …?);
- record, protect, exchange and share spatial information in digital and analogue formats.

However, standard GIS had been found wanting in many dimensions, - in 'objectivity', value-neutrality, access, ownership, democratic representation, control, privacy, confidentiality, ethics and public service values. There were many calls to develop and legitimise an 'alternative GIS incorporating people's participation' and practitioners and research began to adopt a variety of GIT&S to integrate multiple realities and diverse forms of information to foster social learning (originally called "counter mapping" (Peluso, 1995), support two-way communication and broaden public participation across socio-economic contexts, locations and sectors. This spurred the rapid development in community-based management of spatial information through what is now generally termed Participatory GIS (PGIS), building on experience of Participatory Rural Appraisal (PRA) methods (i.e. sketch mapping) that emerged earlier in the 1980s.

Brief description of the main steps involved in application of the tool:

PGIS practice is usually geared towards community empowerment through measured, demand-driven, user-friendly and integrated applications of GIT&S, where maps become a major conduit in the process.

The practice is multidisciplinary and relies on the integration of 'expert' with socially and gender differentiated local knowledge, and builds on high levels of stakeholders' participation in the processes of spatial learning, analysis, decision making and action.

From widely accumulated experiences McCall (2004) suggests a number of key factors and conditions related to 'good practice' for local communities using PGIS methods (Box 1).

Box 1: Preconditions, processes and procedures for PGIS

Pre-conditions for PGIS.

1. "Purpose, - which purpose?, whose purpose?" – a key need is analytical clarity about the purpose of the PGIS exercise. The purpose can be translated into the competing intentions of participation – facilitation, collaboration, and empowerment.

2. Local communities are the principals or partners, not the clients. Thus the PGIS initiatives emanate from them, not from the outside.

3. Ownership of the products as well as the information/ knowledge inputs:
   - Who determines the purpose of the map?
   - Who decides on the priorities between interests and issues?
   - Who selects the information to be included?
   - Who decides on the sources of information, including the choice of "key informants"?
   - Who decides on the legend? i.e. what items will be located on the map.
   - What are the spatial extent & limits of the P-mapping exercise, the boundaries. (It always depends on the purpose).

4. A pre-condition is that the legislative, legal and political climate must be amenable and supportive to participation values. This may not (is unlikely to) be fully met, so the activities will need to be directed towards strengthening political forces towards this.

5. PGIS is usually directed towards the marginalized, the unrepresented, the inarticulate, the resource-poor, the power-deficient. There can be positive discrimination towards disadvantaged peoples identified by gender, age, wealth, resource levels, caste, religion, class, location, etc.

6. Avoid raising expectations. Any process facilitated by outsiders is liable to raise expectations of benefits.

7. Envision collaboratively from the start, what are the geo-spatial information outputs / products going to be? – And, are they of use to anyone? – if so, for whom? This would usually imply that the products should be simple, clear, understandable, testable, and convincing, as well as relevant, reliable, logical, replicable, and coherent.

8. Consider collaboratively what might be the negative impacts of the outputs – Participatory spatial planning (PSP) and participatory mapping (P-mapping) can lead to more conflicts, and more concentration of power or resources in a few hands.

9. Consider beforehand what are the likely needs for confidentiality of spatial information – these range from the locations of rare species or valuable medicinal plants, to secret sacred sites. Avoid exposing people to danger

10. Despite the necessity for a long-range vision, nevertheless, the approach should remain flexible, adaptive, and recursive in the actual approach, without sticking rigidly to pre-determined tools and techniques, or blindly to the initial objectives (participation is learning).

11. Participation is always a learning process – best if it is learning in two directions-: External experts learn the interests, objectives, limitations, constraints, and variability from the insiders. Insiders (community traditional leaders, elected leaders, NGO, CBO, civil society, etc) learn from the expert (planner, GIS, mapper, geographer, doorkeeper to outside knowledge, contact with outside power). Insiders learn technical knowledge, and new technical, economic and social skills, but also a wider vision.

12. Participation is always slow – by procedural design, if not even by definition; this is true also of

PRA, P-mapping, and P-GIS. Nevertheless, the output results should be as timely as possible.

13. Adherence to deep Participatory Rural Appraisal (PRA) and Participatory Rapid Rural Appraisal (P-RRA) principles and methodology, especially in terms of their information needs assessment; and not just blindly use the tools of RRA to exploit local knowledge.

14. Follow international survey guidelines such as the AAA (American Anthropological Association) Code of Ethics that reminds anthropologists that they are responsible not only for factual content of information, but also the socio-cultural and political implications

Process and Procedures:

1. Essential element is the indigenous technical and management knowledge (ITK) and local expertise, seeking to understand local culture, society, spatial cognition, and livelihoods, local resources, hazards and options, etc.

2. Usually there is special need for the historical perspective in local and indigenous knowledge and local spatial knowledge LSK) - conflict analysis especially needs a historical understanding.

3. Make full use of non-conventional information and knowledge acquisition – semi-structured interviews, open-ended discussions, stories, songs, pictures, serendipitous meetings, and the panoply of RRA/PRA methods.

4. Collaborative, scientific selection of appropriate software and hardware by insiders and outsiders together.

5. Acquisition of professional geospatial information - base maps, aerial photos, remote sensing imagery, etc. Also, conventional a-spatial information sources: documents, censuses, reports, etc.

6. Prepare in advance for any desired protection of data layers. How can they be protected? How accessed? etc. Clarify the current and future status of the ownership of Indigenous Technical Knowledge and LSK, taking into account guidelines on the protection of Indigenous Intellectual Property Rights.

7. Apply local indigenous spatial knowledge concepts of boundaries, core areas, conflict and risk zones, resources, priority areas, time-distance relations, dynamic spaces and landscapes, etc.

8. Collaborative selection of the appropriate spatial scale for geo-data inputs, and especially for the map and GIS products, based on social, political as well as scientific criteria. Also, conventional a-spatial information sources: documents, censuses, reports, etc.
   .

9. P-mapping is not independent of other PRA/RRA activities. Utilise spatial P-RRA tools – participatory joint interpretation of air photos, RS images, ephemeral maps, participatory sketch maps, time-space diagrams, profiles, transects, boundary walks, etc. – especially linked to spatial data collection and triangulation in transects.

10. Consider the pros & cons of :
    - enlarged aerial photos or photo mosaics as the base image;
    - copies of topo sheets (or selected thematic map) as the base map;
    - satellite imagery;
    - Google Earth and mash-ups, or other ‘virtual earths’;

    combined with sketch maps and ephemeral maps - even these can be transferred onto paper or GIS (eg use a digital camera, before maps are walked or rained on!);

11. Plan for, acquire, and gather together the field and office equipment, such as GPS, iPAQ (for mobile GIS); and the necessary amount of materials, eg. sizes of paper, plastic overlays, colours of pencils, range of marker objects.

12. Ensure that a broad (representative) range of local people / stakeholders are involved. What criteria to use for the selection? Ensure this includes women, children, people with specialised knowledge (as local experts), Ensure that the groups include the power-deficient or marginalised,

and the inarticulate or disadvantaged, e.g. landless people.

13. It is possible to identify and record spatial information directly on the ground using GPS with mobile GIS (using iPAQs, Pilots, or Tablet PCs). Contemporary G3 mobile phones, iPhones, have similar capabilities of incorporating GPS and mobile GIS software. Participatory sketch maps can be transferred directly onto ArcPad, etc.

14. Supplement these information sources with digital photography, video, sound recordings, and with sketching where photography is ineffective.

15. It may be appropriate to transfer the participatory maps into appropriate visualisation software, such as FreeHand, or MacPublisher, which are better attuned to the LSK 'rich information' visualisation characteristics of ambiguity, qualitativeness, fuzziness, metaphor, emotion.

16. Use physical three-dimensional models (P3DM) (maquettes), when applicable.

17. Cross-check the LSK visualisations and the geo-referenced point ITK data with geo-information from standard maps, topographic maps, etc. But do not treat the LSK maps or 'mental maps' simply as perceptual aberrations; i.e. do not take the standard official maps as the only authentic base against which to measure.

18. Make use of interactive visualisation software for further development and for participatory spatial planning (PSP) with user groups. Presentation and visualisation, interpretation of outputs, and understanding.

19. For visualisation impacts, when applicable, use sound, multi-media, or web-based (dynamic) GIS.

20. Let the people do the activities – keep the instructions and the interference to the necessary minimum. Do not over-emphasise details, or maybe the big picture gets lost. External professional experts should always have patience.

21. The process should be clearly useful to the local participants (in what way it is useful depends on the purpose!) – but, it should also be enjoyable, as well as being systematic, sensible, and scientific.

22. Observe the P-mapping *process* - this also increases understanding on both sides. Ask questions, probe, ask for explanations, e.g. why are there regularities and why anomalies in the results?

23. Prepare a series of counter maps representing the interests and values of various groups of actors, especially the marginalised and power-deficient.

24. Use the maps! - take them on further exercises. Show and discuss the groups' maps in joint meetings – for triangulation, and for awareness.

25. The final outputs may be printed maps (of many scales), hardware models (e.g. 3-D), CD-ROMs (GIS), websites (e-maps), etc. Each type of output has specific and detailed requirements, and different ´ownership´ conditions, eg. even standard printing of good quality maps may be very difficult to organise within reach of the community.

26. Distribution, delivery and dissemination of GI and other outputs should be pre-planned collaboratively so as to meet good governance objectives of equity, respect, transparency and accountability.

27. Follow-ups, monitoring and evaluations should be designed into the P-GIS process from the outset, and with an independent component

Source: McCall (2004)

Expected outputs

As a result, if appropriately utilized, the practice may have profound implications and stimulate innovation and social change. More importantly and unlike traditional GIS applications, PGIS aims at placing control on access and use of culturally sensitive spatial data in the hands of those who generated these thereby protecting traditional knowledge and wisdom from external exploitation.

Basic requirements

Data:
The basic principle of the PGIS approach is that it is combining – in a structured systematic and cross-cutting and back-referenced manner – people's own local spatial knowledge (mix of ITK and cognitive maps) and external 'scientific' knowledge from environmental expert(s), satellite images, maps, etc.

Cost:)

PGIS is usually assumed to be cost-effective, notwithstanding that its lower costs may be offset by lower standards of precision and maybe accuracy, than for full-blown GIS. Costs will depend on

- how long is the activity?
- which sort of people are involved, ie are expensive external experts going to be engaged?
- what equipment is used ? - eg Tablet PC / GPS / iPaq / G3 Mobile phone / printer/ etc.?
- what GI materials are used? Some satellite images are very expensive; whereas Google Earth is very cheap. Aerial photos may be out of date.

Skills and capacity:
Although it might appear that a high level of GIS and other skills are needed, this is not actually the case. In many experiences, it has been found that local people can quite understand and interpret aerial photos or appropriate satellite images, use GPS, and work in a sufficient (though obviously not an 'expert') way with mobile GIS (iPaq), etc. Not surprisingly, young people and school children pick up the techniques much more easily, The future application s of PGIS using 3G cell phones will be even easier for young people, e.g. in Africa where cell phone distribution is most widespread.

Flexibility

PGIS is very flexible. Experiences of using PGIS in many places (with credible anectdotal evidence, eg from Argentina and Cameroon) indicates that **if** the concepts and skills are properly passed on, then the individuals and communities will later apply the PGIS approach to other situations.

Pros (main advantages) and Cons (main constraints in use and results)

The most obvious benefits are:

- Participation, empowerment, inclusion of local spatial knowledge and interests, higher degree of "ownership" of the process
- Skills development, and capacity-building
- Maps and pictures have great visual impact value – can be very convincing.
- Adding proper GIS brings in geo-referencing which is necessary for many legal and planning & policy applications.
- The added value of GIS is described above (e.g. storage & communication).

But, PGIS is:

- Time-consuming - to determine which stakeholders who should participate (especially in P3DM)
- Can create potential to increase the number and scale of (local) conflicts,
- Technologically confusing for some participants (elderly, etc.).

Box 5.4.2: Some examples of using PGIS

- The Dene Mapping Project in northern Canada used digital 1:250,000 maps to designate land use and occupancy, 1890-1975. Boundaries were designated and spatial conflicts reduced, not only with Federal and Provincial governments, but also with neighbouring indigenous peoples.

- In the Philippines, PGIS resulted in strengthening Ifugao community groups when preparing for negotiations with provincial & municipality authorities re. ancestral lands. Participatory 3-dimensional mapping has been used in the Philippines for conflict analysis and resolution between indigenous groups, which should reduce possibilities of inter-group warfare over land resources.

- In Indonesia, natural resource management claims and village boundary conflicts between prior resource rights and recent claims in Kalimantan, have been addressed through participatory mapping and GPS.

- In Cameroon, participatory mapping and PGIS has been applied to the regularisation of communities' customary entitlements to forest land.

- Community PGIS:
    - Brazilian Indians use Google Earth to monitor the appearance of new gold mines.
    - Maori communities in New Zealand have designed a GIS to preserve sacred knowledge for intergenerational transfer.
    - Village organisations in the Himalayas use GPS and hand-held computers to map biomass stocks to market carbon credits under the Kyoto Protocol.
    - Forest-dwellers in the Philippines use participatory 3-D modelling to manage conflicts between villages and Parks.
    - In Cambodia, local farmers work with NGOs to recognise and map landmine hazard areas.
    - Children in India map and investigate environmental hazards in their neighbourhoods.
    - The Coast Salish people, like many other First Nations in Canada and indigenous forest-dwellers (in e.g. the Philippines and Kenya) use mapping technologies to claim rights for their traditional lands and resources.

Source: McCall (2004)

Key sources of further information and useful web-links

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Weblinks

Portal for PGIS and PPGIS literature, training materials, etc. (www.iapad.org)

PPGIS Discussion Group (www.iapad.org/ppgis)

Bibliography on PGIS applications and local spatial knowledge methodologies (http://ppgis.iapad.org/pdf/pgis_psp_itk_cbnrm_biblio_mccall.pdf)

Annex 1: Matrix of participatory mapping tools:
(Source: Jon Corbett, University of British Columbia-OkanaganL

	DESCRIPTION	USES / USERS	STRENGTHS	WEAKNESSES	RESOURCES
GROUND MAPPING	A basic mapping method that involves community members drawing maps on the ground from memory using any available materials, such as plants, rocks or household tools. The final product is kept for a short time only. Commonly used in RRA-, PRA- and PLA-related initiatives	Good for beginning to frame principal land-based decision-making issues Helpful in acquainting community members with maps. Helps build confidence. Users: Application for broad range of users – community members, researchers, development intermediaries, NGOs etc. This activity is often outsider motivated/initiated.	Useful to engage non-expert users Low cost and not technology dependent Tangible short-term outcomes Most participants can relate to product Easily facilitated Tactile – can walk around and interact with the product	Product not replicable (can't copy or produce for dissemination) Impermanent and fragile (also weather dependent!) Not to scale/accurate/precise Medium (i.e. the ground) might affect buy-in and product consequently might lack credibility as a formal decision-making document	Informants use raw materials like soil, pebbles, sticks and leaves. Open space Optional coloured sand Large sheets of paper to draw finished map Cameras can also be useful to photograph the finished product.

	DESCRIPTION	USES / USERS	STRENGTHS	WEAKNESSES	RESOURCES
SKETCH MAPPING	Sketch maps are free-hand drawings. They are drawn on large pieces of paper and from memory. They represent the land from a bird's eye view. They involve drawing key community-identified features. They do not rely on exact measurements, and do not use a consistent scale or geo-referencing. They do show the relational size and position of features. Commonly associated with RRA-, PRA- and PLA-related initiatives	Good to stimulate and inform internal community discussions related to broad-level land-use patterns, resource distribution, areas of conflict, problems and planning Very useful in getting a broad picture of issues and events covering large areas Can be used to help plan subsequent mapping activities Users: Application for broad range of users – community members, researchers, development intermediaries, NGOs etc.	Useful to engage non-expert users with little training. Low cost and not technology dependent Tangible short-term outcomes Easily facilitated More detailed and permanent than ground maps Easily adopted and replicated at community level	Outputs are not geo-referenced and can only be transposed onto a scale map with much difficulty. Not useful when locational accuracy is important – e.g. when need to determine the size of an area or make other quantitative measurements Lack of accuracy undermines credibility with government officials	Large-sized sheets of paper, pencils and/or coloured pens This activity is particularly sensitive to the composition of the participating group (especially in relation to gender, age and status factors).

	DESCRIPTION	USES / USERS	STRENGTHS	WEAKNESSES	RESOURCES
TRANSECT MAPPING	A spatial cross-section of a community, depicting geographic features (e.g. infrastructure, local markets, schools) as well as land use types and vegetation zones observed along an imaginary line. Activities involve questioning community members and walking and mapping transects. A transect aims to cover as many of the ecological, production and social groups along the defined route as possible.	Good to stimulate and inform internal community discussions related to broad-level land-use patterns, resource distribution, conflicts, problems and planning Helps analyse linkages, transitions, patterns and interrelationships of land use and different ecological zones along the transect To have broad application and /benefit, needs to be combined with 2-D maps Users: Researchers, development intermediaries, villagers/community members and particularly farmers	Useful to engage non-expert users with little training Low cost and not technology dependent Community members can relate to product Tangible short-term outcomes Easily facilitated and replicated Relates well to participants' everyday movements and activities (because it tracks their travels at ground level – not aerially as with sketch maps) Gives good perspective for low to high elevation cross-sections	Outputs are not geo-referenced and can only be transposed onto a scale map when combined with GPS data. Not useful when locational accuracy is important – e.g. when need to determine the size of an area or make other quantitative measurements Lack of accuracy undermines credibility with government officials Provides a limited perspective of the landscape	Paper and coloured pencils Depending on size of area to be covered and terrain, a transect can be done on foot, animal, cart or motor vehicle.

	DESCRIPTION	USES / USERS	STRENGTHS	WEAKNESSES	RESOURCES
SCALE MAPPING – DRAWING INFORMATION ON EXISTING SCALE MAPS	Scale maps present accurate geo-referenced data. A scale map means that a distance measured anywhere on the map always represents (depending on the scale) the equivalent distance on the ground – e.g. 1cm on the map equals 1km on the ground. Scale maps are often referred to as 'base maps' by practitioners. This method is commonly used where accurate and affordable scale maps are available (especially in Canada) and people are familiar with them. Local knowledge is gathered in conversation around a map and is then drawn directly upon the map (or else onto transparent plastic sheets placed on top of the map). The position of features is determined by looking at their position relative to natural landmarks (e.g. rivers, mountains, lakes).	Good format to communicate community information to decision-makers because it uses formal cartographic protocols (e.g. coordinate systems, projections) Information on the map can be easily verified on the ground. Information can be incorporated into other mapping tools (including GIS). GPS data can be easily transposed onto scale maps.	After initial orientation with the map, it provides an understandable and accurate representation of an area. If maps are available and relatively cheap, this tool is fast compared to other participatory mapping techniques Low cost and not technology dependent with tangible short-term outcomes Easily facilitated with relatively accurate portrayal of local knowledge. Can be used to determine quantitative information (such as distance areas and direction)	In many countries (especially developing countries), access to accurate scale maps is heavily regulated and difficult. Maps in some areas might not necessarily be accurate or up-to-date (it is important to try to verify their accuracy). Training is required to understand formal cartographic protocols (e.g. scale, orientation, coordinate systems, projections) for their use. More complex to grasp than sketch, transect and ground	Scale maps (usually the most up-to-date maps are not required – the key information needed on the maps is the location of natural features, such as rivers, ridges) Large-sized sheets of mylar (transparent plastic sheets), pencils and/or coloured pens

	DESCRIPTION	USES / USERS	STRENGTHS	WEAKNESSES	RESOURCES
SCALE MAPPING – MAKING SCALE MAPS USING SURVEY TECHNIQUES	Scale maps represent a more sophisticated participatory mapping method aimed at presenting accurate geo-referenced data. A scale map means that a distance measured anywhere on the map always represents (depending on the scale) the equivalent distance on the ground – e.g. 1cm on the map equals 1km on the ground. Scale maps are often referred to as 'base maps' by practitioners. Where scale maps are not available but are required by the purpose of the participatory mapping initiative, they can be made from scratch using a range of equipment including compass and GPS tools. The finished map can then be used to incorporate and communicate local spatial knowledge. It should be noted that this is often a last resort measure because the time and energy required to create a scale map from scratch are considerable.	Good format to communicate community information to decision-makers because it uses formal cartographic protocols (e.g. scale, orientation, coordinate systems) Information on the map can be easily verified on the ground. Information can be incorporated into other mapping tools (including GIS). GPS data can be easily transposed onto scale maps.	On completion, the maps have a relatively accurate portrayal of community lands that otherwise would not be available. Can be used to determine quantitative information (such as distance, areas and direction)	Substantial requirements for equipment as well as training in its use They are prone to error. Long-term commitment (time consuming and hard work) More complex to grasp than using existing scale maps or making sketch, transect and ground maps	Compass, distance measuring devices such as a GPS.

	DESCRIPTION	USES / USERS	STRENGTHS	WEAKNESSES	RESOURCES
PARTICIPATORY 3-D MODELLING (P3DM)	P3DM are stand-alone scale relief models created from the template of a topographic map. Pieces of cardboard are cut in the shape of the contour lines and pasted on top of each other. The model is then finished with wire, plaster and paint. Geographic features are depicted on the model using pushpins (for points), coloured string (for lines) and paint (for areas). On completion, a scaled and geo-referenced grid can be applied to allow the data to be transposed back onto a scale map or else imported into a GIS.	Good to stimulate and inform internal community discussions related to broad-level land-use patterns, resource distribution, conflicts, problems and planning. Finished model can become an installation depicting community spatial knowledge and presented in a museum or community centre – it can become a symbol of community pride. Data depicted on the model can be extracted, digitized and plotted. Initial creation of the community model is in itself a community activity with positive community-building outcomes (also a good tool to learn about map topography).	Reusable for multiple planning exercises Low cost and not technology dependent Effective in portraying relatively extensive and remote areas Can accommodate overlapping layers of information (functions like a rudimentary GIS) The 3-D aspect of the model is intuitive and understandable; this means all community members can contribute either information or labour. The information on the model can be easily transposed and replicated in a GIS.	In many countries (especially developing countries), access to accurate topographic maps is regulated and difficult. Labour-intensive and relatively time consuming when compared to using existing scale maps Storage and transport of the model can be difficult. Makes immediate communication of community information to decision-makers difficult. The information must be transferred to another medium (e.g. paper maps, photos or GIS) to make it more portable.	Topographic map Pushpins, coloured string, paint, plaster and chicken wire Can also be useful to photograph the finished product

	DESCRIPTION	USES / USERS	STRENGTHS	WEAKNESSES	RESOURCES
GPS MAPPING	Global Positioning System (GPS) is a satellite-based positioning system. A GPS receiver is carried to a position in the field and used to capture an exact location on the earth using a known coordinate system such as latitude and longitude. Data are stored in digital format. Recently these technologies have become far more accurate, accessible, cheap and easy to use. As a result, there is a proliferation of their use in participatory mapping initiatives.	Used to capture and store geographic coordinates related to local features (e.g. boundaries or point locations) and then locate these points on accurate scale maps Increasingly used by communities in surveying large areas quickly and making accurate scale maps which are recognized by official agencies Helps add accurate locational information of geographic features onto scale maps, geo-referenced P3DMs (and other less technology-rich community mapping methods), as well as aerial and remote-sensed images and GIS	Provides accurate (within 15 metres accuracy) geographic data After initial training, receivers are relatively easy to operate. Increasingly affordable Relatively lower technology requirements than other computer-based mapping techniques and therefore lower cost	Still relatively expensive for many communities Training is required to understand the equipment as well as formal cartographic protocols (e.g. scale, orientation, coordinate systems, projections) for its use. Equipment requires batteries (which is an additional expense). GPS receivers can be monopolized by men. Getting direct line of site to satellites sometimes hard in heavily forested areas	GPS receiver Scale maps on which to plot the GPS points Logbook is useful to record and back-up key way points. Waterproof box for storing the GPS receiver, a set of spare batteries and a compass

	DESCRIPTION	USES / USERS	STRENGTHS	WEAKNESSES	RESOURCES
USING AERIAL AND REMOTE SENSING IMAGES	Aerial photography and remote sensing involves gathering pictures (often referred to as images if they are in digital form) of the earth's surface using cameras on airplanes and satellite sensors from space. These images can be geo-referenced and turned into air photo/satellite maps and used in much the same way as scale maps (discussed above). Scale, orientation, coordinate system are shown, they make good base maps for participatory mapping initiatives. Plastic transparencies can be overlaid on the photomap to delineate land use and other significant features. Information on the transparencies can be scanned or digitized and geo-referenced later. Recently these data (particularly slightly outdated satellite images) have become more accessible and cheaper (and in some cases free). As a result, there is a proliferation of their use in participatory mapping initiatives.	Good format to communicate community information to decision-makers because it uses formal cartographic protocols (e.g. coordinate systems, projections). Information on the map can be easily verified on the ground. GPS data can be easily transposed onto images. If images of the same area have been taken at different points in time, they can provide an excellent way of understanding the extent of land use change over time. This can be an excellent stimulus for community discussion and strategizing.	Effective in mapping relatively large and difficult to access areas. Can provide broad overview of community land use – watershed level Increasingly easy and cheap to access and download from the Web Can be engaging, offering community members views and perspective of their area that they may never have experienced before. Landmarks may even be recognizable.	Still can be expensive and images are not readily available. May be difficult to obtain permission for access in some countries (i.e. may be under military control) No legend – have to interpret objects. Certain images are sometimes difficult to read and interpret. Does not always clearly depict the features important to community members (e.g. certain forest types or individual trees) Sources of data could be difficult for some community members to relate to (e.g. orbiting satellites far outside earth's atmosphere).	Aerial photos and/or remote sensed images Large sized mylar transparencies, tracing paper, pencils, coloured pens/pencils and tape.

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MULTIMEDIA MAPPING	Interactive, computer-based maps that link digital video, photos and written text with maps. They can be used to communicate complex, qualitative local knowledge related to the landscape. The digital hyperlinked map of the community's traditional lands consists of points, lines and polygons that can be clicked on to link the viewer to related multimedia and textual information.	To support local communities in expressing, documenting and communicating their traditional and contemporary land-related knowledge using a medium that is closer to the traditional oral systems of knowledge transfer Integrates local spatial and non-spatial data to support discussion and decision making processes For communicating land-related traditional knowledge with outsiders and within the community, particularly between generations in an accessible and engaging format (especially video)	Very engaging format, excellent system for communicating local knowledge Combined with tangible computer-based skill transfer to community members Potential to package and sell production material once trained Easy for end-user to access and learn about local knowledge Relatively easy to develop and deploy than more complex GIS initiatives	Expensive for many communities (important to not forget long-term operating costs in addition to start-up outlay) Training required to understand the equipment as well as formal cartographic protocols. Long-term commitment More complex to grasp than using existing scale maps or making sketch, transect and ground maps Video production, photographic editing and file management training required There is a danger that practitioners focus too much on the technology to the detriment of the participatory process. In many remote communities, access to the electricity is limited	Video and camera equipment Digital image of map. Computers and software

	DESCRIPTION	USES / USERS	STRENGTHS	WEAKNESSES	RESOURCES
PARTICIPATORY GEOGRAPHIC INFORMATION SYSTEMS (PGIS)	Participatory GIS are computer-based systems that capture, manage, analyse, store and present geo-referenced spatial information. They include spatial data management tools that can work with aerial photographs, satellite imagery, Global Positioning Systems (GPS) and other digital data. GIS technology has long been regarded as complicated and costly and a technology that is primarily used by experts. Since the 1990s, the PGIS movement has sought to integrate local knowledge and qualitative data into GIS for community use. PGIS practitioners (who are often intermediaries from outside the community) work with local communities to democratize the use of the technology and to enable them to communicate their spatial information to influence planning and policymaking. Practitioners place the control for access and use of culturally sensitive spatial data in the hands of those who generated these, thereby protecting traditional knowledge and wisdom from external exploitation.	To store, retrieve, analyse and present spatial (or land-related) information Used to explore community-driven questions, many of which can be answered using the analytical functionality of PGIS Can integrate local spatial and non-spatial data to support discussion and decision making processes	Good at displaying precise geo-referenced information (either on-screen or as part of tailored paper-based maps) Can use sophisticated database tools to analyse data and create precise quantitative data (e.g.area, distance and orientation). This data can be very important for managing natural resources and traditional lands. Maps and data produced by PGIS initiatives communicate information easily, convey a sense of authority and are often highly convincing.	Steep learning curve (even for people with extensive computer knowledge) Requires continual updating of software and re-training (need to recognize long-term operating costs in addition to start-up outlay) Expensive for many communities Training required to understand the equipment. Requires a long-term commitment (i.e. time-consuming) The persuasiveness of the GIS medium can create a false sense of legitimacy – GIS products are only as accurate as the data used to create them. Danger that practitioners will focus on the technology to the detriment of community participation	Computers, GIS software and data sets In many remote communities, access to the electricity required to run the equipment is intermittent or altogether unavailable.

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