Mapping and surveying

Identifying the locations of the habitats, species and resources of an MPA, and the places and activities that influence it, is an essential first step in providing the basic information needed for management. A map is thus essential. This sheet gives a general overview of methods and technologies available for surveying the MPA and preparing a map.

A map of the MPA has a wide range of uses. It improves the quality of leaflets, posters, souvenirs, and other materials for visitors; it enhances reports; it assists with research and monitoring; and it helps to make boundaries and zonation schemes clear to MPA users. Oil spill contingency planning (see sheet K3) requires sensitivity mapping to highlight areas vulnerable to oil spills.

Maps designed for use at sea are called 'charts'. They show water depth (bathymetry), currents and details related to navigation (e.g. positions of channels, buoys, islands, wrecks or other hazards). These, as well as the routes for surveillance patrols, can be marked on maps produced specifically for the MPA. Modern tools, such as Geographical Information Systems (GIS), and digital or laser printing have greatly simplified map production and increased speed of production and flexibility. However, the accuracy of these more modern tools is only as good as the quality of data collected.

SURVEYS AND ASSESSMENTS

Before a map is prepared, surveys must be undertaken to determine the distribution of different habitats and species, human settlements, boundaries and other important features. Locations are usually measured with a GPS (Global Positioning System), and ground surveys should be undertaken on foot, by boat or by snorkelling and/or diving. Such surveys and assessments will also generally form the baseline for the monitoring programme (see sheets G3 and G4). They should include detailed sampling as well as more rapid, time-efficient methods such as spot-sampling where brief notes are taken. The data can then be matched against information from other sources (e.g. aerial photographs or satellite images), enabling a picture of the entire area to be constructed.

Aerial photographs are useful complements to the ground surveys. If taken during spring low water, they can show the coverage of intertidal areas, type of substrate, presence of macroalgae or seagrass, and shallow seabed features such as coral reefs. Stereo photographs, when examined with an appropriate viewer, provide a three dimensional image that helps interpret topography. Most government cartographic agencies have collections of aerial photographs, copies of which can usually be purchased for a small fee.

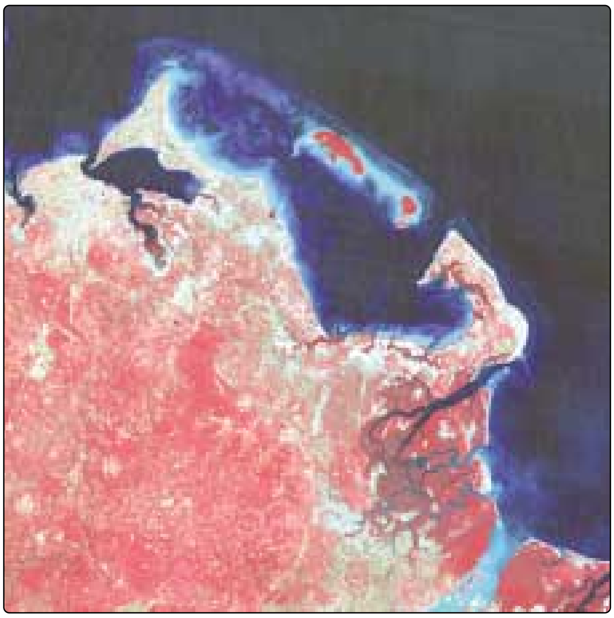
Satellite or remote sensing images may be very useful and relatively cheap. SPOT and LANDSAT satellite images can be obtained from the relevant supply companies for a fee, but their use requires equipment and professional training. Thus, if planning to use them for MPA surveys and mapping, it is best to work with a research department or qualified consultants.

Information can also be collected from local communities and is very useful for improving detail on a map, e.g. determining water currents, seasonal changes in water turbidity or whether certain areas dry out at low tides. Note that such information will reflect the local peoples' perspective and may include their own terminology. It can be stored in the GIS database and incorporated into the production of maps.

PREPARING MAPS AND CHARTS

The data gathered in the survey are compiled to produce a map. A preliminary map can also be prepared by compiling data from other existing maps (i.e. a 'derived' map) and this is often a useful first step. In the absence of computer-aided software (e.g. GIS – see below), a map can be prepared by a cartographer, who uses the surveyor's plot to draw the first map or 'base map', and then adds other features.

Maps can be printed on paper or used in digital form. Digital maps, when viewed on a computer screen appear sharp though the resolution of most screens is only 72 dpi (dots per inch). Prints can be adequate on higher standard printers and good quality paper, but are likely to be expensive and colours often fade with light. Standard printing processes generally have much longer-lasting colours and are produced at greater resolutions, of 2,400 dpi.



Courtesy of Tanzania Coastal Management Partnership

This satellite image of the Mnazi Bay-Ruvuma Estuary Marine Park area, Tanzania, was used when preparing a map for this MPA.

The following characteristics affect the use of maps:

Scale - The size of the MPA, the scale required and the size of the printed map (and thus the paper to be used) must be chosen on the basis of needs and expected uses. Scale refers to the degree of reduction of the graphic representation compared to the true size of the feature. Scale bars are used to indicate the length of miles or kilometres as represented on the map, or may be given as a ratio. A scale of 1:50,000 means that a measurement on the map represents a distance 50,000 times greater on the land or sea; thus 1cm on the map represents 500m in reality. Maps of 1:50,000 (used to show buildings, roads, etc) are considered large-scale compared to those of 1:1,000,000, which are considered small-scale and are used for whole countries or oceans.

Resolution and Accuracy - This refers to how accurately a feature can be depicted on a map: the larger the scale, the higher the resolution. Using a scale of 1:50,000, a 30m long building would be just over 0.5mm on the map. The choice of line widths used can introduce errors; for example, on a map with a scale of 1:50,000, a road represented by a line 0.5mm thick will mean that it is 25m wide in reality. Similarly, a 1mm error in the location of the line on the map will mean a 50m deviation from reality. Factors affecting accuracy can also have cumulative effects.

Coordinates - These are usually marked as intervals along the margins. They can be in the form of latitude and longitude (as used on charts) or UTM units (frequently used by government cartographers). Most GPS and GIS can convert between these two, and other settings.

GEOGRAPHICAL INFORMATION SYSTEM (GIS)

GIS is a program that incorporates a database for positional (geo-referenced) data, allowing manipulation and analysis. A major benefit is that it allows different data layers to be overlaid, e.g. data on coral reef status can be overlain onto data on fishing activity, permitting analysis of any spatial relationships between the two parameters. GIS is thus far more than a mapping tool, but is particularly useful in map production as prints or digital images can be produced as required, containing the selection of data layers needed for a particular use. Setting up and developing a GIS usually requires considerable experience and MPAs are advised to collaborate with relevant institutions. MPA staff will be able to operate the system, once trained, provided there is expert supervision and appropriate maintenance.

Sources of further information

Butler, M.J.A. *et al.* 1987. *Marine Resource Mapping: an Introductory Manual*. FAO Tech. Paper 274. FAO, Rome. 256pp.

Green, E.P. *et al.* 1996. A review of remote sensing for the assessment and management of tropical coastal resources. *Coastal Management* **24**: 1-40.

Mumby, P.J. *et al.* 1988. Digital analysis of multispectral airborne imagery of coral reefs. *Coral Reefs* **17**: 59-69.

Mumby, P. J. *et al.* 1999. The cost-effectiveness of remote sensing for tropical coastal resources assessment and management. J. *Environ. Management* **55**: 157-166.

Roelfsema, C. M., Phinn, S.R. & Dennison, W.C. 2002. Spatial distribution of benthic microalgae on coral reefs determined by remote sensing. *Coral Reefs* **21**: 264-274.

www.esri.com – a commercial website providing information and advice on GIS products, training and support in relation to natural resources.

CASE STUDY

Mnazi Bay - Ruvuma Estuary Marine Park (MBREMP) GIS and maps

Gazetted in 2000, one of the first requirements of MBREMP was a good map to guide development of the management plan and monitoring programmes. With funding from the Global Environment Facility (GEF) and the Government of France, and technical support from IUCN, a geographical database and GIS are being established. Baseline information on biodiversity (mangroves, coral reefs and intertidal areas) and socio-economic issues was collected by survey teams, in cooperation with MBREMP staff. GPS readings were taken at each site surveyed. Data on infrastructure (e.g. roads) and other physical characteristics, like bathymetry, were also collected. Additional data (e.g. topography and mangrove distribution) were obtained by digitising existing maps and interpreting aerial photographs and satellite images (see overleaf).

For the design of the database and GIS, MBREMP is working with a local unit, the GIS Information Centre (GISic) of the Agricultural Research Institute Naliendele. The database is designed so that it can be extended over time, used for long-term monitoring, and takes into account the financial, technical and staff limitations. To ensure long term maintenance of the information system, Park staff are being trained in geographical skills, including databases, GIS, the use of GPS and mapping.

KEY POINTS FOR THE MPA

- ❑ **Ensure that the necessary maps for the MPA are produced and available in printed or digital form as appropriate.**
- ❑ **Use a team approach for preparing maps, involving local stakeholders and technical institutions; involve relevant MPA personnel in the collection of ground and sea survey data and aerial photography, and in finalising the maps (e.g. editing, choosing colours and other details).**