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Note:

This Concise Guide for Technical Managers provides a series of checklists as memory joggers for those managing natural resources data and information projects. Some of the lists are in fact aide memoirs, documenting optional elements that technical managers may wish to consider if relevant to their project. The checklists correspond to the twelve modules of the Toolkit.

0 Capability Road Map – Enhancing Information Management Capacity

There is a wide variety of data and information management capacity across the various natural resource management (NRM) groups throughout Australia which relates to their size, complexity, location, funding, individual and organisational capacity, and time in existence.

Within the context of the need for ongoing improvements in the capacity of NRM regional bodies for managing data and information, it is important to consider a spectrum of information management capabilities. This can be viewed as part of a road map scenario giving consideration to where each NRM group is currently positioned and where they would like to be in the short, medium, and longer term.

The concept of capability spectrums is well established in the information technology industry and within quality management and allied disciplines across all industry sectors.

It is useful to consider the application of the capability-raising concepts to regional NRM groups as the methodologies do not consider current capability as a problem, but merely a starting point for improvement.

The following capability model (Table 0–1)—based on a simple five-stage maturity model as commonly used by the information technology industry—is presented for consideration. The model allows all NRM groups (regardless of their current capabilities) to consider what is needed to improve their capacity, and subsequently develop an action plan to move forward.

Table 0–1 An indicative capability framework for spatial information management within NRM regional bodies

Level	Name	Description
1	Individual capabilities	Individual staff members within NRM regional body are developing one or two projects or a business process.
2	Managed individual capability	The projects of individuals are recognised by the NRM regional group and are being managed, with standards in place. A linkage exists with some business processes and procedures. Training resources are allocated, responsibilities have been assigned and evaluations are taking place regularly.
3	Organisational capability	All NRM group business processes and projects are defined and managed using formal program management procedures. Linkage of all business processes to defined user needs exists. Internal benchmarking is occurring and compares data and information management with other business activities.
4	Quantitatively managed organisation capability	Quantified measures of process efficiency are taken across the NRM region. Data and information management processes, standards, training and support are measured quantitatively.
5	Optimising	Continuous improvement of processes is occurring based on quantified measures of process efficiency and range of management processes to constantly improve measured performance.

It is a useful exercise to consider where your NRM regional group is placed on this capability spectrum and where you intend to go (and how). Specifically, Modules 1 to 11 of this Toolkit are designed to support you in that journey. For some regional groups, raising capability by one or two levels may be sufficient. For others, a strategic plan for high level improvement progressing towards Level 5 may be more appropriate. Regardless, the focus should be on moving forward; either through the development of shared spatial information system services with other NRM regions/organisations, or through your own spatial information system implementation. A module-by-module road map for increasing capability is included at Table 0–2. Signposts are included in each module to guide managers in raising their NRM region's capability.

Table 0–2 A capability raising road map for spatial information management in NRM regional bodies

#	Module	Level 1 › 2	Level 2 › 3	Level 3 › 4	Level 4 › 5
1	Information management and the sustainable development of natural resources – an introduction to information management systems	Develop spatial information management plan including resource needs (people, funds and equipment), business drivers and governance	Comprehensive organisation-wide information management plan linked to business process analysis and underpinned by internal benchmarking	Development of formal measures demonstrating contribution of spatial information to business process efficiency including external benchmarking	Internal and external benchmarking drives continuous improvement process, including appropriate governance models to rapidly enact process improvements
2	Data management principles	Individual people or units have documented data management processes, policies and procedures	Organisation-wide data management processes, policies and procedures in place	Business process review for ensuring compliance with data management processes, policies and procedures	Development of metrics for data management compliance, including continuous external benchmarking
3	Interpretation and visualisation of data – an introduction to spatial info. systems	Understanding of spatial information systems by key staff members	Organisational understanding of spatial information systems	Cost benefit of spatial information systems analysed and recognised	Regular reviews of understanding, implementation and use of spatial info. systems
4	Spatial data priorities, standards and compliance	Individual people or departments have documented spatial data management standards, processes, policies and procedures	Organisation-wide spatial data management standards, processes, policies and procedures	Business process review for ensuring compliance with spatial data management standards, processes, policies and procedures	Development of metrics for spatial data management standards and compliance, including continuous external benchmarking
5	Spatial data	Individual	Formal spatial data	Development of	Continuous effort

#	Module	Level 1 › 2	Level 2 › 3	Level 3 › 4	Level 4 › 5
	discovery and access	understanding of spatial data clearing houses and peer support networks	access and use arrangements within and between regional bodies and other organisations; organisation mandate for peer support	feedback mechanisms to ensure spatial data quality and access align with business drivers across regional bodies	for improving, discovery and access of spatial data by all sections of NRM regional bodies
6	Project management and justification – lessons learnt, pitfalls and best practice procedures	Implement standardised project management, including individual or departmental level business cases	Implement program level organisation-wide project management, including systematic business cases	Analysis of project and program performance in project planning, management and post-project review, including cost benefit analysis of business cases	Comparative benchmarking of project performance between NRM bodies and allied organisations/ sectors
7	Guidelines for selecting spatial information systems software and hardware	System procurement driven by individual or departmental business needs; funded, endorsed plan for system procurement and implementation; selection checklists and criteria followed	System procurement fully integrated with business needs and procurement decisions undertaken on an organisation-wide basis	System audits, user reviews and business alignment assessment; user groups providing quantified feedback on systems	Quantified internal feedback on system usage and performance regularly compared with other organisations
8	Enhancing capability for using spatial information	The projects of individuals are recognised by the organisation or NRM regional body and are being managed; standards are in place and linkage exists to some business processes and procedures; training resources are allocated, responsibilities assigned and evaluations are taking place	All processes are defined and managed through program management of all projects; linkage of all business processes to defined customer needs exists; internal benchmarking is occurring and compares spatial information management with other business activities	Quantified measures of process efficiency across the organisation or NRM regional body; spatial information management process, standards, training and support are measured quantitatively	Continuous improvement process based on quantified measures of process efficiency and range of management processes to constantly improve measured performance
9	Map production guidelines	Unit or departmental documented map production guideline(s)	Organisation-wide documented map production guideline(s)	Comparative analysis and alignment of regional map production guideline(s)	Formal processes in place to ensure continuous improvement and change management of map production guideline(s) generated by quantified

#	Module	Level 1 › 2	Level 2 › 3	Level 3 › 4	Level 4 › 5
					regional analysis and user feedback
10	Introduction to GPS and best practice guidelines	Low understanding of GPS principles; GPS procurement driven by individual needs	Understanding of GPS principles; GPS procurement integrated with needs and procurement based on endorsed plan	Good understanding of GPS principles; formal methods for GPS survey and processing; procurement integrated with needs and procurement based on endorsed plan	Benchmarking of performance, with continuous effort for improving
11	Partnerships and working together – the potential for collaboration	Individuals or departments service the spatial information requirements of others	Organisational mandate for collaboration across all functional areas of an NRM group and formalised agreements for working with other organisations	Performance measures established for internal and external service agreements	Benchmarking of performance measures for service agreements; combined agreements for collaborative spatial information usage

1 Information management and the sustainable development of natural resources

The business case for spatial information

One of the prerequisites for NRM involves the establishment and maintenance of a database of relevant information in digital format. Access to reliable and up-to-date information reduces the uncertainty in planning and management by helping identify, model and analyse situations and issues. Strategies to overcome them may then be prepared and implemented, with the impacts monitored as part of an overall system. The value of the information and the effectiveness of the decision-making and planning processes are very closely related to the quality and completeness of the information and the manner in which it is made available. In this respect data access, management, integration, analysis and communication are key components of effective spatial information management.

Increasingly NRM regional bodies are using spatial data and information as a core part of their business operations and this often involves gaining access to, developing new, and processing existing data. Changes to existing data and the creation of new data should become part of the national resource base and, following completion of the initial project, subsequently be made available to the broader community.

The new natural resources management framework

The contemporary view of sustainable management of natural resources is best achieved by adopting a regional approach involving the development of strong cooperative partnerships between government bodies, the community, on-ground land managers and educational institutions to develop plans that address regional needs.

The shift to a regional approach in Australia was demonstrated in the nationwide implementation of the National Action Plan for Salinity and Water Quality (NAP) and the Natural Heritage Trust (NHT). The success of both initiatives was dependent on regional communities being able to develop and implement their own plans for NRM.

Need for an integrated information management solution

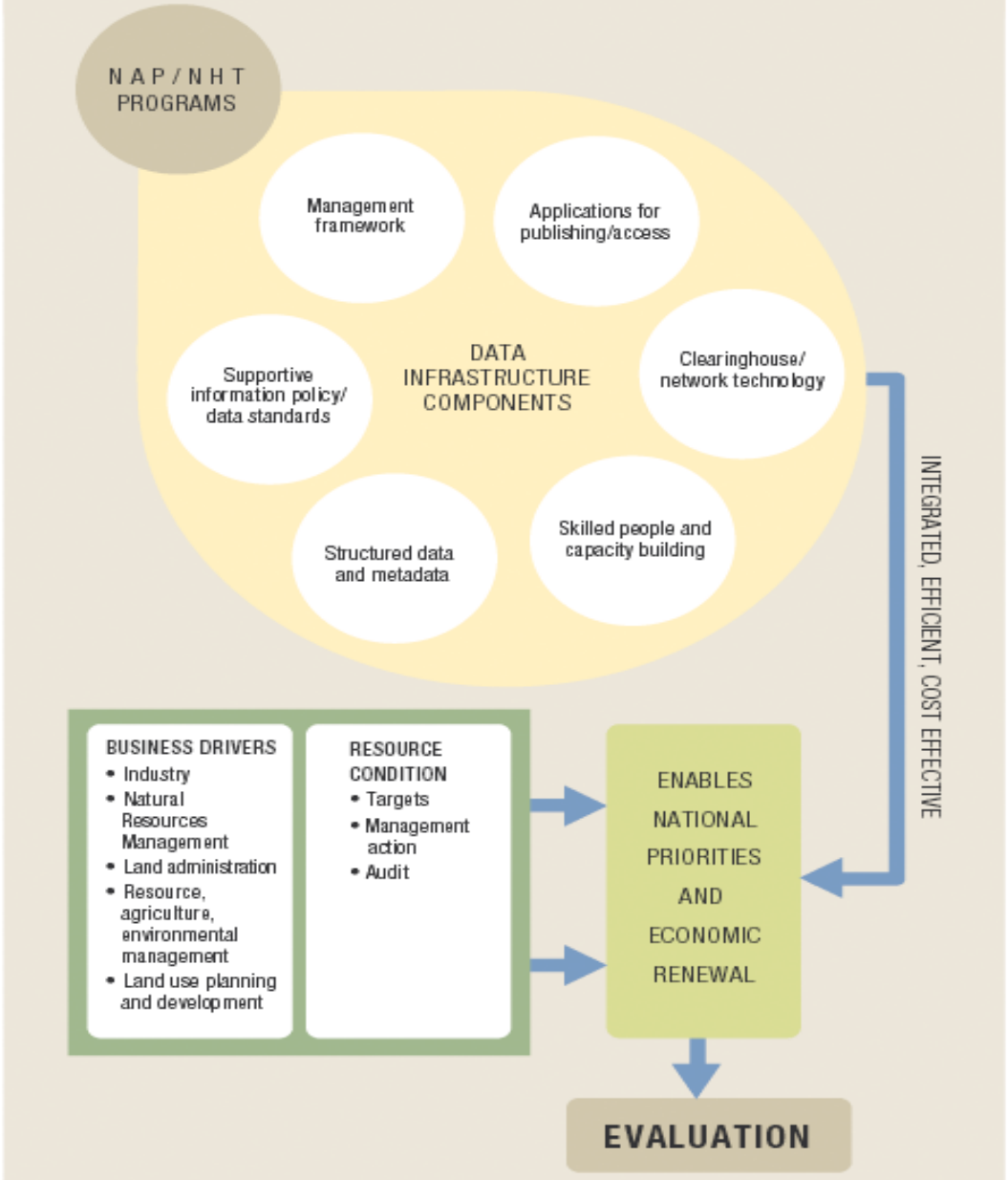
Coupled with this new funding approach is the fact that regional organisations and groups are becoming increasingly involved in the collection, management and use of data to fulfil project requirements. In addition, many groups are involved in integrating information technology (IT) within their organisation. To be effective, IT must be supported by policies and practices that view data and information as long-term assets. This requires dedicated management and coordination within a controlled environment to facilitate delivery to decision makers of the right information in the correct format in a timely fashion.

In recent times best practices have evolved to assist in data-related tasks in NRM projects. Successful projects involving spatial information management have generally adopted an

integrated information management solution—combining the elements of leadership, people, technology, applications and data into a framework that ensures tools and procedures are in place to maintain and transform data into useful information products. An integrated solution also provides opportunities to do new things, and to improve the way current activities are done, in ways currently not foreseen or possible. An illustration of how these elements fit together when viewed through an NRM lens is shown at Figure 0–1.

An integrated solution also promotes the development and acceptance of standards through the use of common data, systems and a participatory information management structure. This has the potential to reduce costs and increase the value of the data.

Figure 0–1 Effective tools and technologies are one component of an integrated information management solution.



Integrated management best practice guidelines

	Checklist for information management
☐	**Leadership:** Leadership is required to ensure that activities in the development of information management systems remain coordinated and focused. When involved in collaboration with other agencies the designation of a lead agency among the partners, with dedicated resources to be able to provide coordinating mechanisms, is a key ingredient to facilitating successful implementation.
☐	**Steering committee/board of directors:** Adoption of an integrated management solution and establishment of a data infrastructure often involves the creation of organisational responses such as a data utility and policy/standards group. To be effective some formal arrangement is required to oversee implementation and provide vision, direction and approval of resources. Typical roles for such a committee involve: ■ partnership development and policy framework ■ communication/participation ■ data standards ■ system requirement priorities ■ data collection and maintenance priorities ■ training.
☐	**Training and expertise:** The development of an integrated management solution and data infrastructure needs to be accompanied by a training strategy to build and sustain capacity. One of the key lessons learnt from past initiatives is that not enough attention has been given to capacity building and the development of corporate knowledge bases that enable data and information to be readily available for all partners and stakeholders. The following key issues should be considered: ■ identification of skills and training needs ■ recognition that specific training in spatial information systems and other applications (e.g. databases) may be required along with training in application development, system and network administration and program management.
☐	**Focal points within NRM regional bodies:** A key component to the successful implementation of an integrated management solution involves having a focal point for the development and implementation of a number of component activities, including the following tasks:

	Checklist for information management
	■ communication (providing and disseminating information among partners) ■ technology support, planning and implementation ■ support for the management/steering committee ■ development of information products and services ■ training and capacity building.
☐	**Information policy:** Access to accurate and up-to-date data and information in a timely fashion is critical to the successful management of natural resources. A number of key information policy issues need addressing, and include: ■ cost ■ format ■ system design ■ copyright ■ privacy ■ liability.
☐	**Partnerships and working together:** The development of an integrated management solution and data infrastructure presents many opportunities for partnerships. Information access enables groups and partners to do things in new ways, provide new services and information products, and reduce the reliance on traditional approaches. A single agency is unlikely to have all the resources, skills and knowledge required to undertake the development of all aspects involved in developing an integrated management solution and data infrastructure. Having organisations and partners working together from the outset is vital to ensure activities occur in a way that supports all the partners in their use of data.

ANZLIC policies and guidelines

ANZLIC has prepared a number of policies and guidelines to assist in the development of policies and protocols for spatial data management that are relevant for use at a regional level. These documents are available online at http://www.anzlic.org.au/policies.html.

Additional information

For detailed information refer to *Module1: Information management and the sustainable development of natural resources*

Other useful information is included in the Audit's publication, Australian Natural Resources Information 2002 http://www.anra.gov.au/topics/publications/national/introduction.html

2 Data management principles

Wherever possible, managers should give consideration to the following guiding principles for data management.

	Checklist for guiding principles for data management
☐	**Don't reinvent the wheel:** Expedite the project process by not reinventing the information management wheel.
☐	**Look for efficiencies in data collection:** Where possible data should be captured once for multiple/generic use.
☐	**Share wherever possible:** Where possible share data and foster the development of networks and partnerships.
☐	**Present a sound business case:** Data collection is expensive. There must be good business justification to support any data collection activity.
☐	**Reduce duplication:** Avoid duplication in data acquisition. Where possible team up with others.
☐	**Look before you collect:** Find out what already exists. Look for existing point-of-truth and authoritative datasets.
☐	**Fitness-for-purpose:** Undertake fitness-for-purpose assessments prior to using external datasets.
☐	**Classification systems:** Check for standards and existing classification systems or methodologies. Use existing systems and facilities wherever possible.
☐	**Think beyond your immediate use:** Manage data to maximise their value both during and after the project. Give priority to the broadest value data that are of benefit to multiple processes.
☐	**Data custodianship:** Select the most robust organisation with the broadest span of interest as the most appropriate custodian of high-value general use information. Reinforce and support data custodians and where possible negotiate access arrangements.
☐	**Metadata:** Complete metadata documentation is required for every dataset to demonstrate best practice. Metadata provides information about datasets such as accessibility, currency, completeness, fitness-for-purpose and suitability for use.

Benefits of good data management

Good data management policies and procedures ensure that data are treated as valuable assets. It is important to remember that data management and standards are tools to facilitate improved decision making in NRM. In general the benefits of good data management are reflected through:

- better decision making
- maximising use
- avoiding duplication
- maximising integration and interoperability
- improving equity of access
- improving communications
- facilitating partnerships.

Additional information

For more detailed information refer to *Module 2: Data management principles*

For other related information refer to *Module 4: Spatial data priorities, standards and compliance*

3 Interpretation and visualisation of data – an introduction to spatial information systems

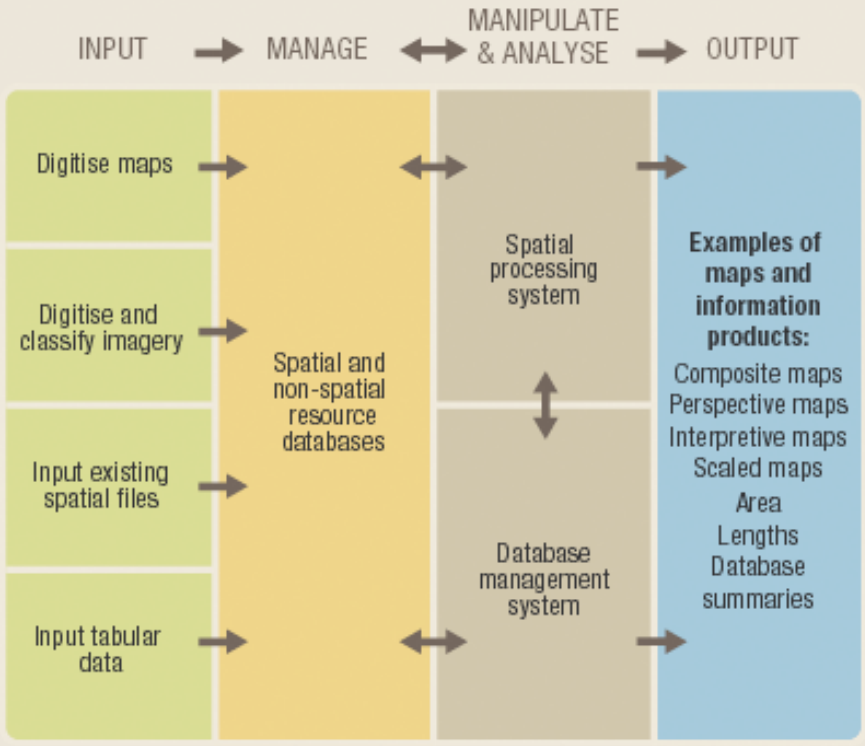
Increasingly, many NRM regional bodies and organisations throughout Australia are integrating mapping and spatial information system (SIS) technology into their business processes.

For the purpose of this document, spatial information systems include geographic information systems (GIS), image processing applications for raster data (e.g. satellite images and aerial photographs) and spatially-enabled databases.

Spatial information and information management systems allow users to manage, understand, question, interpret, manipulate, model and visualise data in new ways.

One of the major strengths of an SIS is its ability to link numerous databases of information within a single system. In this sense many datasets previously confined to simple external spreadsheets or large regulatory databases can be integrated into an SIS to generate a new level of information and analysis. A theoretical schematic for an SIS is illustrated at Figure 0–2.

Figure 0–2 Theoretical schematic for a spatial information system.

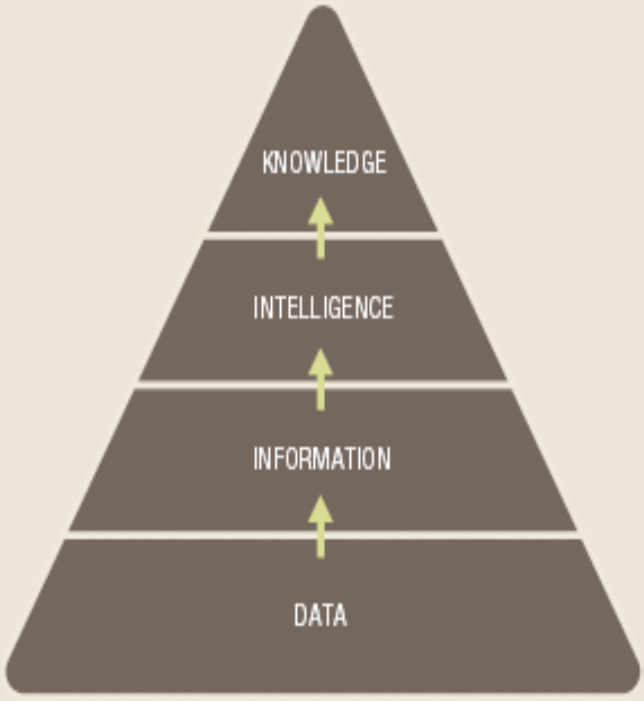


The goal of information systems is to assist the conversion of data into information and knowledge to achieve results.

In general terms ***data*** refers to a collection of facts, concepts or instructions in a formalised manner suitable for communication or processing by humans or computer. ***Spatial data*** refers to data that have positional values related to them. In some situations the term ***geospatial data*** is used as a further refinement. This refers to spatial data that have been geo-referenced to a location above, on or below the earth's surface.

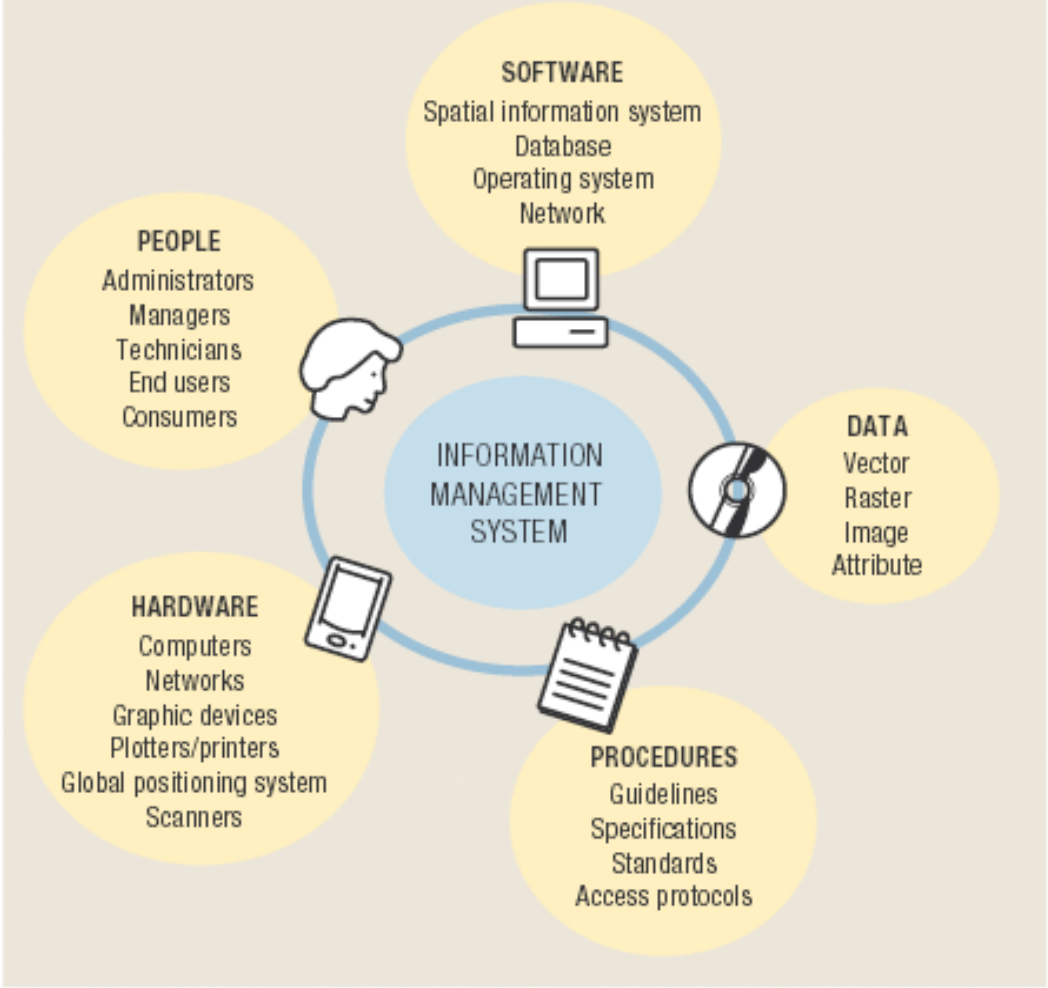
Information is the term applied to data that have been value-added, processed and interpreted. ***Geoinformation*** is a specific type of information that involves the interpretation of spatial data. It can be argued that it is the transformation of data to information products that brings a level of understanding and knowledge, and the ability to make informed interventions to improve the management of natural resources. A schema for this concept is illustrated at Figure 0–3.

Figure 0–3 Schematic illustration of the progression of data into knowledge.



As with all organisations and groups dealing with sophisticated technology, new tools can only be used effectively if they are properly integrated into the entire business strategy and operation. In this sense, an SIS should not be considered as a single piece of software but within the framework of an information management system, including people, procedures, data, software and hardware. This framework is illustrated at Figure 0–4.

Figure 0–4 Framework for an integrated information management solution.



An increasing number of agencies, universities and other groups are developing spatial data in SIS ready formats. When coupled with the development of simple free desktop spatial visualisation applications and improvements in technology (e.g. web-based mapping) it enables an increasing number of people to distribute, publish, share and use datasets that were previously available only to specialists.

Additional information

For more detailed information refer to *Module 3: Interpretation and visualisation of data – an introduction to spatial information systems*

4 Spatial data priorities, standards and compliance

Most agencies and NRM regional bodies are both information providers and clients; i.e. they collect and use data for their own purposes, use data provided by others, as well as make data available to other users, most importantly their state/territory equivalents. Standards form a key ingredient underpinning the management of data and information.

Benefits of standards for data include:

- increased data sharing
- higher quality data
- improved data consistency
- increased data integration and interoperability
- better understanding of data
- improved documentation of information resources
- improved control over data updating activities and development of new versions of datasets
- improved data security.

It is important that organisations involved in NRM appreciate the importance of standards, and the elements involved in their development. Such an understanding assists in asking the right questions when searching for data, planning data capture programs, or negotiating technical support for provision of data services.

An important goal in the development of an integrated information management solution is to facilitate the development, publishing and acceptance of data standards. Such standards are a key ingredient for all users and producers of data and information. They are particularly important in any co-management, co-maintenance or partnership where data and information need to be shared or aggregated.

Regional groups need to focus on the development of standards, and ensure they are widely promoted and adopted by the user community.

The peak body responsible for the promotion and coordination of standards for spatial data in Australia is ANZLIC – the Spatial Information Council.

ANZLIC policy in relation to the development of standards may be summarised as follows:

- Where possible adopt the following in order of priority:
  - international standard
  - national standard
  - regional or jurisdictional standard
  - local standard.
- Where possible adopt a minimum standard, i.e. less is better than more.
- Give consideration to a particular version of a standard (note: standards are constantly being updated).

Standards evolve

Standards often change in parallel with changes in technology and business processes. A process with built-in continued participation and review is important so that standards evolve rather than drop out of favour as parties find new individual approaches. It is recommended that NRM regional groups maintain close contact with their respective state or territory representatives to ensure they are kept up-to-date with the latest information on standards.

A wide range of support material is available on the development and application of standards relating to NRM datasets.

ANZLIC has produced a series of policy documents and support material on standards, including a Policy Statement on Spatial Data Management, and Model Data Access and Management Agreements which serve as useful templates for regional groups. All documents are available online from the ANZLIC website at

http://www.anzlic.org.au/policies.html.

The publication Australian Natural Resources Information 2002, produced by the Audit, also provides useful background material. This report is available online at:

http://audit.ea.gov.au/anra/data/docs/national/Data_Contents.html

Within most jurisdictions each state, territory or discipline (e.g. land resource assessment) has its own overarching policies and standards for data collection, maintenance and classification criteria. **Regional groups are encouraged to contact their respective state or territory representatives to obtain information on the most appropriate standards for their region and subject matter.**

The following guidelines should be kept in mind when developing standards.

Spatial standards

Following is a list of various spatial data standards that practitioners need to be aware of, or may encounter, when managing or searching for data.

	Checklist for spatial data standards
☐	**Map projections:** A map projection may be described as a mathematical model that transforms the spatial relationships of features on the earth's three-dimensional surface to locations on a flat map or two-dimensional surface. In order to achieve this, some method must be used to depict a map in two dimensions, as a flat map does not accurately reflect the shape of the earth.
☐	**Datum:** In reality the earth only approximates a sphere. For small-scale maps such as an atlas (which often represent a large area such as a country), map makers treat the earth as a sphere. For large-scale maps that may reveal far more detail for a given area compared with small-scale maps, the earth must be treated as an ellipsoid or spheroid. A datum consists of a set of parameters and control points that are used to accurately define the three-dimensional shape of the earth.
☐	**Coordinate system:** A coordinate system provides a reference to measure horizontal and vertical distances on a map. Coordinate systems are usually defined by a map projection, spheroid reference, datum, and a number of other parameters such as standard parallels, a central meridian and possible shifts in the x and y directions. The two most common coordinate systems are geographic (i.e. latitude/longitude) and the Map Grid of Australia (MGA) (i.e. easting and northing).
☐	**Scale and accuracy:** The term scale refers to a statement of measure. It is often the ratio of the distance on a map as related to the true distance on the ground. In general, maps with smaller scales (e.g. 1:1 million) show less detail. This is also the case for SIS datasets, which are often derived from maps or images at given scales. SIS software functionality enables the user to zoom in closely on a dataset and print it at very large scales. Please note that such zooms or prints are not any more accurate than the maps or images that they were derived from. When considering scale and accuracy, there is also the need to distinguish between accuracy and precision for both raw and derived data. ***Accuracy*** is associated with reliability to conform to a given standard and a lack of bias. In contrast, ***precision*** involves the ability to make fine distinctions. **Note:** Your local state or territory coordinator can provide additional information about which map projections, datum and coordinate system is appropriate for your region and purpose.

Non-spatial standards

A number of non-spatial standards are involved in the management and use of datasets. Following is a brief overview of what issues may need to be considered.

	Checklist for non-spatial data standards
☐	**Data acquisition/collection standards:** Methods and processes for collection of new or conversion of existing data
☐	**Database structure and content:** Organisation, representation and content of files and data elements
☐	**Data processing standards:** Standards to which data are subjected to for the purposes of data manipulation and conversion into information products
☐	**Data quality standards:** Includes such things as: ■ accuracy ■ precision ■ resolution ■ reliability ■ reproducibility ■ currency ■ relevance ■ ability to audit ■ completeness ■ timeliness
☐	**Database maintenance standards:** Process and timing of updates, including additions, changes and deletions to datasets
☐	**Data dissemination standards:** Access and dissemination processes and products (e.g. maps, reports) plus other elements such as copyright, privacy and Freedom of Information (FoI)
☐	**Terminology/symbology standards:** Terms or symbols which must be used or adhered to
☐	**Presentation standards:** Methods for displaying and formatting information from a dataset for display/presentation purposes
☐	**Quality control and assurance standards:** Used to achieve a specified quality and to check the quality of an existing dataset
☐	**Data classification:** Standards which outline procedures to be followed when using a certain methodology
☐	**Storage procedures:** Procedures to be used for data storage, archiving or back-up
☐	**Data analysis procedures:** Standards for comparing, contrasting, assembling or evaluating a dataset for an application or specified product
☐	**Data transfer:** Standards for data transfer are independent of technology and applications and facilitate the moving of data among systems. This occurs without the prior specification of the intended end use of the data.

Checklists and scorecards are often used to assess compliance of a dataset to a particular standard as part of quality control and assurance processes. An example of a compliance checklist taken from the Audit's 'Australian Natural Resources Information 2002' document follows.

	Compliance of the 1996/97 Land Use of Australia map with standards for the Australian Spatial Data Infrastructure
☐	**Access** **Are the data easily accessible?** ■ Land use data are available free of charge online via the Australian Natural Resources Data Library. ■ Data may be mapped through the Australian Natural Resources Atlas Map Maker. Detailed regional summaries of land use for each river basin are available through the Australian Natural Resources Atlas.
☐	**Are the data documented?**
	■ Summary documentation and full metadata are available through the Australian Natural Resources Data Library and the Australian Spatial Data Directory.
☐	**Supply** **Are licence arrangements in place to ensure that the information is accessible, while protecting copyright, intellectual property, privacy and confidentiality?** ■ A licence agreement exists between the Audit and ANZLIC, and is supported by the Australian, state and territory government agencies.
☐	**Quality**
	Do the data meet national guidelines or standards? ■ Data meet the following national guidelines: ▪ Spatial data are available in the Geocentric Datum of Australia (GDA94). ▪ Attribute data use the Australian Land Use Management Classification Version 4, October 2000. The Executive Steering Committee for Australian Land Use Mapping monitors compliance with the classification. ▪ Download of data from the Australian Natural Resources Data Library is subject to an agreement with licence conditions.
☐	**Maintenance** **Are there national coordination arrangements in place to help ensure that data are being assembled, maintained and delivered in a nationally consistent way without duplication of effort?** The Australian Government Department of Agriculture, Fisheries and Forestry coordinates the Executive Steering Committee for Australian Land Use Mapping with representation from the Australian, state and territory governments. **Are custodians of the data maintaining the data according to national guidelines or standards?** The Australian Government Department of Agriculture, Fisheries and Forestry maintains data according to the Australian Land Use Management Classification. **Source:** Australian Natural Resources Information 2002, National Land & Water Resources Audit (http://audit.ea.gov.au/anra/data/docs/national/Data_Contents.html).

Additional information

For more detailed information refer to *Module 4: Spatial data priorities, standards and compliance*

5 Spatial data discovery and access

Timely access to data and information in a suitable format is critical to informed decision making by NRM regional groups. Currently a wide range of data and information products is readily available—these include spatial databases, spreadsheets, reports, imagery and photos, multimedia documents, tables, posters and maps that are freely available to support the management of natural resources. A number of specific services have been established to facilitate the discovery, visualisation, access and distribution of these resources.

Access to reliable and up-to-date information reduces the uncertainty in planning and management by helping identify, model and analyse situations and issues. Strategies to overcome them may then be prepared and implemented, with the impacts monitored as part of an overall system. The value of the information and the effectiveness of the decision-making and planning processes are very closely related to the quality and completeness of the information and the manner in which it is made available. In this respect data access, management, integration, analysis and communication are key components.

A number of specific services have been established to facilitate the discovery, visualisation, access and distribution of NRM data and information. The philosophy underpinning the creation of a number of these services (e.g. the Australian Natural Resources Data Library and the Australian Natural Resources Atlas) is that the development of datasets is an expensive activity, and datasets accrue far greater value if they are readily accessible to a wide range of users.

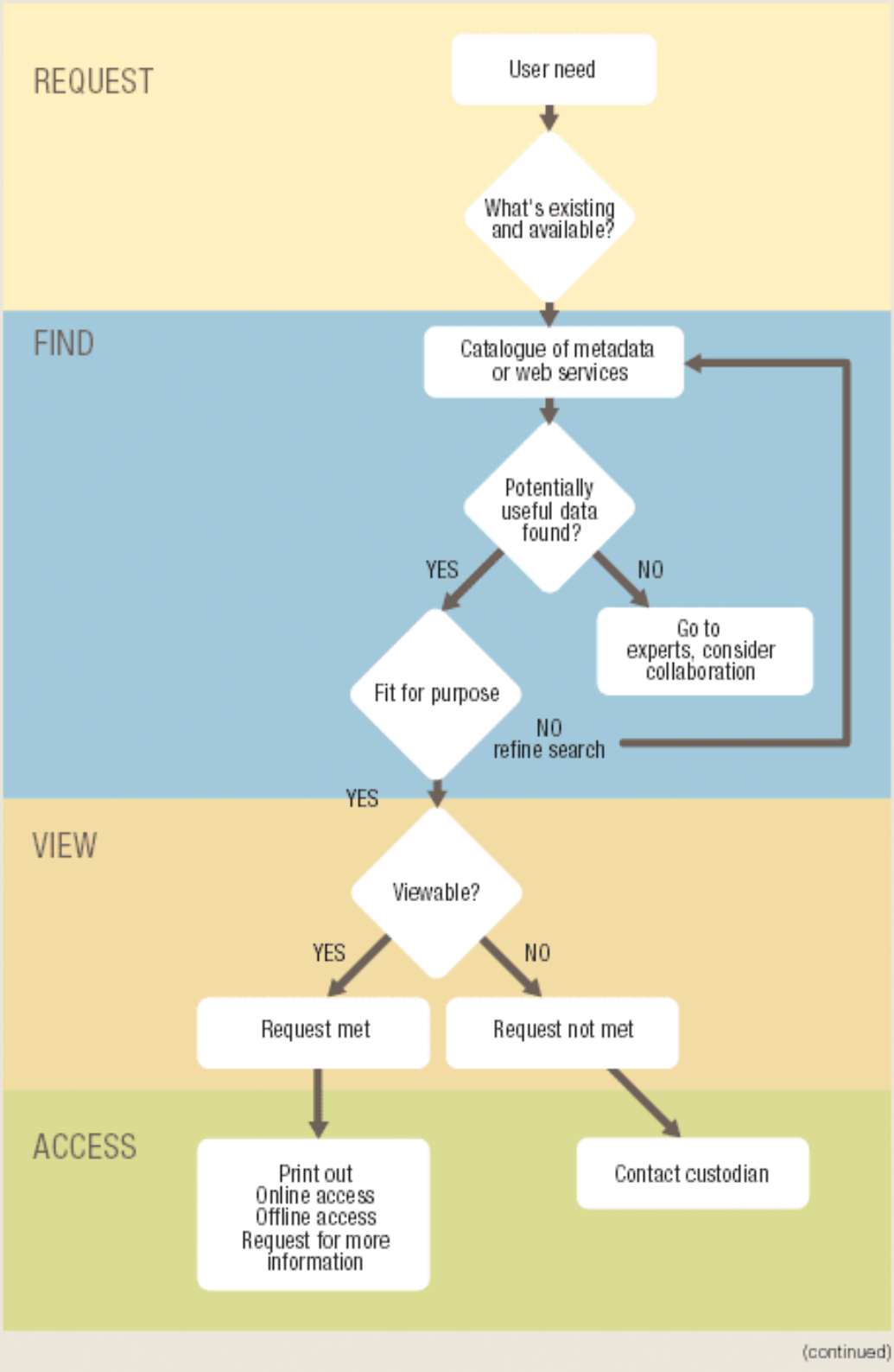
To be successful, accessing and publishing of data should be carried out within a controlled framework. This protects the rights and responsibilities of data providers and data receivers. A number of model frameworks exist for regional groups to develop similar protocols, e.g. the ANZLIC guidelines and policies available online at http://www.anzlic.org.au/policies.html.

The process of acquiring existing data, often referred to as data discovery, involves a number of steps all of which are carried out within a controlled framework:

1. Searching (request and find) to determine the data actually exists
2. Viewing and assessing their fitness for use
3. Completion of accessing and licence agreements
4. Supply or delivery.

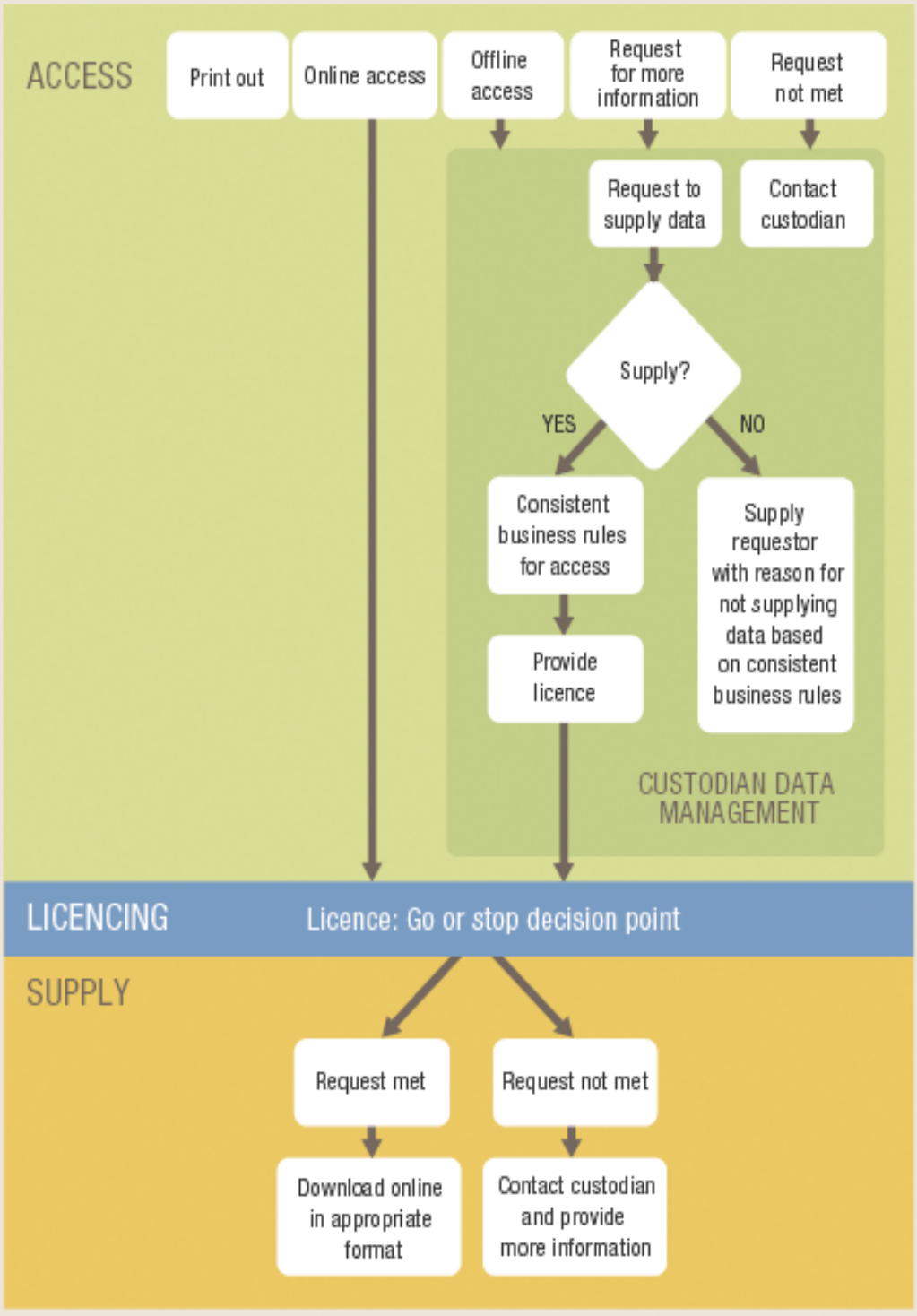
This process is illustrated in the flow-chart at Figure 0–5: parts (i) and (ii).

Figure 0–5(i) Flow chart for discovering and accessing spatial data and information: a user's perspective.



(continued)

Figure 0–5(ii) Flow chart for discovering and accessing spatial data and information: a user's perspective.



The major sources of natural resources data and information available at a national level may be found at the following sites:

Australian Spatial Data Directory: http://asdd.ga.gov.au/asdd/

Australian Natural Resources Atlas: http://www.anra.gov.au

Australian Natural Resources Atlas Theme Reports: http://www.anra.gov.au

Australian Natural Resources Data Library: http://adl.brs.gov.au/

Australian Resources Online: http://www.anra.gov.au/aro/

Australian Agriculture and Natural Resources Online: http://www.aanro.net/

Discover (NRM) Information Geographically:

http://www.environment.gov.au/erin/dig/index.html

Environmental Reporting Tool: http://www.environment.gov.au/erin/ert/index.html

Geoscience Australia: http://www.ga.gov.au/

Additional information is available online via the Australian Spatial Data Directory at

http://asdd.ga.gov.au/asdd

Many jurisdictions have developed 'clearing houses' and one-stop-shops where state/territory agencies lodge information about their spatial data. These clearing houses generally have associated policies and standards that ensure the consistency of their spatial data resources.

Queensland: http://www.qsiis.qld.gov.au and http://www.information.qld.gov.au/

Western Australia: http://www.walis.wa.gov.au/

New South Wales: http://www.canri.nsw.gov.au/ and http://www.nratlas.nsw.gov.au/

Tasmania: http://www.thelist.tas.gov.au/

ACT: http://asdd.ga.gov.au/asdd/tech/node/act-1.html and http://www.gim.act.gov.au/actLocate/index.dwt

Victoria: http://www.land.vic.gov.au and http://www.dpi.vic.gov.au/dpi/vro/vrosite.nsf/pages/vrohome

Northern Territory: http://www.ntlis.nt.gov.au/ and http://www.ntlis.nt.gov.au/imfPublic/imf.jsp?site=nt_atlas

South Australia: http://www.asdd.sa.gov.au/ and http://www.atlas.sa.gov.au/

Additional information

For more detailed information refer to *Module 5: Spatial data discovery and access*

6 Project management and justification – lessons learnt, pitfalls and best practice procedures

An awareness of lessons learnt from other organisations (and their experiences) can assist to ensure that projects are designed and implemented to achieve maximum benefit. There are many examples where an integrated management solution has been successful in NRM projects. However there are also examples of projects that have failed to return any measurable benefit to the organisation.

Tips for the successful implementation of information technology in NRM projects include:

1. Understand the problem before jumping to a solution
2. Always include key stakeholders in the feasibility process
3. Carefully assess internal development capabilities
4. Define requirements clearly
5. Distinguish the problem from the symptoms surrounding it
6. Resolve political issues.

Many organisations throughout the world have invested heavily in SIS software and data capture programs. Unfortunately in some cases the implementation processes have not operated in an effective or efficient manner and the anticipated benefits have not been realised. Careful adherence to proven project management principles and learning from others' mistakes should assist regional managers to implement successful projects.

A consistent approach to managing IT and SIS projects can improve project management and outcomes considerably. Many large organisations—including state/territory and Australian government agencies, and private companies—now use project management approaches based on proven methodologies. The project management systems used by the Tasmanian and NSW State Governments provide good examples with a wide range of free resources. More information on these systems is available online at:

http://www.egovernment.tas.gov.au/

http://nrims.nsw.gov.au/policies/imf/index.shtml

The Tasmanian system has two different styles of business case documents for small and large projects providing a very valuable resource to support justification of expenditure on spatial information by NRM regional bodies.

(http://www.egovernment.tas.gov.au/themes/project_management/project_management/resources).

Additional information

For more detailed information refer to *Module 6: Project management and justification – lessons learnt, pitfalls and best practice procedures*

7 Guidelines for selecting spatial information system software and hardware

Managers need to make judgments and decisions when selecting new spatial information systems, upgrading existing systems or evaluating whether to change to another system. Software and hardware selection should be based on the range of actual functionality and applications needed by an organisation. It is important to be aware of context, and not be influenced by the loudest voice. If in doubt, get additional advice.

In recent years there has been a proliferation of SIS software and an almost exponential increase in the range of functionality or tools available.

It is important to remember that SIS hardware and software are part of an integrated information management solution, and therefore they need to be considered in relation to other components (e.g. procedures, standards and protocols), designed to provide ready access to data and information, and support best practice procedures. As such, NRM regional groups are encouraged to purchase software products that are fully compliant with OpenGIS® specifications, enabling them to interoperate with other information systems.

Best practice guidelines and standards are available to assist in the design and evaluation of SIS software and hardware. The following is a summary of issues that need to be addressed when choosing an SIS software product:

	Checklist for selecting spatial information system software
☐	**Do you need a spatial information system or a mapping package?** If so, what scale or type—simple desktop viewer, professional workstation, custom application?
☐	**Cost:** Hardware and software requirements (including ongoing maintenance)
☐	**Type of operating system** that will be used (e.g. Linux, Unix, Windows, Mac)
☐	**Format requirements:** Ability to handle raster (pixel data), vector (point, line, polygon data) or both formats
☐	**Local support:** Are you going to be able to get immediate help if you have problems?
☐	**Complexity/personnel resources (including staff and training):** For a beginner, it will be important to have a user friendly SIS, i.e. one with an easy to understand graphic user interface (GUI). Ensure that budget funds are available for initial training and continued capacity building activities for both SIS technical and casual user groups.
☐	**Company, agency or organisation requirements (general and specific):** Develop a needs assessment. Can specific benchmark requirements be met? Does the software fulfil a variety of needs? Does the system have the functions needed?
☐	**Reliability of system and vendor:** Will they be around for the next ten years to service equipment and provide technical support?
☐	**Scalability, maintenance and upgrading:** Does the technology have an update or production development program? Does it offer a migration path or suite of options? Will you need to buy add-ons and are they available?
☐	**Support material:** Is there a pool of people, locally or within your organisation, which uses your preferred SIS? If so, will it be possible to get help from more experienced users? Capacity building is one of the most important aspects in the successful implementation of an SIS.
☐	**Maintenance and licensing:** What maintenance and licensing options are available?
☐	**Interface with other software used and interoperability:** For example, between computer aided drafting (CAD), mapping, image processing, database and web systems.
☐	**Open system support:** Does the software support OpenGIS® specifications, World Wide Web Consortium standards and the Australian Spatial Data Infrastructure?

Additional information

For more detailed information refer to *Module 7: Guidelines for selecting spatial information system software and hardware*

8 Enhancing capability for using spatial information

Decisions to train staff in SIS, hire new staff with existing SIS skills, or hire consultants, are no different from any other technical issue faced by NRM regional groups.

In many cases these groups may need access to activities related to increasing GIS capacity including training, recruitment of new staff or hiring specialist firms or consultants to provide guidance and recommendations, or to undertake specific software development or data analysis tasks.

A wide range of SIS staff training options are now available in Australia. These range from full-time university courses to short courses, in-house training and mentoring through professional associations, cadetships and informal networks. There are also a number of tertiary training courses that provide specific SIS skills (which are credited within the tertiary education system).

Best practice guidelines are available to assist in determining when a consulting firm is required and what to look for when choosing one.

	Checklist for selecting a consulting firm
☐	Where possible, use stakeholders or partners to determine what is needed and then task a particular unit or resource information centre with the responsibility of sourcing a consultant.
☐	Similar to choosing software, decide what is required and not what potential clients may offer.
☐	Where possible, develop a matrix or scorecard on what the consultants offer and your requirements.
☐	Leave room for evaluating intangibles. For example, factors involved may include: ■ Potential for on-going relationship and support ■ Skills—do the consultants have the breadth and depth to meet your needs? ■ Distance—are the consultants available at close call?

Additional information

For more detailed information refer to *Module 8: Enhancing capability for using spatial information*

9 Map production guidelines

To be effective, maps need to convey relevant information to the expected audience.

Managers need to make sure that mechanisms are in place, as part of quality assurance procedures, to ensure that map production fulfils relevant compliance criteria. In this respect, checklists identifying minimum requirements for internal and external map production are a useful method of facilitating quality control.

The following list, based on material from the operations manual prepared for the Audit, provides an example of a checklist identifying mandatory and optional elements for the production of Audit maps. It serves as a useful template for the production of maps in most project type activities.

	Checklist for map production
Mandatory elements	
☐	**Title:** A descriptive name of the map
☐	**Publisher:** The name of the publisher (e.g. NLWRA), place of publication and date of publication
☐	**Copyright:** A statement indicating who holds copyright for the map and the year of publication
☐	**Acknowledgments and source:** The origin and nature of the information shown on the map, including derived or interpreted data—the statement should also indicate the currency of the data
☐	**Scale:** A scale bar with optional representative fraction in the form of 'Scale 1: xxx xxx'
☐	**Legend:** Clearly depicted colouring and display characteristics for the information shown on the map—the legend should display symbols or coloured boxes with a brief description of each
☐	**Colours and shading:** In general for large areas on the map use light colours. For small areas use dark colours. Ensure that readers of the map are able to easily distinguish between the colours. For maps to be viewed on a screen do not use colour spectrums (e.g. blue-green-yellow-red) as they do not print out well in black and white and some colour-blind people have difficulty reading them on the web (particularly red-green combinations). The main principle to follow when choosing colour ramps to represent increasing or decreasing values is to use colours of increasing intensity or darkness. This allows the maps to be printed out in black and white and still accurately convey the information. Do not use a red colour ramp. While this is a little constraining, it ensures that our information products will cater for as broad an audience as possible.
☐	**Symbols:** Use established simple and clear symbols wherever possible. Symbols portraying related objects or concepts should have common characteristics.
☐	**Font:** The number of different fonts and font sizes used should be kept to a minimum. Fonts that are sans (without) serifs, such as Verdana, Univers, Triumvirate or Helvetica are recommended, particularly for web products.

	Checklist for map production
☐	**Projection and datum** Australian continent: ■ Users need to compare areas >> Albers Equal-Area Projection. ■ Users need to compare distances/angular relationships >> Lambert Conformal Conic Projection. Small local areas of the Australian continent use the Map Grid of Australia (MGA94). Data are mapped using the Geocentric Datum of Australia (GDA94). For Albers Equal-Area, the parameters used when creating a map of Australia should be set to: ■ Map units: metres ■ Projection: Albers Equal-Area Conic ■ Spheroid: GRS80 or WGS84 ■ Central Meridian of 132 degrees East (132°E) ■ 1st standard parallel 18 degrees South (18°S) ■ 2nd standard parallel 36 degrees South (36°S).
☐	**North arrow:** Only show if the clear delineation of north will be advantageous. If a graticule is used then a north arrow is redundant. Do not use a north arrow for small-scale maps with projections in Albers Equal-Area Conic or Lambert Conformal Conic as north varies across the map.
Optional elements	
☐	**Map number:** This should be included if the map is part of a numbered series. It is normally grouped with the title.
☐	**Contact:** Use the format 'For further information contact [name and/or position], [phone], [email].'
☐	**Status and constraints:** The status of the map may be draft, working map, version number, etc. Access constraints may include confidential, internal use only.
☐	**Caveats:** A statement of the reliability and restrictions on use
☐	**Graticule:** At scales larger than 1:5 million the minimum requirement to delineate geographic coordinates (e.g. latitude and longitude) is to display labelled graticule 'tics' (short lines) around the borderline of the map sheet.
☐	**Additional text:** Additional text should generally be the same font, size and colour as text for the publication block.
☐	**Logos:** Where a number of organisations are responsible for the content and publication of a map, each organisation's logo should receive equal prominence, however, logos should not be overly prominent on the map. Where more than one logo is included, they should be of the same size and prominence and generally grouped together.

Additional information

For more detailed information refer to *Module 9: Map production guidelines*

10 Introduction to GPS and best practice guidelines

Recent progresses in technology, and reductions in the cost of many products, have made it possible for general practitioners to have access to equipment previously considered the domain of specialists. The global positioning system (GPS) is one such piece of equipment becoming increasingly used by the general community. GPS receivers are widely used in NRM projects, e.g. determining the location of a stream recoding station, through to precision agricultural tasks relating yield to paddock locations, and sophisticated geodetic control surveys.

As with any data collection exercise, GPS surveys can be time consuming and expensive. As such, they should be treated like any other data collection and processing activity, and be carefully designed and planned to return maximum benefit.

Additional information

For more detailed information refer to *Module 10: Introduction to GPS and best practice guidelines*

11 Partnerships and working together – the potential for collaboration

One of the additional benefits of introducing spatial information systems (SIS) into organisations and NRM regional bodies is that it can encourage cooperation and communication across the multiple sectors that require and use spatial information in their everyday work. It can also encourage organisations and NRM regional bodies to work together with neighbouring groups, plus local, state/territory and Australian governments.

The collection of data for an SIS can be costly and may require the purchase of specialised equipment and technical expertise. Careful planning is required to ensure that collection activities are well coordinated and that, where possible, data can be collected once and used many times by different business units within a single organisation. There are also potential cost savings in working together with other groups.

Based on lessons from practice, NRM regional bodies that work together on spatial information initiatives will experience some or all of the following advantages:

- broad support for vision and expectations
- champion individuals/community support
- knowledgeable, respected participants
- frequent contact with national (higher order) organisations
- proactive, open, and inclusive processes/procedures to enable maximum participation/diverse perspectives
- improved understanding/outreach.

Experiences from groups working together through regional networks in Australia underline the benefits that can be achieved. These benefits are also highlighted in Queensland with an initiative by the state government to collaborate with local governments in the development of spatial information systems.

Additional information

For more detailed information refer to *Module 11: Partnerships and working together – the potential for collaboration*