Field Techniques Manual:
GIS, GPS and Remote Sensing

- Section D: Planning & Practicalities

Chapter 12: Project Planning and Management

12 Project Planning and Management

Unless you have a sound way of utilising GISci tools and techniques during fieldwork, a lot of time and effort could be wasted. The remaining chapters therefore focus on the practical aspects of GISci usage on expeditions. For general information on expedition planning, the reader should refer to the Expedition Advisory Centre's *Expedition Handbook* (Winser 2004). A brief set of expedition planning guidelines was published in a special supplement of the November 2003 *Geographical Magazine,* while Nash (2000a, 2000b) has produced a useful set of general guidelines on carrying out overseas fieldwork projects. Most of the field technique examples given in this handbook are from geoscience, ecology or conservation projects – such are the backgrounds of the authors – however, if you want to carry out anthropological, socio-economic or cultural studies, the Expedition Advisory Centre has published a very useful booklet on people-orientated research (Kapila & Lyon 1994). Advice on planning terrain surveys is given by Mitchell (1991); while Clarke (1986) produced a useful handbook for those planning an ecological monitoring project. Clifford & Valentine's (2003) textbook on *Key methods in geography* contains general advice on fieldwork techniques, sampling strategies and data analysis, with a particularly useful chapter by Professor Ian Reid, on making field observations and measurements.

The origins of 'planning' go back to the Latin word *planus*: a plain, an area where all is visible. When you plan you expedition, you should strive to have a clear vision of what you will be studying and how you will carry out those studies. Professor Robert Allison (2003) states that there are four key ingredients in making an expedition fieldwork project as practicable, useful and focussed as possible:

- Well-developed questions or hypotheses
- Realistic goals within the given constraints and circumstances (time, people, skills, equipment, climate, logistics, money)
- Neither too much nor too little work
- Results that relate to a wider research framework and/or have useful application

Try going through these four points, relating each one to your own ideas. You should regard Geographical Information Science as a tool, rather than an end in itself. For example, if the aim is to produce a vegetation map, a GIS may be used to store field observations of vegetation structure, relate them to satellite images, and produce a map of different vegetation classes. Furthermore, ask yourself if you are choosing 'appropriate' technology, in terms of cost, time, technical skills, maintenance, access to technology, and most important, in relation to local agendas for research, monitoring, training and education (see Dunn *et al.* 1997).

12.1 Project design

There are a number of distinct stages that most fieldwork-based projects follow, regardless of whether they are using GISci technologies. These are listed below in the order in which they would be carried out and with an indication of the time required for each stage of the project.

At least one year before departing:

1) Desk study 1: deciding on the scope of the study
2) Deciding the project aim and objectives
3) Desk study 2: getting as much information as possible on the project area
4) Selecting appropriate fieldwork techniques, possible modifications to the project aim and objectives
5) Site selection: seek advice from contacts in host country, use existing maps or remotely sensed imagery to find optimal survey sites

About six months before departing:

1) Preparation of work schedule, obtaining necessary permits, insurance and medical cover

In the host country (allow a minimum of one month):

1) In the study area: recce visit to selected sites
2) Detailed fieldwork at optimal sites, possible field laboratory analyses
3) On-site data processing: allows you to check and correct erroneous field data
4) Presentation of preliminary results: a summary will probably be appreciated by relevant researchers and managers in the host country

Back home:

1) Further data processing: here the full power of GIS analyses can be very useful
2) Presentation of results: try to complete your final report within one year of returning, otherwise it may never get finished!

12.1.1 Aim and objectives

"…a principal aim of most geographical research is to make useful generalisations - that is, to seek out and explain patterns, relations, and fluxes that might help to model, predict, postdict or otherwise understand better the human and physical worlds around us." Rice (2003)

A crucial initial stage is deciding what the overall goal or aim of the project will be. Once the aim of the project is decided, a set of objectives can be drawn-up which will need to be met if you are to achieve that aim. Some projects will have relatively simple sample-and-record goals, such as compiling inventories of species for a conservation area. On inventory projects, using GPS receivers as data-loggers is a very effective sampling technique, especially if GIS can be used to examine the distribution of mapped features. Other projects might be driven by the need to find solutions to geo-ecological and/or socio-economic problems affecting a study area: this often involves many factors and complex systems of cause and effect. When examining such complex situations the best approach is to develop concepts or hypotheses that can be used to test a set of research questions that seek to identify the causes and effects affecting a given site. Most field sites are multifactoral – such is the inherent complexity of Nature – and hypothesis testing will therefore involve statistical statements of probability about targeted causes and effects. GIS can be a very useful tool at this stage of the project, as it allows the visual comparison of existing map-based datasets (including remotely sensed imagery), assisting with the targeting of key factors for testing.

When formulating your project aim, objectives and activities (or 'deliverables'), there are some management techniques that can help to try to clarify your thoughts. A comprehensive approach to this is the Logical Framework: this is used by the UK Darwin Initiative for Biodiversity Conservation when assessing projects bidding for funding. The logical structure that links the project activities takes this form: IF <activities> AND <assumptions> THEN <outputs>; IF <outputs> AND <assumptions> THEN <purpose>, and so on. It can get a tad tedious working through these logical steps, but the plus side is that you are forced to review the practical aspects of each step of your project plan and may find inconsistencies or invalid assumptions that would otherwise have caused severe problems later. The example given in Table 12-1 is from a project that aimed to map areas of enhanced habitat loss on the coastal plain of the Republic of Georgia, with an associated programme of GIS training for Georgian scientists to continue the sampling after the UK team returned home.

Table 12-1 Example of a completed logical framework proforma.

Project summary	Measurable indicators	Means of verification	Important assumptions
Goal To assist countries rich in biodiversity, but poor in resources, with the conservation of biological diversity & implementation of the Biodiversity Convention.	Provision of training materials for GIS mapping of land cover types, habitat types, habitat loss and target areas for biodiversity conservation. Case study of Georgia coastal plain.	Production of GIS training materials (in English, Georgian and Russian). Publication of the cited database and maps; access to the information via a dedicated website.	Will the products be understandable ? *- yes: text will be in English, Georgian and Russian.* Does the region have adequate provision for website access ? *- yes.*
Purpose To provide a database and 1:60,000 scale maps of: (i) land cover types, (ii) habitat types, (iii) habitat loss (1991-2001), (iv) biodiversity target areas.	The cited database and three sets of maps, will be available in Georgia by the end of December 2002.	i) Publication of the Project Report, database and cited maps; posting of findings on the Project website.	Is there a need for the cited database and cited maps in Georgia ? - *yes, checked and confirmed by our Georgian partners.*
Outputs 1) GIS-generated database and 1:60,000 scale maps of Georgia coastal lowlands for: a) Land Cover Types; b) Habitat Types; c) Habitat Loss, 1991-2001; d) Biodiversity Target Areas. 2) Project Report. 3) A Project website,	Land cover types, habitat types, habitat loss and targeted areas for bio-diversity conservation, mapped by July 2002. 'Ground-truth' of GIS maps checked by end Sept 2002.	Weekly email discussions, with monthly progress reports posted on the Project website. Fieldwork in Georgia to check groundtruth of the GIS maps. Publish a Report; establish a Project website. Disseminate findings in Georgia and Black Sea countries; number of visits	Is access to lowland Georgian fieldsites straight-forward ? - *yes.*

allowing public access to database, and digital maps. 4) Press releases, TV and radio cover, Georgia & UK. 5) Methodology and results published in peer-reviewed journals. 6) Batumi Biodiversity Conservation Workshop.	Report and website completed by end Dec 2002. Media coverage over Dec 2002, with scientific publications submitted by March 2003. Biodiversity Conservation Workshop March 2003, Batumi, Georgia.	to Website; distribute Report to libraries and govt agencies; number of radio, TV & newspaper features. Two scientific publications by mid-2002. List of delegates attending the Biodiversity Conservation Workshop and the GIS Training course.	
Activities i) Process Landsat data; GIS maps of Land Cover Types, Habitat Loss & Biodiversity Target Areas. ii) 1-week UK visit by Georgian partners: train to edit digital maps; review methodology and outputs. iii) Fieldwork by Georgians, checking map accuracies. iv) Up-dating of the data-base and maps; write-up Report. v) Place Report and maps on website*. vi) Press releases, radio & TV features: Georgia & UK. vii) Black Sea Workshop on Biological Conservation / GIS training course. viii) Submit scientific papers.	Land cover types, habitat types, habitat loss and biodiversity target areas mapped using Landsat images & GIS by July 2001. 1-week UK training course for Georgian 'ground-truth' surveyors, July 2001. 'Ground-truth' fieldwork & editing of maps over August – September 2002. Report written, translated, placed on website and publicised by end-Dec 2002.Two scientific papers submitted by March 2003.	Public access to the processed Landsat images and provisional GIS-generated maps, via the Project website. Informal assessment of skills, before and after the training. Posting of the Georgia 'ground truth ' field data on the Project website. Publication of Project Report; posting of findings on Project website. Number of peer reviewed papers, international conference presentations: UK/EU and Georgia/Russia.	Is Landsat cover available for the relevant areas and required periods ? - *yes.* Can the Georgia team travel to the UK then ? - *yes.* Do the Georgia team have basic GIS skills and fieldwork survey skills ? *- training to be provided during their week in the UK.* * = Translate into Georgian and Russian

Another approach to project planning is SWOT analysis: expedition participants and its advisors are asked to list the **S**trengths, **W**eaknesses, **O**pportunities and **T**hreats associated with the proposed project, or a particular aspect of that project. This technique allows all concerned to have their viewpoints considered and it may well highlight adverse features that were missed in the original project formulation. When carrying out a SWOT analysis of your project, try to answer the questions in Table 12-2, from your own perspective and that of others. Bear in mind that new Opportunities may be opened (a) by some of your project's strengths and (b) by eliminating some of its weaknesses.

Table 12-2 A framework for SWOT analysis.

Strengths: • what are your skills? • what resources do you have?	**Weaknesses**: • what do you do badly? • what could you improve?
Opportunities: • what are the mapping and analytical opportunities facing the project? • how can you utilise your GISci capabilities?	**Threats**: • what obstacles does the project face? • can any of your weaknesses seriously affect the project?

12.1.2 The GISci KISS Principle

During your expedition planning, try to follow the KISS Principle ("*Keep It Simple & Scientific*"). There is no doubt that remote sensing, image processing and GIS-based map production can be of great value to planners and natural resource managers in developing countries. The transfer of GISci technologies is certainly appropriate, but it must also be affordable. If your expedition is using GISci techniques in association with partners in a developing country, then the use of low-cost software – supported by user-friendly training materials – will improve the long-term sustainability of the project. Ideally, workers in the host country should be able to continue to collect samples, analyse data and produce summary maps, after you have returned to the UK. In this respect, expeditionary fieldwork is ideal for providing sustainable GISci-based projects in developing countries, especially if the software and hardware are extensively used during fieldwork, as most expeditions simply cannot afford expensive kit. A modified version of the KISS Principle, "*Keep I.T. Simple & Sustainable*", operates with GISci on most expeditions because they cannot afford to use the sophisticated, top-of-the-range software and hardware. In contrast, some projects initiated in developing countries by major governmental aid agencies have opted for the most sophisticated software available, requiring the powerful computers and highly-trained support staff. The results are all too predictable: after the initial training period there are often problems with computer maintenance; furthermore, the highly-trained staff look for better-paid work overseas, leaving behind some very expensive, sophisticated, but useless computer kit.

Landsat or ASTER imagery provides a low cost means of both navigating and mapping study areas. In Plate 21, from a geological mapping project in Burkina Faso, a geocorrected Landsat TM image has been used in conjunction with GPS to guide the expedition Land Rovers around areas of active sand dunes and river valleys prone to flooding at the onset of the rainy season.

12.2 Sampling strategies

"*Making field observations is not difficult. Making appropriate field observations is a challenge*." Reid (2003)

There are basically two approaches to sampling on fieldwork projects: generalist or specialist. The specialist, or 'case study', approach will examine a few sites in great detail, studying the mechanisms that form general pattern: for example, the trapping of rainforest butterflies at set locations and set times of the day – dawn, noon and dusk – over periods of many weeks. Another example is illustrated in *Figure 12-1* a very detailed study of gully erosion (see Faulkner *et al*. 2004 for more details). Problems with the specialist approach are that (i) the few selected sites may be inappropriately located and (ii) the sampling intervals might miss the impacts of key events, such as thunderstorms or seasonal climatic changes. Expeditions to the tropics and sub-tropics should bear the latter in mind: for most expeditions the easiest and most comfortable time to carry out fieldwork is the dry season; unfortunately in many cases most of the geomorphological activity occurs during the wet season and there are correspondingly great seasonal variations in tropical ecosystems.

Figure 12-1 Detailed surveying and sampling of a gully erosion site near Almeria, Spain: an example of the 'one site / many samples' approach (courtesy of Hazel Faulkner).

The generalist approach involves sampling many locations a few times, allowing the mapping of general patterns. Most expeditions are faced with problems of limited time and money, with study areas in remote and poorly-mapped regions, so the generalist approach to fieldwork is often the most appropriate. You could spend most of your time and budget examining in great detail the erosion processes along a single gully, when a more useful task would be to produce a geomorphological map for the whole region. An effective way of rapidly collecting a lot of samples from a study region is to select roads or motorable tracks that traverse the main geo-ecological units of the area and then to use the odometer ('mileometer') of your vehicle to stop every kilometre along those routes to record features and/or collect samples. This can be done very simply using compass bearings alongside the kilometre readings (though keep the compass well away from the vehicle when you take a reading!). If you use a GPS, this type of 'many sites/few samples' survey becomes even more versatile: the vehicle odometer is not needed, as most GPS sets can be set to beep every kilometre along a given bearing – allowing surveys on foot (or on horse-back, or on yak-back…). Furthermore, the GPS unit can double-up as a data-logger that can input your field records directly into a GIS – though remember to take back-up paper records too. An example of a regional soil erosion survey in Zambia's Luangwa Valley, carried out using a Land Rover to traverse almost 60 km of tracks with samples collected every kilometre, is shown in Table 12-3.

Table 12-3 Results from a regional soil erosion survey, Luangwa Valley, Zambia: an example of the 'many sites / few samples' approach (Teeuw 1990).

site no.	% slope	bare ground	soil type	surface crusting	surface lowering	soil lost (m^3ha^{-1}) gullies	rills	surface	
1	0	40	Silty clay	Y	10cm	30	0	1000	
2	0	75	Silty sand	Y	10-15	26	0	1250	
3	0	15	Vertical	.	.	96	0	0	
4	1.0	5	Clay loam	.	10	0	0	100	Sands taken
5	1.0	40	Silty sand	.	.	491	0	0	for building
6	0	5	Clay loam	.	.	0	0	0	
7	0	55	Silty loam	Y	5	0	0	500	
8	4.0	65	Vertisol	.	.	10	0	0	
9	4.0	35	Silty clay	.	5	0	0	500	
10	1.0	50	Sandy loam	.	5	0	0	500	
11	19.5	50	Sandy loam	.	15	3648	240	1500	Soil piping and
12	14.0	40	Silty clay	Y	50	600	0	5000	severe erosion
13	1.5	45	Silty loam	.	5	0	0	500	
14	7.0	0	Silty loam	.	5	0	0	500	
15	0	30	Silty loam	.	.	0	0	0	
16	1.0	40	Silty clay	.	.	0	0	0	
17	0	60	Vertical	.	.	0	0	0	
18	1.0	50	Silty clay	.	5	0	168	500	
19	4.0	60	Skeletal	.	10	0	0	1000	
20	5.0	80	Sandy loam	.	5	0	0	500	
21	9.0	80	Skeletal	.	5	0	0	500	
22	4.0	35	Sandy loam	Y	5	0	0	500	
23	9.0	60	Sandy loam	.	.	2000	0	0	Dry riverbed
24	2.5	45	Sandy loam	.	.	250	0	0	
25	1.0	20	Sandy loam	.	.	0	0	0	
26	1.5	25	Silty clay	.	.	0	0	0	
27	1.5	60	Silty clay	Y	.	0	0	0	
28	1.0	20	Silty clay	.	.	0	0	0	Dry riverbed
29	0	80	Silty clay	Y	.	0	0	0	
30	0	80	Sandy loam	Y	.	0	1	0	Soil piping
31	0	20	Sandy loam	Y	.	0	0	0	
32	1.0	50	Clay	.	.	0	0	0	
33	1.5	50	Clay	.	.	0	0	0	
34	0	60	Clay	.	.	0	0	0	
35	1.0	25	Clay	.	.	0	2	0	
36	4.0	50	Sand & clay	.	5	0	204	500	
37	1.5	40	Sand & clay	.	.	0	0	0	
38	1.0	60	Clay	Y	.	36	0	0	
39	0	70	Clay	.	.	0	0	0	
40	2.5	40	Sandy loam	.	2	0	0	200	
41	0	50	Clay	.	.	36	0	0	Severe gullying
42	0	100	Sand	.	.	0	0	0	Dry riverbed
43	1.0	60	Clay	.	.	0	0	0	
44	1.5	60	Sandy silt	Y	30	0	5	3000	
45	3.5	10	Sandy silt	.	20	0	0	2000	
46	1.5	10	Sand	Y	20	0	1	2000	
47	1.0	75	Clay & sand	Y	5	0	8	500	
48	1.0	100	Sand & silt	.	.	0	0	0	
49	0	90	Sandy clay	Y	.	0	0	0	
50	1.0	70	Silts	Y	.	0	0	0	
51	3.5	0	Sand & silt	Y	.	0	0	0	Dry riverbed
52	3.5	95	Silty sand	Y	15	0	0	1500	
53	2.5	60	Silty sand	Y	15	0	10	1500	
54	2.5	40	Silty clay	Y	35	0	0	3500	
55	0	30	Silts	.	.	0	0	0	
56	0	90	Silts	.	.	0	0	0	
57	0	5	Silts	.	.	0	0	0	
	2.2	48				127	11	510	*Averages*
	3.5	48				657	71	1210	*Averages for eroded sites*

Another example of a generalist fieldwork methodology is the Land Systems technique of geo-ecological mapping discussed in the *Image processing and interpretation* chapter (viz. Figure 8-5). This was originally devised in the 1950s to map land suitability for agriculture across the whole of Australia. Once regional geomorphological or geo-ecological maps have been produced, more specific studies can be attempted, such as detailed sampling of soil and slope properties, which can then be used in a GIS to generate soil erosion hazard maps. The Land Systems approach has been used extensively in the Luangwa Valley of Zambia as the basis for erosion hazard mapping and examples from the planning of some of those expeditions are given below. Mapping the geo-ecological characteristics using Land Systems is an example of *Nested or Stratified* sampling, moving from regional levels to more detailed scales of study. A disadvantage of this strategy is that it is dependant on image interpretation, a subjective process that may introduce bias into the dataset. *Systematic* sampling involves the collection of samples at regular intervals, such as the corners of grid squares on a 1:50,000 topographic map, or at 1 km intervals along a track: the main disadvantage of this method is that the sampling interval may introduce bias into the dataset. Adopting a *Random* sampling strategy will remove operator bias and sampling interval bias, but it may leave you with no samples from what are clearly important parts of a data population. An effective compromise, widely used in field surveys, is to use a *Stratified Random* sampling strategy: all of the major groupings in a data population are recognised and sampled, but the sampling of each data grouping is done randomly. One of the most rapid types of geo-ecological surveys is to follow a straight transect line from a hilltop to an adjacent valley bottom, measuring breaks of slope along the way and marking them with survey tape or blazes on trees, then returning back up the transect line, sampling soil and vegetation types in each of the similar-slope units.

Whether you opt to follow the specialist or generalist mode of sampling you will probably be faced with more potential samples than you have time to collect. Sampling methods have been devised that allow you to collect data from a relatively small part of a much larger data population, often with a means of inferring generalisations about the larger group. The basis of most of these sampling methods is probability and the assumption that most data populations follow a normal distribution (giving a bell-shaped curve when plotted as a graph) allowing the validation of inferences by statistics. See Rice (2003) for an easy to follow summary of geographical sampling and inferential statistics. In addition to statistical analyses, a GIS can carry out spatial and temporal analyses, allowing you to examine distribution patterns and changes over time.

12.2.1 Project management

Expeditions will vary in their complexity depending on the number of objectives that they are aiming to complete. Most will involve a number of often inter-linked fieldwork projects based in one study area, although another common variant involves sampling just one thing at many remote locations. Whatever the case, careful management of time, money, equipment and expertise is needed, if all of the project objectives are to be met. Reconnaissance (‘recce’) surveys are an essential aspect of successful field project management. A common practice is for one or two expedition members to make a one-week recce visit to the study region, so that access to study areas can be checked, permissions obtained and goodwill visits made to key associates in the host country. Plans can then be modified accordingly after the recce visit and the whole expedition then decamps to the host country for at least a month's fieldwork. On many expeditions costs will preclude a recce visit, however, this can be compensated by having expedition partners in the host country who can check the field conditions and associated logistical factors.

Project budgeting is not just limited to financial considerations. Most expeditions are faced with limited time and limited manpower, so careful consideration is needed of who does what and when, with which bit of equipment. With so many eventualities on any given expedition, the best approach to tackling these logistical problems is for you to go through the following check-list, considering how the questions might apply to your field project.

People

- Who will have the time & skills for GIS work? Who can help?
- Who will be involved? (students, rangers, wardens, villagers, politicians)
- Who will have training? When, how and where?

Time-tabling

- Before fieldwork (1/3): liaison, learning, research, datasourcing, digitising, testing
- During fieldwork (1/3): data entry, possible problems
- Afterwards (1/3): data cleaning, analysis, mapping, reporting, distribution

Equipment

- What hardware and software is needed for the project?
- Should you use existing kit or purchase new items? Check GIS software licenses for multiple usage conditions
- Can the GISci kit be integrated with existing facilities? e.g. university Departments, National Parks, Government agencies, maintenance, insurance, power supplies

Finance

- Have you budgeted thoroughly, e.g. for equipment, provisions, accommodation, transport, insurance?

Flow diagrams and *Gantt Charts* (Figure 12-2 and Table 12-4*)* are widely-used and useful techniques for ensuring the effective use of time, manpower and equipment during the life of the field project. Gantt charts usually have a horizontal time axis and a vertical list of project tasks: more complex variants can include the names of expedition members who have been allocated to each task. In Table 12-4 the shaded boxes show the time in the life of the project when a given task is to be carried out. Colour coding of time lines can be used to illustrated whether tasks are completed, in progress or overdue, and marker symbols can be used to highlight when key stages in the project have been completed.

Another technique to consider is 'C*ritical Path Analysis'* (CPA), a type of flow diagram that divides a work programme into its components and displays them in a chronological network, detailing the number of days needed for given tasks, using flag symbols to highlight critical events or activities along the time-line of the project. Mitchell (1991) discusses CPA and provides an example from a terrain analysis project. The advantage of

CPA is that it identifies critical tasks that have to be completed on time for the whole project to be completed on time, as well as those tasks that you could afford to delay if a resource needs to be reallocated to help speed-up a delayed critical task. The disadvantages of CPA are that it is most effective when prepared by someone with experience of expedition planning, who will best be able to judge how much time tasks will take – and CPA can be very complex! Useful websites to find out about and download these planning aids are: *www.smartdraw*.com and *www.mindtools.com*.

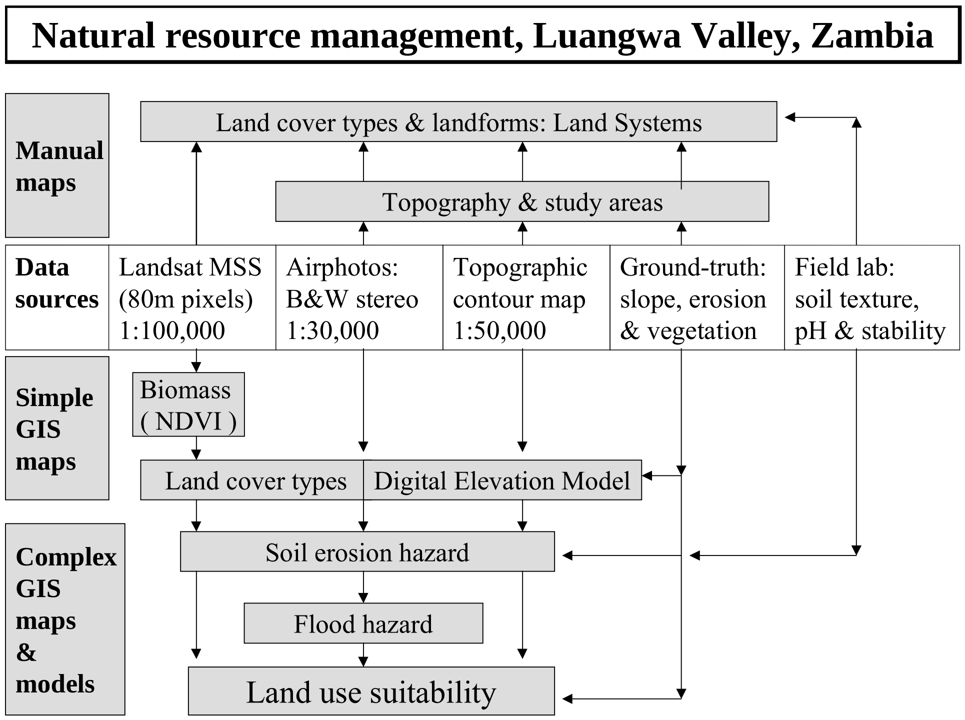

Figure 12-2 Flow diagram illustrating the scales of study, types of data and analyses carried out on a soil conservation expedition in Zambia.

Table 12-4 Gantt chart for a project examining urban water quality (original example courtesy of Hazel Faulkner).

Activity	**Year 1**			**Year 2**			**Year 3**		
Work plan & model calibration Desk study & field site recce visits Field site sediment granulometry Cultures of field-associated bacteria	■								
Flood event data collection Site hydrology Field variations in bacteria		■		■		■			
Hydraulic flow model development		■	■	■	■	■			
Field and laboratory data analysis						■	■		
Model testing							■	■	
Write-up and dissemination of results								■	■

12.3 Data

12.3.1 Data requirements

Data requirements are determined primarily by the project's GIS aim. Having formulated your expedition GIS question or aim, what data will be required to answer the question or achieve the goal? There is something of a ‘chicken and egg situation’ with the project aim and the available data. Ideally the aim, or research question, will lead to the data *requirements*; but it also likely that data *availability* will to some extent determine the questions being asked. The availability of a particular dataset should not in itself lead your GIS operations. It is tempting, for example, to use a good cloud-free satellite image to produce attractive image maps, but make sure these are being produced with a use or user in mind. An example of the various types of data, scales of data and degrees of data analysis that were needed for a soil conservation project, is given in Table 12-5.

Table 12-5 Data sources used by the Luangwa Soil Conservation Project, Zambia.

Data sources	Details: type of source data used	Manual maps produced	Simple GIS maps produced	Complex GIS maps of models
1. Digital maps & databases	CIA: Zambia FAO: soils			
2. Satellite imagery	Landsat MSS	Geo-ecology (land systems)		
3. Aerial photography	1:30,000 panchromatic	Geo-ecology (land systems)	River bank erosion hazard	Land suitability map
4. Fieldwork: surveying	Compass / tape / inclinometer; surveyor’s level	Geo-ecology (land systems)	Erosion plot micro-relief	Change analysis: net erosion & deposition
5. Fieldwork: sampling	Soil pits; gully sizes; signs of surface erosion	Geo-ecology (land systems)	Soil erosion hazard map	Land suitability map
6. Laboratory: (a) Field (b) UK-based	Soil texture, pH, aggreg. Stability (b) % organic, % clay / silt / sand	Geo-ecology (land systems)	Soil erosion hazard map	Land suitability map

Key considerations when gathering data before the expedition concern the relevance, accessibility and cost of the datasets. A dataset may be available for your study region, but does it actually cover your study sites and is it an appropriate scale for your research objectives? The date when the data were collected should also be checked, as should the amount of cloud cover or haze if you are seeking remotely sensed imagery of your study sites. Some ideal datasets may exist in the host country, but you may not get access to them unless you have a partnership agreement with an organisation in that country - and even then you may experience bureaucratic delays of many months. Data costs have always been a major concern with scientific expeditions: the good news is that international agencies such as the United Nations Environment Programme (UNEP) the UN Food & Agriculture Organisation (FAO) and various major universities – notably the University of Maryland - have built-up numerous useful datasets that are open to free public access.

A major boost for overseas fieldwork, especially at local to regional scales of study, are the improved capabilities – but lower prices – of Earth observation satellite imagery. For instance, 60 km x 60 km scenes from the Japanese-American ASTER satellite give you multispectral coverage of just about anywhere on the planet with 15 m pixel detail, for just US$60 (UK £35). Details on data types and data sources are given in the GIS chapter near the start of this handbook and details of data suppliers are given in the Appendix.

There are a number of questions that can guide you in selecting the most appropriate satellite imagery for a fieldwork project:

- *Do you need data from as near a time as possible to your fieldwork period?* If so, the available imagery will probably be expensive and may well have significant amounts of cloud cover. If having very up-to-date imagery is not an issue, get free Landsat ETM+ imagery from the University of Maryland website.
- *Is the season of the imagery important (e.g. start or end of dry season, end of rainy season)?* Archives of satellite imagery spanning many years are available that should allow you to select imagery from suitable seasons.
- *Is the mapping of vegetation, soils and rock types a key aspect of your project?* For vegetation mapping, opt for imagery from the start of the dry season; for soils and rocks, select imagery from the end of the dry season. If dry season dust storms affect the area, opt for early rainy season (and pray that you can find a cloud-free image).
- *Do you need a wide range of spectral bands across the visible and infra-red (e.g. for mapping soils and rock types)?* If yes, opt for the relatively low cost ASTER imagery
- *Would a 3-D digital elevation model be of use to your project?* If so, ASTER can provide a DEM with 15 m pixels and 15 m contours, while the SRTM DEM (available free from the University of Maryland website) can provide 90 m pixels with 10 m contours.
- *Do you know of someone who has suitable data?* If so, start practicing your begging skills!

12.3.2 Scale and resolution

What scale or resolution is appropriate for the collection of data and the presentation of results? In choosing a suitable spatial resolution, a key criterion is the size of the spatial variations you are investigating, e.g. AVHRR data with 1 km pixels provide useful environmental information, but will not help if you are mapping habitat variations over a few hundred metres. Likewise, if you are scanning or digitizing airphotos or paper maps, choose a resolution appropriate to the task. Too much detail makes the data sets large, expensive and slow; but too little detail will not answer your questions. The same consideration applies to temporal and spectral resolutions. If you are using a series of satellite images to monitor seasonal changes in vegetation, they need to be frequent enough to represent significant temporal changes, yet not so frequent as to be impractical or too expensive. Particular care is needed when using remotely sensed images to map tidal regions, due to the daily variations in inundation extent and soil/sediment moisture content, both of which can have notable effects on radar and multispectral imagery.

Bear in mind that the optimum scales of remotely sensed data required for most geo-ecological surveys will change as the project progresses. During the desk study and recce visit stage you will probably be using satellite imagery at scales of 1:500,000 to 1: 25,000 (e.g., AVHRR or MODIS for regional mapping, with Landsat, ASTER or SPOT for mapping smaller areas of interest). Once areas for detailed study have been selected, more detailed imagery will be needed, typically at 1:25,000 to 1:10,000 scale, consisting of aerial photographs or 0.6 m-3 m pixel imagery from IKONOS or Quickbird. Finally, detailed surveys and mapping will be carried out, ideally aided by airphoto basemaps at scales of 1:10,000 to 1:3,000.

12.4 Equipment, software and fieldwork practicalities

Although guidelines on choosing appropriate expeditionary hardware and software are given in dedicated chapters, an overview of key points is given here, in the form of checklists that you can compare against your own project plans.

Hardware (and to some degree, software) considerations:

- Suitability for project's needs
- Ease of use / expertise required
- Compatibility with systems already used, for example at your own institution or the one you will be working with, such as a local university or national park office
- Support in the host country
- Costs
- Robustness for fieldwork: heat, humidity, dust, cold….

Maintenance, especially for printers:

- Consumables (ink, toner, paper, etc.)
- Connections (computers - data recorders - GPS - power supplies)
- Power supplies, in the field and smaller towns: solar recharging panels, lightweight generators (500W), vehicle batteries
- Insurance / packaging / import duties (or tax-free status?)
- Regulations about technology import / export

Training and testing – crucial for a successful expedition:

- Attend the annual EAC Expedition and Fieldwork Planning Seminar - EXPLORE (held in mid-November at the RGS-IBG, London)
- Attend specialist GPS and GIS courses (low-cost workshops are run by the EAC)
- Assemble your equipment, check how it works
- Organise a 'dry run' over a weekend to test all equipment in the field and become familiar with its usage
- Check how you are going to collect, analyse and present data on the 'dry run' to simulate expedition conditions

How will field data be recorded?

- Pencil and paper, then type into a computer in the evenings. Pro-forma systems for data entry can save a great deal of time in the field and help ensure a degree of consistency in observations; an example is shown in the Appendix.
- Enter data in the field, via laptop, data-organiser, GPS with data-logging capabilities
- A 'belt and braces' combination: use of both paper and digital data collection
- Other methods: photographic, specialist instruments, data loggers

How will locations be recorded?

- GPS data loggers, computer connections

How will you minimise the chances of errors occurring during data collection?

- Try to establish a clean, secure, and tidy field laboratory
- Check data as you work: revise data collection methods if necessary; download digital field data at the end of each day
- Have back-up equipment & procedures, *use paper records, as well as digital data*
- Prepare a data-loss disaster plan e.g. if your computer or GPS crashes, theft etc.

Document details about what you sample!

In summary, the key to a successful expedition with fieldwork projects using GISci technologies, is to have a well thought-out aim and set of objectives; a project team who are well-versed at using the GISci kit and techniques under field conditions; a sound sampling strategy, preferably building on a recce visit or advice from co-workers in the host country; and a tried-and-tested data back-up system to avoid data loss. And finally, remember that all of this logistical planning involves a lot of thought, a lot of people and a lot of time: allow at least one year, preferably two, to get your ideas from the drawing board to fruition. A little bit of planning can avoid a lot of confusion in the field.

Figure 12-3 Geoscientists working on the western edge of the Sahara ponder the next move…..