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Report on the development and use of GIS for iwi and hapū: Motueka case study, Aotearoa-New Zealand

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Introduction

Having access to high quality information is a fundamental pre-requisite for making good decisions on resource use, sustainable resource management, and managing special places and sites (e.g., significant cultural and natural areas) based on values. As decision-making becomes increasingly complex, the development and use of efficient information systems for different groups (e.g., community, indigenous, project, issue, agency) becomes essential. These information systems underpin good decision-making processes by: storing and organising vast quantities of information; improving access to that information; promoting and facilitating collaboration with other groups; improving systems and processes for organising information and information retrieval; providing a comprehensive basis for quality plans and policy; and helping to support, plan for, and implement projects and actions. It is necessary for groups to have access to quality information from many sources, to have the ability to generate their own information and record and store their own knowledge, to share that information, and to have appropriate systems and processes in place. These are modern requirements to cope with increasing workloads in response to responsibilities, national legislation, governance, activities and projects, and relationships with other groups. Indigenous Māori in New Zealand are interested in developing their own information systems, including GIS, based on their own cultural identity and issues, thereby blending cultural tikanga-based approaches with western approaches and technology. This paper reports on progress of an iwi-led project to develop their own information system and describes some of the issues they have faced in the design and implementation of such a system.

Indigenous information systems

Up-skilling in new technology is a major focus for many Māori organisations, and a number of Māori groups are either presently engaged in or planning to develop their own systems and expertise in information technology. Information systems are becoming increasingly important in helping iwi and hapū build capacity through skills, training, employment and educational opportunities. Many of these systems are being developed to

help in areas such as environment, research, cultural heritage, resource management, social policy, health, education, training, social services, business planning, legislative compliance, economic development, and property management. Those iwi and hapū Māori groups working in the environment/resource management area have shown great interest in developing spatial geographic databases using Geographic Information Systems (GIS) to record, analyse, and present information electronically, online, and in map form, Fig.1 (Harmsworth 1997a,b, 1998). Many have already used spatial information, such as maps and tables, for: Treaty claims; planning development of Māori land; iwi and hapū management plans; developing cultural heritage databases; environmental planning and projects. GIS are regarded as being very helpful in the visualisation and presentation of information to accompany discussion, and in the recording, managing, and analysis of resource and cultural information.

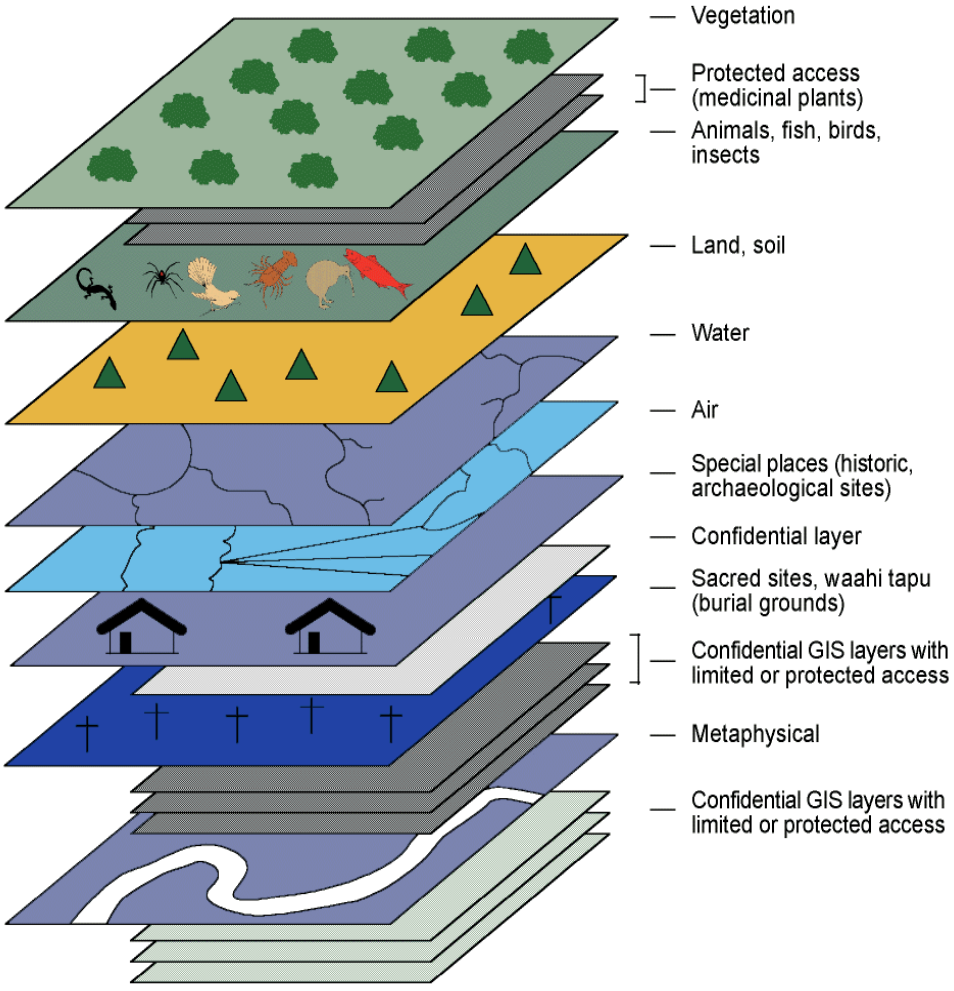

Figure 1: GIS layers and confidential sub-layers

There are a number of examples of iwi and hapū developing iwi information systems in Aotearoa-New Zealand, often exploring, developing, and using GIS for many applications. In the resource management and cultural planning area, such examples included the development of:

- concepts, methods, and frameworks for collecting, storing, recording, and presenting Māori knowledge (mātauranga Māori), cultural heritage, cultural values, taonga classifications, and inventories
- concepts, methods, and frameworks for collecting, storing, recording and presenting natural resource information

A number of conceptual design models and frameworks have been produced (Fig. 1; Harmsworth 1997a, b, 1998). A large amount of international literature is available on indigenous knowledge and GIS (Harmsworth 1998; Bibliography).

Goals and needs

Iwi and hapū groups have very detailed needs, and developing an information system is a complicated task. Most groups start with a planning and scoping exercise (Walker 2004a, b) to identify what their needs are, what the system might look like, who the end-users will be, and what the issues are. Many issues are addressed at this early stage and are ongoing:

- what is the goal, the vision
- what are the requirements
- who are the potential users and what are their needs
- what type of information or knowledge will be recorded, stored and accessed
- hardware and software
- potential products
- types of analyses and data produced
- intellectual property rights
- confidentiality and sensitivity of some types of information/knowledge
- networking and access
- sharing information between individuals, groups and agencies
- development and long-term maintenance of the information system
- system updates and upgrades
- resources for technology and staff
- capacity needs, training, to maintain such a system

Motueka case study

In November 2003 work began on the development of a plan to design an iwi information system for Te Tau Ihu, a pan-iwi group in the northern South Island of New Zealand. The project is led and managed by the Motueka Iwi Resource Management Advisory Komiti (MIRMAK). The Komiti is made up of representatives from three main iwi – Ngāti Rarua, Te Atiawa, and Ngāti Tama and the Māori organisations, Ngāti Rarua Atiawa Iwi Trust (NRAIT) and Wakatu Inc.

The work is part of the larger FRST funded programme "Integrated Catchment Management (ICM): From ridge tops to the sea" centred on the Motueka catchment, New Zealand (Figure 2), and also continues from a number of previous small, collaborative projects with Te Tau Ihu iwi groups associated with the ICM programme in the Motueka

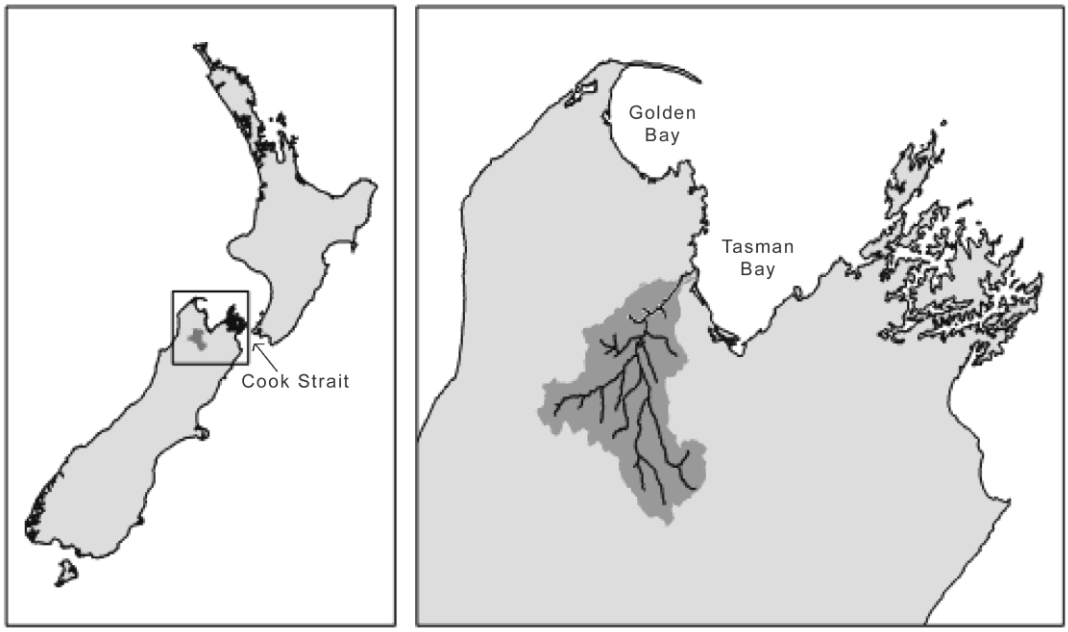

Figure 2: Motueka River catchment, New Zealand. Local iwi (tribal) groups refer to the top of the South Island as Te Tauihu o te Waka a Maui or Te Tau Ihu for short.

catchment. The projects are being used to increase participatory research with iwi, improve the relevance of research to iwi, stimulate iwi members to drive research areas beneficial to themselves and the community, and develop other iwi-ICM, local government, and community collaborative projects in the Nelson-Motueka region. Projects are also being used to build capacity (both human and social) for iwi and for the ICM research personnel by improving the way we work and learn together and by increasing the level of mutual understanding.

In 2003, using an issues analysis approach, along with documentation of present iwi activities and aspirations, a number of potential research areas were identified (Harmsworth 2003b). Iwi information systems were identified as a key area of research in which iwi wished to become engaged, as such systems were seen as central to many of the activities iwi were carrying out in the region. They were also seen as central to iwi and hapū Māori, to kaitiaki, to organisational aspirations, and to the improvement of processes for dealing with increasing resource management workloads. Iwi also felt a well-developed information system would help support planning for several potential and current projects being developed in the region, be a repository for cultural (e.g., traditional) and environmental knowledge, and help manage and protect culturally significant sites and places.

Projects in which GIS had been used by MIRMAK and the Nelson based Nelson Iwi Resource Management Advisory Komiti (NIRMAK – made up of six main iwi), included the:

- Te Atiawa Treaty of Waitangi hearings
- Waimea Estuary Cultural Impact Assesment

- Maitai River Iwi Indicators project (NIRMAK)
- Puketawai cultural and ecological restoration project

Iwi groups were therefore aware of the benefits of using GIS and some members had experience in using GIS and presenting GIS data in the form of maps and accompanying data. For MIRMAK, the development of spatial databases was seen as a tool that could greatly improve the way the group could carry out operations efficiently, and could collectively address resource management and cultural issues:

> This would greatly improve our capabilities to make decisions on resource management issues, such as the resource consent process, and we would be able to provide better information to clients and council (MIRMAK 2003).

The initial information system proposal

MIRMAK identified a computer-based information management system, such as a Geographic Information System (GIS), as the appropriate tool to increase their resource management decision-making capacity. The system would be for wider use by iwi/hapū/whānau. Such a tool would also improve MIRMAK's ability to carry out resource management projects, record and retain cultural knowledge, and enhance their kaitiaki role. Landcare Research (Manaaki Whenua) in collaboration with MIRMAK, identified this need, and funding was applied for.

The original funding proposal in 2003 outlined several areas that would benefit iwi, hapū, and stakeholders. At the ICM annual general meeting for stakeholders in Nelson and Motueka in October 2003 some of the reasons for developing an iwi information system were summarised (Harmsworth 2003a):

- improve decision-making for the sustainable management of natural and cultural resources (e.g., resource consent process, cultural impact assessment)
- record and store cultural information, iwi and hapū knowledge (mātauranga)
- record and store historic information
- increase access to technical and scientific information held by other agencies (e.g., Government, local government, CRIs, private)
- promote and increase the sharing of information
- promote and facilitate collaboration and interaction with key stakeholders
- promote learning and understanding, and establish new research projects
- help support the planning and implementation of collaborative projects and activities

- help build iwi and hapū capacity, such as training and up skilling in technology and resource management

The key components of an information system include:

- A set of goals or reasons for its development or establishment
- Resources
- Software
- Hardware
- Data and information
- Trained personnel

A spatial information system would create a central information site or repository to store, organise and provide access to many information types, such as: aerial colour photographs; topographic maps; resource maps; property boundaries; historic information; archaeological sites; resource consent applications and processed consents; cultural knowledge; and scientific resource and technical information (e.g., land-use, soils, riparian zones, sediment, water chemistry, sampling sites, coastal surveys, monitoring sites). Such a system would be a central repository for iwi and hapū knowledge (public domain and confidential) relevant to planning, such as cultural heritage sites, archaeological sites, and cultural layers and datasets based on values that could be used to intersect and overlay with natural resource information and other community values. It could also house iwi-specific information on project sites, community and regional projects, site monitoring, cultural impact asessments, resource management activities, etc. This information would be used in conjunction with iwi management plans, environmental and cultural monitoring, environmental projects, and the processing of resource consents. It would therefore organise and share existing knowledge, provide a basis for collaborative learning, and create new knowledge. The development of such a system could include the following steps:

- collate and document iwi knowledge for the Motueka catchment to provide descriptive spatial and temporal information on culturally significant sites, traditional placenames, cultural landscapes, iwi values, historic and present records of land tenure, natural resources, and cultural frameworks for integrated catchment management

- develop iwi information systems that could store both culturally sensitive information (e.g., silent files, restricted GIS layers, sacred sites) and public-domain information, and promote information sharing for non-sensitive data

- develop tools such as GIS to record, store and analyse cultural and environmental information, and house data from the ICM programme to enhance iwi decision-making and build iwi capacity

- work with stakeholder groups and ICM researchers to improve systems, processes and models for effective decision-making on sustainable management of cultural and natural resources

- produce GIS maps showing cultural values and cultural sites both for the Motueka and for other significant areas for environmental and cultural management planning and policy

- identify and map environmental areas (e.g., natural areas, indigenous plants, biodiversity, riparian zones, native vegetation corridors) and culturally significant areas (protection and management of cultural sites and areas, and enhancement and restoration of cultural resources) to increase links and collaboration with stakeholder groups and ICM researchers, and make positive contributions to biodiversity, sustainable land management, and cultural enrichment strategies.

A specific proposal to the Foundation of Science Research and Technology (FRST) was written and submitted in mid-2003, and a small amount of funding was received as an ICM programme iwi subcontract in October 2003. Contracts and identification of key personnel were subsequently arranged.

Scoping and design exercise

In 2004, MIRMAK (Walker 2004 a,b) identified a number of key areas for which information systems could assist them achieve more efficient operations, and learn, and function collectively:

- management and protection of cultural sites and resources
- sustainable management of natural resources in the rohe
- cultural impact assessment (CIA) approaches/methods
- monitoring, reporting, and evaluation
- standard forms and letters for all RM work
- standardised iwi reporting
- consistent environmental and cultural monitoring frameworks and approaches
- planning and implementation of cultural and biodiversity projects

Early design of an iwi information system had to consider a regional IT framework for Te Tau Ihu (northern South Island) iwi groups providing the context for any information system developed in the Motueka. As a pilot project this would benefit the manawhenua iwi of Motueka but also provide a model for other areas. If the project was successful, it could well expand into other Te Tau Ihu areas and should be planned accordingly with this in mind. Politically the information and system would be easy to transfer to the Mohua, Wakatu and Waikawa, "cousins" of the Motueka iwi; however, equity issues in relation to the other iwi across the Te Tau Ihu and their access will have to be discussed. It may be prudent to develop a memorandum of understanding (MOU) among MIRMAK komiti members on the future access of data and for any system developed.

Iwi researchers produced two documents in February 2004 for internal and confidential discussion (Walker 2004 a, b). The first was entitled "Improving Motueka Iwi Information Systems: Project design phase", the second "GIS project update: Memo to the Motueka Iwi Resource Management Advisory Komiti". After much discussion these

documents formed the basis of the ideas and issues being considered as part of a scoping and design phase for an iwi information systems (including GIS) project.

In terms of resource management, the decision-making ability of MIRMAK members is currently constrained. The Tasman District Council sends a weekly list of resource consent applications to the relevant resource management officers (or equivalent); typically, about 25–30 consent applications per week. The resource management officers are then expected to make decisions on these applications in a short time frame, which is difficult without an appropriate information system from which to work.

> To date most iwi information is either held in people's heads, is in hard copy files or maps, or the information has been lost or unavailable to MIRMAK for a variety of reasons (MIRMAK 2003).

Building a spatial information system

In the early scoping and design phase, the main types of uses were recognised as (Walker 2004 a, b):

- *Building our own databases:* For example developing cultural layers, native vegetation resource layers, etc. A cultural heritage mapping product can provide a practical example of GIS at an early stage
- *Resource consent applications:* Processing and administering the weekly list of consent applications provided by local government.
- *Cultural Impact Assessments:* Carrying out these projects, provided iwi have the ability to develop their own information/knowledge layers and can use them in conjunction with those from other agencies.
- *Environmental-Cultural Projects, e.g., Puketawai*: Supporting iwi, community and local government projects that benefit national strategies, outcomes and the wider community, provided iwi have the ability to develop their own layers and can use these layers in conjunction with those from other agencies.

Developing a spatial information system requires consideration of a large number of factors and requirements:

- recognising existing iwi/hapū knowledge systems
- recognising existing and historic technical and scientific knowledge systems
- must be networked amongst iwi/hapū members and stakeholders
- training of key individuals and groups in the use and maintenance of such a system
- the system must be sustainable in the long term and have adequate resourcing (must have ownership by the group)

- acknowledgement that learning and understanding go hand-in-hand with the development of information systems

- must take into account confidentiality, intellectual property rights, and sensitivity of information

- must acknowledge the limitations of GIS, including the fact that GIS is just a tool and does not, for example, make decisions; can never store all types of cultural information e.g., spiritual and forms of Maori knowledge i.e. mātauranga; only stores a fraction of the integrated knowledge available; does not deal with politics.

Issues

Many issues need to be considered as part of the project design phase. These include:

- ***Determining data requirements***: Identifying what data are required, what will be "housed" in the iwi information system, and some of the potential sources of such information/data

- ***Data costs*****:** Once data requirements and sources are identified, the costs of obtaining these data require careful consideration

- ***Access:*** Access could pose a number of potential difficulties for acquiring and using data and information. Access problems that need to be planned for and resolved in time include: licensing requirements, and present and future access

- ***Use of data:*** Most data carry certain copyright and licensing conditions. Some data can be acquired without restrictions, while others will require conditions to be set in place that may restrict the way such data are used. As a group, iwi and hapū do not always have legal status to purchase and manage data. Data and information layers often have to be assessed separately for conditions/restrictions on use.

- ***Location of main information system/GIS:*** A central location is recommended for maintaining and upgrading data. While satellite locations may access information, issues are often associated with: who is responsible for and allowed to enter new information and data (e.g., data entry), what checks are made on the data, editing and changing data/information, upgrading information, quality assurance, and whether the maintenance and upgrading of data can be carried out from a number of locations or from one central location. Individuals will need to be identified for certain levels of responsibility.

- ***Types of information stored on the GIS:*** Public domain and confidential information must be separated and treated differently. This will affect access and sharing. Only certain individuals will be permitted to access confidential information and records.

- ***Networking:*** Individuals, groups, and agencies will need to establish protocols for networking and who should be linked to the system. This may also involve internet access and lines of responsibility for maintaining, upgrading, and editing information and data from a central repository or archive.

- ***Sharing data and information:*** This requires a thorough investigation into who holds what information, the form of the information/data, and the ownership conditions of the data, and the willingness to share or provide. It needs to be established what agencies are prepared to share data and information, what type of information it is, and whether this information can be changed from its original form or only allowed as 'read only' information.

- ***Security:*** Cultural, sensitive and confidential information must be well maintained, linked to reliable cultural knowledge sources following strict tikanga protocols, and made secure.

Specifications
The key components of the information system were recognised as hardware, software, and data:

Hardware
Modern computers increasingly have the capacity to run software such as ArcView GIS. Information systems generally include large amounts of data in different forms, and include data files, graphics, aerial photographs, base digital maps, satellite imagery and mosaics, point data linked to spread sheets and GIS, databases, internet connections and access, digital elevation models (DEMs), and text. Recommendations are that personal and office computers have at least 512 Megabytes of RAM, a central processing unit (CPU) of at least 1.6 Gigahertz (Ghertz), and a hard drive of at least 20 Gigabytes (Gbytes). A CD or DVD writer to back up all files and a colour printer/plotter to produce at both A3 and A4 size maps are recommended. Most modern computers now have these specifications. Monitors with screens larger than 19" are preferred. Office PCs can be linked with laptops that can be in the field. Other hardware might include a GPS or pocket GIS for fieldwork and data capture, and a digital or video digital camera.

Software
As large a selection of software and modules is available, an initial evaluation of GIS software is essential. In New Zealand a large number of organisations, including central and local government, CRIs, and private entities, commonly use ArcView. Selecting software compatible with that used by other organisations is an important criterion. ArcView can also be used in conjunction with ArcExplorer. Key issues are resourcing, (e.g., costs), licensing requirements, and training.

Data
Data are held by many different organisations. Acquiring information requires careful examination of what it is, where it is, how to acquire it, and in what form, associated costs of acquiring data, and conditions and agreements for using data/information.

Identifying what data exist also avoids duplication of datasets from various organisations. This is one of the most important steps in the early design stage before decisions are made on what software and hardware to purchase.

Existing information and coverages
Many information data sets and coverages presently exist, including: aerial photographs; topographic data; property data; digital elevation models; natural features, i.e. rivers; infrastructural features, i.e. roads; etc. Such data are held by organisations in various locations and usually require purchase, licensing or agreements before they can be used. However, several organisations have data sets they can share or provide under special conditions and arrangements on terms of use. A usual stipulation is that data should not be onsold to any third party. Confidentiality issues surround many types of data/information. In the Motueka, organisations that hold data/information include:

- Crown Research Institutes (CRIs), such as Landcare Research (environmental and Motueka catchment data, scientific and technical information)
- Other iwi/hapū organisations, groups, and individuals holding cultural and base data
- Māori organisations and businesses
- Māori Trust Boards, local iwi authorities that may already have GIS
- Local councils, local government, such as Tasman District Council
- Private research institutes (e.g., Cawthron Institute, Nelson)
- Government departments, such as Department of Conservation (DOC), land Information New Zealand (LINZ)
- Private industry, sector groups
- Community groups
- Non Government organisations (NGOs)

Access to other information systems
As a critical step in the design phase for the development of an iwi information system, data and information held by other agencies are identified and evaluated. In 2004 MIRMAK researchers (Walker 2004 a, b) identified and assessed data/information sources of interest, including the agency, the type of data/information, and the form of the data, and assessed regional availability, access issues, and other requirements. The evaluation that began in 2004 also considered the wider use of information by iwi/hapū/whānau groups. Intellectual property issues are ongoing and should be addressed early in the planning. Key agencies holding important data/information included:

Local Government – Tasman District Council (TDC):

- A comprehensive GIS on an internal Intranet system called *Explore Tasman* (essentially a "read-only" system).
- Provides access to a local government mainframe GIS
- Quality data that are well maintained and regularly updated
- Contains comprehensive resource, administrative, and base information
- Access only to some layers (up-to-date colour aerial photographs, property boundaries, owner titles)

- Layers absent include the archaeological layer (recently updated by the NZAA) and a planning maps layer(s) including zones and areas (i.e. the information contained in the TRMP)
- Read only greatly limits queries, interrogation-analysis of data, or derivation of new layers from existing layers and may limit the capacity of an iwi group to manipulate and analyse data
- Security and confidentiality conflict with local government issues where iwi and hapū groups are working on conflicting environmental and cultural issues
- Can be accessed, sometimes slow, but a broadband connection is recommended
- Could represent a major cost saving in terms of data purchase
- Can be connected from outside via the internet using a static IP address
- Access and use can incur additional internet charges
- Printing data, such as maps, is limited
- Could potentially reduce duplication of effort for iwi/hapū developing their own datasets and databases

MIRMAK researchers (Walker 2004 a, b) evaluated *Explore Tasman* against the four main information system uses documented previously. The evaluation is summarised next to each of these design uses below:

- *Iwi databases*: For the development of layers on cultural values, cultural sites and places, confidential iwi knowledge, native vegetation, taonga, the *Explore Tasman* has limited application. In development of iwi/hapū/whānau information layers *Explore Tasman* will have most use as background layers, allowing iwi to intersect its own GIS layers with the TDC base information.
- *Resource consent applications. Explore Tasman* will greatly help with the weekly list of resource consent applications provided (a) MIRMAK are able to overlay its own layers, and (b) MIRMAK is supplied with legal descriptions or valuation numbers with resource consent lists. These issues will be addressed in time.
- *Cultural impact assessments. Explore Tasman* will help these projects provided iwi have the ability to develop their own information layers, such as cultural values, and can use these 'cultural' layers in conjunction with other applications.
- *Cultural, environmental, and community projects, e.g., Puketawai: Explore Tasman* will be useful in carrying out these projects provided iwi have the ability to develop their own layers and can use these in conjunction with other applications.

Government – Department of Conservation (DOC):

- DOC has a comprehensive information system based on GIS, accessed through DOCs extranet at http://extranet.doc.govt.nz
- It does not require a static IP address
- It has some inherent problems and is quite a bit slower than *Explore Tasman*
- Data/information held in the Wellington head office, and the Nelson regional office
- Environmental and cultural heritage information

- Includes the New Zealand Archaeological Association File (NZAAF) of site records and archive that is maintained by the New Zealand Archaeological Association (NZAA). DOC heritage staff (e.g., Nelson, Wellington) often have a dual role as NZAA file keepers. The NZAAF is not a GIS database and archaeological point data need to be converted into shape files before being used in a GIS.
- DOC also maintains a large amount of environmental, property, research, and historical data including: old aerial photographs, research results, vegetation and ecological information, property boundaries of DOC estate, and other types of historical and physical resource information.

Issues for iwi in using this information included:

- Access and use agreements to DOC information
- Costs
- Security of confidential records
- Using data in suitable formats compatible with GIS

New information, knowledge and coverages

New information often needs to be recorded and considered during the development of information systems. This project includes large amounts of cultural information from a number of sources never systematically recorded or organised before, including mātauranga Māori. Acquiring these types of information largely depends on the number of people willing to share knowledge, and requires contacting and working with people or groups that have stored knowledge in some form, for example: oral histories and knowledge, mātauranga Māori (traditional iwi/hapū/whānau Māori knowledge), local knowledge, narratives, historical documents and manuscripts, photographs, paintings, artworks and carvings, waiata (songs), old maps, and Treaty claim documents. Some of this information will be in the form of narratives and stories accessible only through interaction with and by gaining the trust of selected individuals. Information may have to be recorded in various forms to be useful for decision-making and planning, such as spatially represented using geo-referencing onto maps. Much of it will require organisation and input into an appropriate system. Confidential information will require protection and ownership where acknowledging the original or derived source is a key requirement.

It is always necessary at the start of a project to provide some clear explanations and guidelines to cover the use of Māori knowledge (mātauranga Māori) and other types of cultural, historic or resource information. Information acquired during research should only be used in accordance with the wishes of those participating groups, such as iwi and hapū members and research agencies.

Protocols, intellectual property

An important component of an iwi or hapū information system is to develop the appropriate intellectual property (IP) frameworks and protocols regarding collection, recording, storage, organisation, use, access, sharing, protection, and interpretation of information/data. It entails identifying all those individuals, groups and agencies that will

have control and oversee the recording, maintenance, and access to information, on an on-going basis.

Confidentiality, ownership, and use of intellectual property
The confidential and sensitive nature of cultural information, such as Māori knowledge (mātauranga Māori), requires recognition of intellectual property rights and will affect the way the information is recorded, stored, accessed and presented (Harmsworth 1998). This needs to be incorporated into the design of the GIS from the start and also into all information use and sharing agreements.

Systems should be developed to protect, limit, or exclude "confidential or sensitive" information from the public domain or general readership (e.g., silent files). An iwi information system can be designed to protect sensitive, restricted, or confidential information as determined by those groups from whom information/data originates, such as tangata whenua. A GIS under the control of iwi or hapū can be linked to national, regional, district and research databases that have the right safeguards in place. The appropriate protocols and GIS architecture can help facilitate the sharing of information across networks such as the intranet and internet.

Progress to date
A number of significant issues have been raised during the design and implementation phase of this project to date. The assessment and evaluation of organisational datasets and information services in 2004 provided a large amount of information. Access to information held by other organisations will provide valuable base data, and although a number of specific issues and problems have been identified, it is believed most of these can be resolved. Meetings with a range organisations (e.g., Wakatu Inc., Te Atiawa Mana Whenua Ki Te Tau Ihu Trust, Ngāti Rarua Atiawa Iwi Trust Board – NRAIT, Tasman District Council – TDC, Department of Conservation (DOC), Landcare Research, and Cawthron Institute are proceeding. For each organisation, this early scoping exercise lists: what data sets/ information are available; whether they are prepared to provide the information in a suitable form; the conditions for using such information; and what types of use or sharing agreements (e.g., MOU, licensing) might be required. This will help limit any duplication of effort in developing datasets and information layers that already exist. Scoping also identifies information gaps, where iwi might have to develop its own information layers, where additional data might be obtained from, and the associated cost.

Funding was sufficient to purchase a limited amount of hardware, software and data, and commence training in early 2005. Through detailed assessment and discussion, MIRMAK has proceeded with the development of a spatial information system based on a central GIS and purchased ArcView version 9 software. This was identified as the most suitable GIS software to meet iwi and hapū needs, taking into account compatibility with other types of software, and GIS in other locations, particularly that with local government and research agencies. ArcView also provides extensive data storage, retrieval, sharing, analysis, and modelling capabilities and opportunities. A number of specific training courses were identified by iwi members to help increase skills and in

future experienced operators will ensure ongoing development and maintenance of the information system.

A successful participatory GIS workshop was held 12-13 April 2005 (Walker & Park 2005; Walker 2005) at Te Awhina Marae, Motueka, where a power point and GIS presentation by the GIS working group of MIRMAK was given. The workshop involved a number of organisations including: MIRMAK members, staff from Landcare Research, Cawthron Institute and Tasman District Council. The workshop participants presented data from several sources and discussed future access to data and sharing agreements. MIRMAK presently holds limited GIS data including: a digital topographic base map, some rectified aerial photography covering the lower Motueka, Motueka catchment data from the ICM programme, limited files from two forestry companies, data from Treaty of Waitangi Tribunal hearings (e.g. maps, historic data, and mātauranga), data from previous environmental-cultural projects such as Puketawai, Waimea Estuary and the Maitai Rivers, and point data from the New Zealand Archaeological Association site records. Project GIS layers presently under development include:

- Vegetation – changes since 1840
- Rivers – changes in river and stream course since 1840
- Māori placenames
- Māori made soils (Māori plaggen soils)
- Archaeological sites and areas (cultural sites)
- Māori tracks and trails
- Coastline – changes since 1840

A number of GIS applications/uses were highlighted at the April workshop including:

- Identifying historic settlement sites and their associated human-cultural activities
- Giving the spatial distribution and extent of native vegetation at 1840 along with other historic dates
- Identifying areas and sites suitable for planting native plants (e.g., restoration, rehabilitation, riparian planting, re-establishment of habitat corridors)
- Determining impacts of resource consents on cultural iwi values

MIRMAK outlined a number of initiatives and steps for the future (Walker 2004 a, b) Walker & Park 2005):

- Continue to identify where information resides, summarise its description and potential use, and describe the form it is in
- Purchase additional software based on needs
- Continue to work with a number of key groups and organisations to develop protocols for information access, transfer, and sharing
- Identify appropriate training for iwi members
- Organise access to the local government intranet GIS *Explore Tasman* to avoid duplication of effort. The TDC is at presently updating *Explore Tasman* to a Version 2 that will also have local planning maps available in it. The new version will contain information on physical resources, property information, base maps, aerial photographs, and some upgraded archaeological site information within the

Tasman District Management Plan (archaeological data subsequently added to the plan).

- Connect to a broadband service, to access data in central and local government internet and extranet GIS information bases – this would speed up the service and will be necessary to access existing data and build new information layers
- Complete the building of the following databases: coastline pre-1842; rivers pre-1842; vegetation pre-1842; Māori made soils, Māori trails pre-1842; Māori traditional placenames; cultural sites, district maps showing cultural values; existing native vegetation.

Conclusions
Findings to date indicate that:

- Software and hardware requirements need careful investigation before any purchase

- A geographic information system (GIS) is regarded as a key component of an iwi information system

- Information needs of individuals working for iwi/hapū/whānau have to be determined in practice and in the context of a set of goals

- Information held by other agencies and by iwi/hapū/whānau is ongoing and requires in-depth evaluation/assessment in order to consider information access, use, and sharing strategies and arrangements

- Implementing training and up skilling in IT, GIS, and internet use are very important requirements from an early stage

- It is particularly important for those who work outside a main office to have access to the same data and information at anytime. Satellite sites should be networked from a central computer or server so that key iwi and hapū members have access to information. Information can also be downloaded onto laptops from main computers and databases.

The present model being considered
MIRMAK's present model is to have a central computer housed at Te Awhina marae on which a large amount of technical, environmental, and cultural information can be stored and used for their resource management activities. Local iwi/hapū/whānau groups will be encouraged and trained to record cultural values information and create new knowledge. Information will be managed and updated from the main site and networked to other sites, and to other data service providers. Other sites could have variations of information, where data relate more specifically to a specific geographic location where distinct iwi/hapū/whanau groups reside or with which they have a specific relationship. The iwi will continue to work with a number of external organisations such as Tasman District Council, Department of Conservation, Landcare Research, and Cawthron Institute, to

gain access to their datasets and develop protocols, agreements, and standards for sharing data and information.

Options to ensure access to iwi/hapū/whānau individuals include: individuals having GIS software on their own office/ home computers and receiving regular data updates on CD-ROM; or, having data accessible on a secure internet site. Both options have advantages and disadvantages.

An iwi vision

An ideal situation or vision for an iwi and hapū information system would be: where key operators, resource management officers, kaitiaki, or other appropriate or recognised people, have readily available organised knowledge and are able to make relevant resource management decisions. This would invariably mean a computer in an office or home that would contain all the GIS coverages (also called layers or data sets) necessary for decision-making, planning and policy. The information (e.g., data) would be regularly updated and those using it would be trained in the use of the software and be able to carry out queries and analysis to a reasonable level. The information system would not be confined to just helping to make decisions about consent applications but would also be used for the creation of new iwi and hapū knowledge alongside existing historical and cultural knowledge, technical and scientific information, as well as relevant information/data sets. Information can be used to help develop and manage a range of projects. Once a GIS is established, desirable products or outputs might include:

- Polygon information giving the location of cultural sites
- Point information giving exact locations of resource consents
- Geo-referencing of information such as maps and aerial photographs
- A map showing cultural values and sites for a given location
- Information on archaeological sites
- A narrative of the history/cultural heritage of a specific area
- Spatial representation of iwi values of areas at different scales.

Māori GIS in New Zealand

The progressive development of GIS for Māori groups in New Zealand, although demonstrating high levels of interest since 1990, as well as localised examples, has not exhibited the same momentum as that experienced in Canada with First Nations people or in the United States where many researchers and academics are dedicated to maintaining and growing this area of work (see Bibliography). At present there are few operational information systems or GIS being used or accessed by Māori groups, or by agencies working with Māori; and few Māori with experience in GIS and Information Technology exist to support resource management planning, policy, and projects. There are also few research projects that integrate indigenous knowledge with western science, or using GIS tools in indigenous research activity in New Zealand. The scarcity of examples reflects mainly a lack of funding, the low level of importance given to this area of activity, and a lack of capacity and capability in the area. Those indigenous Māori groups that have established and used GIS in the past have been very creative, innovative, and dedicated, but most systems have only been set up with a temporary time-frame in mind (i.e. in response to, or associated with specific projects such a Treaty claims, iwi management

plans), and planning for IT has lacked a wider purpose, links to other activities and services, support, or contextual and strategic planning. Most operational GIS examples involving Māori have been poorly resourced with no attention paid to maintaining or sustaining the system. The reasons for this are many, including: poor strategic planning; a lack of a clear vision or purpose; limited resources and funding; expense of the technology and data; a piecemeal approach to developing information systems; IT separation from the wider iwi or hapū organisational, political and social issues; a lack of exposure to overseas research and pragmatic examples; and a lack of skilled operators. Most Māori GIS work has been set up by committed individuals who are often not well supported and remain isolated from wider organisational structure of planning, policy and service groups. Many experienced GIS operators working for Māori groups in the past have therefore been transient because employment has been short-term, the systems maintenance and upgrading has relied on too few or just one individual, and the information system has been disconnected from other iwi and hapū activities. These factors have resulted in information systems that are not maintained and fall into disrepair.

As shown in this paper, the solution to developing robust sustainable Māori information systems will only be found through careful planning. It is important to gain buy-in from the wider iwi, hapū groups, and associated organisations, and also to develop strong strategic links with supportive organisations such as local government and research agencies. To sustain GIS in the future will not only require adequate funding streams and resourcing, but also cooperation, coordination and partnerships – such as those between various organisations, including iwi and hapū, and collaboration with research and funding agencies, wānanga and universities, Māori, Government, and non-Government organisations. Partnerships between iwi and hapū groups and selected private industry groups will also be important. Since the latter part of the 1990s there has been increasing commitment to developing collaborative projects between Government, local government, iwi, and other community groups. This has helped create the momentum to develop technological tools that can help resolve complex resource management issues, provide guidance on sustainable development, address cultural-social issues, and improve engagement in planning and policy. This cooperation creates a large number of opportunities for future research, particularly centred on collaborative learning and the development of integrated knowledge systems.

Directions for future research

For use as a spatial problem solving and planning tool in sustainable resource and cultural heritage management, GIS is still in its infancy in New Zealand. Most efforts to date have been to acquire and store vast quantities of data but few examples actually demonstrate the real strength and analytical and modelling capabilities of GIS.

Future research opportunities obviously need a GIS platform from which to work but should move beyond simply acquiring data and preparing data overlays. These types of discussions involving indigenous groups have also taken place in Canada, and provide the basis for new innovative research and planning approaches. As more and more organisations develop their GIS capability – including iwi and hapū in New Zealand – the

scope for collaborative projects increases immensely. A number of potential collaborative projects linked to the Integrated Catchment Management programme (ICM) are outlined here, and require further discussion and exploration. They are grouped below accordingly:

- *Motueka:* Those GIS projects linked to ICM for the Motueka catchment, ongoing as at 2005
- *National:* Those GIS – indigenous knowledge projects that have national research, planning, and policy application
- *International:* Those GIS – indigenous knowledge projects that have a international research, planning, and policy application

Motueka

A number of GIS projects linked to ICM for the Motueka catchment, ongoing as at 2005, have been discussed. They include:

- a cultural GIS coverage for parts of the Tasman District
- a coverage of flora/indigenous biodiversity/taonga in cultural sites for the Tasman District
- intersecting the ICM project GIS riparian zone classification with iwi cultural values in the Motueka catchment to prioritise areas for future collaborative projects on biodiversity-cultural restoration
- using the GIS to provide examples of cultural impact assessment and effects-based planning

National

Potential GIS research, planning and policy projects with a national application include:

- Prioritising areas/sites, and demonstrating cultural and environmental monitoring approaches for state of the environment reporting
- Producing cultural value maps in urban catchments, identifying culturally sensitive sites as overlays
- Integrating knowledge – Cultural value maps and potential/actual contaminated sites
- Integrating cultural values maps for planning biodiversity and restoration projects

Internationally linked research could include:

- Demonstrating the integration of traditional, historic and modern indigenous knowledge forms with western science for practical planning and policy outcomes. “Building a bridge between indigenous knowledge systems and GIS” (Johnson 1997), and using GIS as a spatial planning tool. Showing links between cultural landscape mapping, oral histories, and cognitive spatial landscapes

- Pragmatic and innovative approaches for presenting Māori and western science knowledge in new forms suitable for planning and policy using a range of media, techniques and methods: modelling, visualisation, multi-media, knowledge integration, problem-solving, internet, intranet

- Using GIS in education, collaborative learning, to improve awareness of issues, and promote engagement in planning and policy

- Collaborative research with international researchers using spatial information systems, cultural values, indigenous knowledge, and participatory action frameworks in a range of applications

- The role of participatory GIS in adaptive management

Hopefully many of the potential projects above will allow us to rectify the present paucity of "real-life" examples using GIS, indigenous knowledge, and western science to resolve complex resource management problems and achieve sustainable development using collaborative approaches.

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Book and Article Reviews

Aboriginal and local mapping, the power of maps in British Columbia, Canada:
Boundaries of home: Mapping for local empowerment

Participatory action research (PAR) and Geographic Information Systems (GIS) can be combined to form a powerful resource decision-making tool:
From elders' knowledge to co-management utilizing Participatory Action Research (PAR) and a Geographic Information System (GIS)