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Zia S. Maumenee

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The Moorea Community GIS: Internet-based GIS for public participation in resource management

By

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Abstract

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The Moorea Community GIS: Internet-based GIS for public participation in resource management

Chair: Eric Edlund

Internet-based Geographic Information Systems (GIS) can aid in greater community involvement in resource management decisions as well as provide information to the government, local residents and scientific communities to broaden perspectives on marine issues. The Service de la Mer et de l’Aquaculture, a government entity in French Polynesia initiated a plan for marine protection on Moorea, an island in the Society Island chain. Some citizens worked with the government to express their ideas for the best possible solution to marine protection, but others voiced frustration with the plan and the government’s methods of public involvement.

Public access GIS is one solution to increase involvement in resource management from the onset of the planning process. Several components such as cooperation from the government, engaged community members, and Internet access are necessary to implement an Internet-based GIS into the community of Moorea. I conducted preliminary interviews with citizens to determine their enthusiasm in GIS tools and contacted scientists regarding data contributions to the GIS. Then I developed several web interfaces and tested them in the field. Survey results provided respondents’ comments on the effectiveness of the Internet-based GIS for public participation in resource management. Limitations to Internet-based GIS include the labor intensity required to design, maintain, and update the website.
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Chapter I. Introduction

In 1997, the French Polynesian Government began developing the Plan de Gestion de l’Espace Maritime (PGEM), a natural resource management plan intended to protect the marine resources in the lagoon surrounding the island of Moorea. The objective of the PGEM is to ensure conservation of the maritime species while taking into account the uses of the lagoon for resource extraction and leisure activities (SNC PaeTai-Pae Uta 1997). This plan was developed in response to threats to the health of the ecosystem of the lagoon. The coral reef /lagoon environment surrounding Moorea is rich with diverse species. Overfishing, coral extraction, increased tourism, and development have been cited as contributing factors to the decline in the ecosystem (SNC PaeTai-Pae Uta 1997).

In the proposal *Proposition De Zones De Reserve De Peche Sur L’Ile De Moorea* the French Polynesian government’s Service de la Mer et de l’Aquaculture in Papeete 1997 described the development of a Geographic Information System (GIS) designed to review options for the protection of the marine ecosystem. GIS is a mapping technology that incorporates different spatial layers of data into a format in which a user can query for information. This GIS included digital base maps of major roads, primary and secondary streams, and administrative districts on Moorea (SNC PaeTai-Pae Uta 1997). Layered on top of this base information were data collected by researchers including physical parameters, the lagoon substrate, and the anthropogenic influences and activities in the lagoon. Upon completion of this GIS evaluation, the Service de la Mer et de l’Aquaculture planned to bring maps of the data analysis to the fishers on the island and show them how important it was to establish reserve zones.
The fishers did not respond as positively to this plan as was hoped by the government (Walker 2002). They voiced anger and frustration at not having access to, or knowledge of, the computer mapping technology used by the government. At the same time, citizens may have been reluctant to provide their own data to policy-makers because they did not trust the state to input or analyze their marine knowledge fairly in the GIS (Walker 2002). People in Moorea expressed concern about the alienation they experienced from participation in the resource management process due to language, cultural and technological barriers (Carlson 2002).

A government and community supported Internet-based GIS could eliminate citizens’ apprehension towards future conservation planning in Moorea and strengthen communication between the decision makers and concerned citizens. New online GIS tools provide an alternative to traditionally expensive and technically complex GIS software (Peng 2001), and Internet-based GIS is customizable for a specific community. It also has the capability for users to input data and extract maps based on personal needs (Kingston et al. 2000; Peng 2001).

Rural and indigenous communities around the world are beginning to use GIS to solve issues of public participation in resource management (Bocco 1999; Kingston 2002). GIS can assist with protecting ownership of territory and presenting local knowledge of natural resources. GIS has the potential to empower a community, but to achieve this potential it is important for the whole of a society including the marginal communities to be involved from the onset in the creation of the GIS data and its system in order to avoid the disenfranchising of a particular group (Craig, et al. 1999; Engle 2001; Harris and Weiner 1998; Laituri 2002).
Because of Moorea’s problems with unshared knowledge and lack of communication through the planning process, an online mapping system could greatly enhance communication between different community groups including scientists, government and local people. The purpose of this thesis is to identify online mapping methods that can best serve the community of Moorea’s needs for public participation in the resource management process, and to determine the extent to which the community would use these types of mapping tools. It is particularly important to understand and describe the framework for creating a GIS for community use, because of the rapid expansion of GIS into many sectors of government, non-government organizations, as well as grassroots organizations. As access to the Internet becomes more prevalent and GIS tools become more accessible, the gap between the technically elite and the non-technical public is diminishing. Understanding a community’s needs and interest level is essential to the progression of these tools and methods for future implementation into the broad range of socio-economic groups.

With a case study of Moorea, I address the question: What components are necessary to implement Internet-based GIS in this community, and which method of online mapping best serves the community for resource management and research purposes? The “community” that I chose to interview is composed of the local residents of Moorea, the government and research station directors, and the scientists who have conducted work on the island of Moorea. I chose these groups of people based on information reviewed in the literature. Historically in South Pacific cultures community participation was the source of marine protection (Lam 1998). Today, centralized administration governs planning and rule writing. Successful marine protection requires
government support, political support, community, and scientific support (Morin 2001). Thus, I decided to involve the local community, the scientific community, and the government in my research.

In the following chapters I outline the foundation for Internet-based public participation in resource management and discuss the enthusiasm that Moorea citizens and scientists have for GIS and its evolving online capabilities. The authorities working in the field of resource management are skeptical about the use of the GIS for public participation, but are willing to assist in the technological involvement of the community in some capacity. Limitations to this study and challenges involving sustainability create important methodological considerations for future research.
Chapter II. Background

The purpose of this chapter is to highlight key points to support the idea that Internet-based GIS can enhance public participation in resource management. I begin with a discussion of marine resource management including traditional as well as community-based approaches, then lead into participatory planning and Internet-based GIS, and end with a technical summary of Internet-based GIS.

A. Marine Resource Management

1. Traditional Marine Management

Traditional marine management measures sustained the biologically diverse ecosystems of South Pacific coastal zones’ until the colonial period introduced centralized systems of administration (Lam 1998). Customary marine tenure systems practiced in South Pacific societies promoted management at the community level. Clans or larger communal groups often owned near-shore areas, including reefs, and regulated access to fishing. Centralized administration imposed by European colonial or territorial governments eroded some of the traditional management measures. In developing countries fishers no longer played a role in the decision making process. Instead of the community deciding how to manage the resources, government administrations made management decisions. Further, marine resource development and management schemes in developing countries are often designed without consulting the resource users (Johannes 1998; Lam 1998).
A local woman from Moorea described the traditional marine management of the island as regulated by cultural and spiritual beliefs (Carlson, pers. comm., 2002). During specific times of the year, the chiefs of each village prohibited the harvest of certain marine species. The waxing and waning of the moon signified events where islands would come together and share in a feast of the particular harvest. Each family or clan who resided along the shores of the lagoon was responsible for the lagoon resources from shore to the edge of the barrier reef surrounding the island.

The creators of the PGEM on Moorea intended for it to include the opinions of the local community. In the feasibility study for the PGEM, Service de la Mer et de l’Aquaculture, 1997 explained how the government would consult with the fishers on the scientific maps developed to assess the environmental degradation of Moorea’s lagoon. They stated that in order for the PGEM to work they would need to have the agreement of all the parties. In order for the plan to serve the needs of the people of Moorea, planners stated their intention for the PGEM to be designed with the traditional Polynesian marine conservation methods in mind.1 (SNC PaeTai-Pae Uta 1997).

2. Marine Protected Areas

Some of the most biologically diverse ecosystems in the world are in the South Pacific coastal zones (Lam 1998). These coastal marine environments consist of estuaries, beaches, mangroves, coral reefs, sea grasses, algal beds, as well as other habitats. In-shore and near-shore fisheries harvest species of shallow water finfish, mollusks, crustaceans, and miscellaneous marine products such as marine turtles and sea cucumbers. These economic resources sustain the communities on many South Pacific

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1 “Bien sûr, ce project est une reprise de l’ancien système polynésien des rahui et correspond à reprendre de vieilles et efficaces règles de gestion de la ressource” (page 27).
Islands. Aesthetic qualities of the South Pacific islands bring tourism to the islands leading to more money in the local economy and increased interest in protection of the marine environment.

In recent decades researchers and governments have acknowledged the increasing severity of anthropogenic effects on coral reef ecosystems and the need for action (Hodgson 1999; Roberts et al. 2002; Wilkinson 1999). Concern that population growth could contribute to coral reef degradation was expressed at the Fifth International Coral Reef Congress in Tahiti (Guilcher 1985), and the role of management in halting reef decline was emphasized at the Seventh International Coral Reef Symposium in Guam (Wilkinson 1999). Governments around the world introduced the International Coral Reef Initiative in 1994 (Australian Institute of Marine Science 2003). The consensus over the last 20 years has grown from an initial focus on local effects to an emphasis on global factors responsible for the degradation of coral reefs (Wilkinson 1999). The local effects often pose an immediate threat; these include natural occurrences such as storms and anthropogenic issues such as increased sedimentation, pollution and exploitation. Global climate change, including shifts in the timing and severity of El Niño events, will pose a threat in the near future (Roberts et al. 2002; Wilkinson 1999).

Marine reserves or marine protected areas (MPAs) have been promoted as a fisheries management and conservation tool (Murray et al. 1999; Roberts et al. 2001). No-take zones and limited restriction zones are two different types of marine reserves (Halpern and Warner 2002). A no-take zone is a marine reserve where it is illegal to extract organisms in any way. In a limited restrictions area, some restrictions apply to either the method of extraction or the number of organisms taken.
The effectiveness of marine reserves has been demonstrated through ecological research. Marine reserves appear to maintain a significant increase in average levels of density, biomass, and diversity within 1-3 years, with persistence of these values through time (Halpern and Warner 2002). However, a clearly stated objective and public acceptance are also important to the success of any MPA (Osenberg 2002).

3. Community Based Marine Protection

Community based systems of resource management have been implemented in a number of island communities in the Pacific including Vanuatu, Micronesia, and the Philippines (Christie, et al. 1994; Johannes 1998; Lam 1998; Russ and Alcala 1999). Several essential concepts of the resource management process that led to successful marine protection are similar across the case studies including education, training, and government support. These aspects aided in the establishment of the resource management projects (Christie, et al. 1994).

In Vanuatu, a south Pacific island nation that gained independence from Great Britain and France in 1980, customary values and village structures are seemingly intact (Johannes 1998). Community cohesion and education has led to the success of several village-based marine resource management plans. Johannes (1998) conducted a study of 26 villages to identify village-based marine resource management measures. The lessons learned from this case study can be applied to other tropical islands with small-scale fisheries. Elements identified as important for success include: government publicized willingness to collaborate; projects starting small; community cohesion; villagers conducting surveillance; single or limited type fisheries; government provided management information; support by national law for local authorities; formal legal
assistance for local disputes that are difficult to resolve; and trained fisheries extension personnel to effectively assist the community.

Like many South Pacific Islands since colonization, Palau incorporated highly-efficient fishing technologies and tourism into its economic structure (Graham and Idechong 1998). Palau’s institutions and positions of authority, both customary and governmental, were experiencing stress, and control over marine resources was challenged. The degree of in-shore resource interest by the state and the villages decreased and the stage was set for increased local control. The lessons learned from this study are that social cohesion is necessary, but may become threatened by increased population due to paved roads linking urban and rural regions; that marine law enforcement is expensive; and that national support for local authority is important.

Low per capita income, poor coral reef status, conflicts between legal and illegal resident anglers, and accessibility by nonresident fishers, are common on many islands in the Philippines (Christie, et al. 1994). A top-down management approach began in the 1940’s and was found to be less effective in terms of creating long-term, holistic development. A community organizing approach that includes education, capacity building, and implementation of concrete projects, has subsequently become established in most sociopolitical groups in the country.

These island case studies show that projects greatly benefited from government support, political support, as well as community and scientific support. Understanding political institutions and management systems that govern island communities is important for marine management (Morin 2001). Local community members must be convinced of the benefits of management, and their support must be continuous and long-
term (Russ and Alcala 1999). Without community involvement in resource management, communication may break down and conflicts among residents can lead to lack of common support for the conservation effort.

**B. Participatory Planning and GIS**

1. **Community Groups and Participatory Planning**

   Community groups form to solve common issues. “Only by organizing can individuals have the impetus to participate in the traditional power structure” (Craig and Elwood 1998, p. 95). These groups range from neighborhood associations to larger groups, such as the global community that interfaces with the World Wide Web.

   According to Craig and Elwood (1998) an effective community group inspires others to appreciate their situation. They propose solutions and motivate others to be effective. The cohesiveness and commitment of the groups’ members is essential to the success of the organization.

   Effective citizen involvement requires access to resources (Barndt 1998; Ghose and Huxhold 2001; Kingston *et al.* 2000). Depending on lines of communication between government and policy makers, the level of information is not always optimal for community groups’ objectives.

   Decision-making processes are affected by public opinion, which can be effectively invoked by community groups and individuals. Planners have incorporated public opinion into the planning process for some time now. In the United Kingdom varying degrees of public participation have existed since the first Town and Country Planning Act of 1947 (Kingston *et al.* 2000). Public participation has risen to the
forefront of literature on natural resource management (Obermeyer 1998; Peng 2001; Talen 2000). Public participation also encourages the integration of both scientific information as well as publicly held knowledge (McCool and Guthrie 2001).

There are drawbacks associated with traditional tools of public participation such as town hall meetings. Some of these weaknesses include potentially-inconvenient location and time of meetings, an atmosphere of confrontation, and dominance by vocal individuals. These issues may discourage participation by a broad range of individuals and limit the range of opinions to a small sample of people (Kingston et al. 2000). Top-down planning is described as an “expert-driven, science-based model of planning, that seems at odds with increasing pressures for more intimated participation in decision making demanded by a public that has growing misgivings about the federal government” (McCool and Guthrie 2001, p. 309).

New methods *may* be able to overcome these drawbacks and incorporate a broader range of opinions into the planning and decision-making processes. When the Internet is used as a medium, participation is not restricted by geographical locations or time constraints, and the end user has the option of privacy to express his/her opinion. This method has been shown to increase the number of respondents (Kingston et al. 2000).

Websites can promote public participation by encouraging public input as well as providing resources. A public website works best when coupled with town hall meetings (Peng 2001). Information needs to be current, relevant and organized in an appropriate format (Barndt 1998).
2. Public Participation GIS

The cost associated with GIS, and the technical expertise required for use of GIS make it difficult for the general public and community groups to access and utilize GIS software, data and tools (Harris and Weiner 1998). GIS has been used in planning for several decades. Much of this use has been criticized as top-down, technically elite, and non-participatory. The decision-making process involves many steps where planners incorporate information into a GIS. In many cases, the only opportunity for public comment is at the final stage, the “well-prepared” outcome.

Talen (2000) describes a new approach to planning with GIS called “BUGIS” or “Bottom-Up GIS”, an alternative that incorporates residents’ perspectives into GIS. In contrast to a top-down GIS approach where data are provided, manipulated, and presented by technical experts, “BUGIS is an approach in which residents use GIS to communicate how they perceive their neighborhood or community, via their description, evaluation, or prescription for their local environment” (Talen 2000, p. 280). Community members are beginning to take ownership in creating GIS knowledge. BUGIS involves the community participants from the initiation to the completion of a planning project and allows for the personal input of each participating member of the community.

3. Internet-based Participatory GIS

Internet GIS can encourage community participation throughout all stages of the planning process. Internet-based public participation GIS (PPGIS) should provide all sectors of the community with equal access to information and data (Kingston et al. 2000; Peng 2001). There are several criteria for the website developer and planners to
take into account when developing an Internet-based GIS that will promote public participation.

The Internet enhances but does not replace traditional planning. The Internet and public meetings must be used in conjunction in order to provide a variety of options for community members willing to participate in the planning process. Discussion forums and comment forms are necessary for feedback and continued dialogue, but it is also necessary for the planners to incorporate the feedback into the planning and decision making process. Visual images such as photos and videos enhance the PPGIS website as well as instructions and a help menu.

A website that is easy to use will keep a user interested. Help menus may be necessary to make the website more user-friendly, and simple instructions can allow the user to move easily through the steps of viewing data in an Internet-based GIS viewer. One cannot assume that every person will understand the structure of a website or tools within the site. It is also necessary to take copyright issues and ownership of data into consideration. Query tools and other GIS tools are important for the user to evaluate alternatives (Peng 2001). Information that is bipartisan and includes metadata is also important (Evans et al. 1999). A profile of the website users can be used to help validate responses and improve the effectiveness of the system (Kingston et al. 2000).

Other considerations in the development of an Internet PPGIS include the following (Kingston et al. 2000): 1. Does the public understand the system? 2. Is the public comfortable using the system? 3. Do they understand the maps? 4. Is it easy for them to use the computer and Internet? 5. What is their degree of involvement? 6. Do they have access to the PPGIS?
C. Technical aspects of Internet-based GIS

In order to understand how GIS can operate on the Internet it is necessary to understand the architecture of the Internet itself. A user can access the Internet through a computer network. Open standards and protocols such as hypertext transfer protocol (http) and hypertext markup language (html) are universally recognized. Some common image formats such as .gif (“graphics interchange format”) and .jpg (“joint photographic experts group”) are supported by the Internet for general access, while other image formats like .sid (“MrSID,” “multi-resolution seamless image database”) or .svg (“scalable vector graphics”) may require special “plug-ins” to operate on client computers. Tools that provide customized functionality, such as java and animation techniques, are not yet standardized (Gifford 1999).

In the basic model of Internet-based GIS, there is a server or a network of servers and there are one or more clients. A server may be dedicated to an Internet GIS, or the GIS may be hosted on a multipurpose website. The client asks for data and views it through a browser on the local computer. Various software packages can be used to develop an Internet GIS. ArcIMS software (ESRI, 2003, not in references! ArcIMS 4.0.1) is an industry standard. I chose this package for Internet GIS evaluation because of its widespread acceptance and because it is available through the University of Montana’s ESRI site license.

The ArcIMS architecture includes both server- and client-side components. ArcIMS runs in Windows or Unix operating systems. Server-side components are the ArcIMS Spatial Server, Application Server, Application Server Connectors, and the Manager. When the server receives a request from the client, spatial functions such as
creating cartographic map image files or querying the database are performed by the ArcIMS Spatial Server. The server processes the request and sends the requested information back to the client. To complete the architecture a Web server and servlet engine are all needed (ESRI 2002).

The ArcIMS HTML Viewer and Java Viewers are client-side tools. The basic requirement is an Internet browser such as Microsoft Internet Explorer. ArcIMS services using either the HTML Viewer or the Java Viewers require the client’s browser to interpret HTML and javascript code; protocols for these languages are generally standard in most modern browsers. The Java Viewer is considered a “thicker” client, requiring a properly configured Java Runtime Environment (JRE) on the client machine.

Requirements for the Internet-based GIS are many and may require some research into the needs of a particular audience before building the site. Peng (2001) discusses several general system requirements to consider in designing a website. First, it should be “platform neutral”; the website will have a higher success rate for users if it does not conform to one standard, but is accessible to all Internet browsers and operating systems. Multiple forms of communication should be possible; for example email, chat rooms, etc. Finally, sites should be fully-compatible with current standards. The International Standard Organization (ISO) and the Open GIS Consortium (OGC) are the two main standards to consider.
Chapter III. Study Area

In the heart of the South Pacific, French Polynesia is located approximately midway between the continents of Australia and South America. It is 5700 km from Sydney, and 6200 km from Los Angeles (Présidence du Gouvernement de la Polynésie française 2003). French Polynesia is composed of five archipelagos consisting of 118 islands; 84 of these are atolls and the remainder are high volcanic islands (Salvat et al. 2001). These island chains are the Marquesas, Society, Austral, Tuamotu and Gambier Islands. Moorea (17°30’S, 149°50’W) is part of the Society Island chain of French Polynesia.

A. Physical environment/basic geography

Moorea has an area of 132 square kilometers (51 square miles) and has mountainous terrain (figure 1). The tallest inactive volcanic peak is Tohiea with an elevation of 1,207 meters (3,983 feet) (Présidence du Gouvernement de la Polynésie française 2003). Moorea is enclosed by a barrier reef at a distance of 1-2 kilometers from shore; the reef joins the land to become a fringing reef at the northeastern corner of the island, near Lac Temae. There are 12 reef passes, several of which are large enough for ships to pass. The two major bays to the north, Opunohu and Pao Pao also known as Cook’s Bay, are large enough to support the docking of major cruise ships. Moorea is a Windward Island along with Tahiti located 17 kilometers (10 miles) to the west (Tahiti Traveler Inc. 2004).
B. Population/economy

Tahiti and Moorea combined (figure 2) are home to the majority of the population of French Polynesia. The 1996 census identified 219,521 residents in all of French Polynesia with 150,000 living in Tahiti and about 12,000 on Moorea (Présidence du Gouvernement de la Polynésie française 2003). Some of Moorea’s residents commute daily to Tahiti due to its close proximity, but tourism sustains much of Moorea’s economy. Other economic activities include some commercial deep-sea fishing and traditional subsistence fishing. France supports the Territory of French Polynesia, but exports including black pearls (97% of French Polynesia’s total exports), coconut oil and nacreous shell are also part of the economy (Salvat et al. 2001).

C. Status of coral reef ecosystems

Human impacts on the coral reefs are a major problem in the Society Islands. Modification of the shoreline in urban areas, runoff and sedimentation from the land, algal blooms, and sewage all contribute to the destruction of the coral reef (Salvat et al. 2001). Although there is a considerable amount of information available on the status of the marine ecosystem in French Polynesia, and even though these resources are critical to the local economy, there is a lack in active management of these resources (Salvat et al. 2001).

D. Planning and policies for ecosystem/fisheries management

Le PGEM: Plan de Gestion de l’Espace Maritime is a marine management plan established for the islands of Bora Bora and Moorea (SNC PaeTai-Pae Uta 1997). When it was first developed, the PGEM was intended as a collaborative process between
government, scientists, and citizens to restore the coral reef ecosystem through a system of no-take reserves (MPAs) throughout Moorea’s lagoon (SNC PaeTai-Pae Uta 1997). The plan has evolved since its onset and is currently at the point where education and implementation are taking place (Monier, pers. comm., 2003). The revised plan proposed in 2002 included dedicated special fishing zones and smaller MPAs than earlier drafts (Figure 3).

The International Coral Reef Fish Workshop held in Moorea in April, 2002 highlighted some key concerns for the restoration and sustainability of coral reef fish communities. Oceanic and lagoon fisheries have expanded in the absence of any management plan for lagoon fisheries (Galzin 2002). Marine Protected Areas (MPA) were evaluated as an approach to managing Moorea’s lagoon. Monitoring and fish surveys were considered as ways to assess the need for and effectiveness of MPAs (Kulbicki 2002). Scientists also offered critiques of the proposed MPAs; in particular, concerns were expressed that MPAs must have clear objectives and community participation in order to succeed (Osenberg 2002).

Two research stations are located on the island of Moorea. The Centre de Recherches et Observatoire de l’Environnement (CRIOBE) is a French research station affiliated with the Université de Perpignan, France. The Richard B.Gump South Pacific Research Station is a U.S. research facility operated by the University of California at Berkeley. Scientist and government collaborators study the terrestrial as well as marine ecosystems of Moorea and surrounding islands. Research areas including coral reef, lagoon fisheries, fisheries management and marine protected areas are all recent topics of study (International Coral Reef Fish Workshop 2002).
Figure 1 Study Area: Moorea
Figure 2 Moorea relative to Tahiti

Figure 3 PGEM 2002
Figure 4 Agriculture: Pineapple plantation west of Pao Pao Bay

Figure 5 Pineapple plantation in the interior of Moorea
Figure 6 Tourism: The Gauguin Cruise Ship

Figure 7 Hotels: Over-the-water bungalows
Figure 8 Papeete, Tahiti: Fish Market

Figure 9 Fringing Reef and Lagoon
Figure 10 Fringing reef within the lagoon and barrier reef beyond.
Chapter IV. Methodology

This project consists of a website development process and a survey of public, government, and researcher perspectives on the website and Internet-based GIS. To begin the process, I interviewed community members and scientists to determine the resources available and the appropriate elements to include in an Internet-based GIS. I created a website at <http://maps.geog.umt.edu/mooreaproject> primarily designed for the audience of the people of Moorea to use for interactive mapping. I incorporated website design principles based on academic research on website development and public participation GIS (PPGIS) web sites. Finally, I conducted a qualitative survey with members of the three different stakeholders of this community. These are the researchers, local citizens, and the government officials working on the PGEM.

This chapter describes the methods used for obtaining data and information from the community; chapter 5 describes the design of the Moorea website.

A. Initial Interviews

My methods for this aspect of the research involved a structured email interview (Appendix A) sent to 36 scientists who have conducted research on the island of Moorea, and a review of unstructured interviews that I took on the island of Moorea in spring, 2002. Seven of the 36 scientists responded to my emailed interview and many expressed enthusiasm for the efforts that I was making to implement an Internet-based GIS. I captured the Richard B.Gump South Pacific Research Station scientists’ perspective on data sharing and Internet-based GIS with an emailed open-ended questionnaire.
This was a “convenience sampling method” (Berg 2001) in that I contacted all of scientists for whom contact information was available from Gump and CRIJOBE. The actual number of researchers who have worked on the island is unknown, but it undoubtedly numbers in the hundreds, not including additional hundreds of students completing projects as part of classes at the University of California at Berkeley, University of California Santa Cruz, University of Redlands and other programs. Each research station’s dormitory accommodations house up to several dozen researchers from May through August each year and the occupancy is often full. Due to time and financial reasons, I contacted the international group of scientists by email. One scientist was in the Marquesas, one from New Zealand and another was in Moorea. Several of the other scientists live in California.

I conducted three interviews on Moorea with local residents. The interviewees expressed a wide range of their opinions and feelings in these unstructured and detailed conversations. There was a language barrier between me and the local French and Tahitian speakers. I am not fluent enough in French to understand all the nuances of the interviews. An interpreter from Moorea, Tehea Tramier, assisted me with translation of these interviews. She and I both took notes, and I taped some of the interviews. When we finished the interviews, Tehea assisted me in combining both of our interview notes.

B. Internet-based GIS

After conducting the initial research on the interest and enthusiasm of the community concerning Internet-based GIS, I developed the Internet-based GIS interface. For comparison, I also designed a section with printable maps for users to have easy access to completed maps for research or personal use. Once completed, I returned to
Moorea to show the site to the residents and scientists and obtain feedback on the site. I also acquired information from government officials and research station directors on the sustainability of an Internet-based GIS for public participation in the resource management process. This preliminary version of the Internet-based GIS was used for testing purposes and to instigate discussion on the subject.

**C. Community Interviews**

Upon completion of the website, I conducted interviews with three community groups: residents of Moorea, government officials and research station directors, and scientists on the island of Moorea. Most of these interviews were conducted on Moorea and Tahiti in 2003. I designed these interviews to be qualitative and open-ended in nature. My population sample included both purposive and convenience methods. A convenience sample represents the available subjects, and a purposive sample signifies a sample chosen for a purpose (Berg 2001). I used the convenience sampling method to acquire as many participants from the research and local communities as were willing to answer my survey. As with the initial interviews conducted with the research community, I acquired the list of email addresses of Gump and CRIOBE station researchers and sent approximately 40-50 emails to these international scientists. Only four people responded to my survey after several attempts.

The local community interview began with people I met during my initial visit to Moorea and extended to people they recommended. This sample is not representative of the entire population. I interviewed 10 local residents in all during my September 2003

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2 I do not know the exact number of scientists contacted because I asked people to send the survey to other colleagues who worked in Moorea.
visit. They are a diverse group representing various professions including business owners, a harbor employee, a pilot, construction workers, an events coordinator, a fisher person, a grocery store employee, and a maintenance man. I interviewed middle-aged men, elderly men, and two women. Clearly not represented in my sample is the portion of Moorea’s population that lives in poverty, speaks only Tahitian and most likely does not own computers\(^3\). I did not seek them out due to lack of time and language barrier. It is beyond the scope of this thesis to determine how PPGIS could be made accessible to this segment of the population.

The essential topics addressed in my survey questions included computer access, Internet access, and a basic understanding of how to use the Internet (See Appendix B for entire survey). In addition, I asked about the extent to which respondents use maps. More in-depth questions addressed respondents’ participation in resource management, and asked them to consider ways they could be more involved.

The government and research station survey (Appendix C) varied from that given to the community. I interviewed two government employees and two research station directors (one from each station). Questions also involved computer and Internet use. I also asked if they use GIS or Internet-based GIS. Since some residents of Moorea do not have computers or Internet access, I asked if they would be interested in providing a public access computer and training or education.

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\(^3\) This statement is based on both observation and personal communication. Many of my contacts talked about the local Tahitian members of the population who do not speak French, who depend on fishing and agriculture for their livelihood, and who typically live in the high country. Personal communication with both the local government and French Polynesian government employees brought this to light as well. I drove into the high country and viewed shacks without running water or electricity that are homes to a minority of local Tahitians.
Chapter V. The GIS development process

A. Background

The Moorea community GIS developed as part of a larger project organized by Barbara Walker, Ph.D., of University of California Santa Barbara (Walker, 2002). In a grant proposal to the MacArthur Foundation in 2000, Walker included the creation of a community-based Geographic Information System (GIS) in which all lagoon users would have the opportunity to “create, up-date, disseminate, and acquire knowledge about the lagoon in a spatial context” (Walker 2000, p. 1). The University of Montana Department of Geography collaborated in this project.

B. Data sources

The Moorea Community GIS contains a wide range of spatial layers produced by many sources. Several of these layers are included in the Internet-based GIS, while others are restricted due to data limitations or French Polynesian government conventions limiting their use. The GIS includes both raster (e.g. scanned and georeferenced images) and vector (e.g. digitized shapefiles) data layers. Scientists and California students contributed the data for many of these layers. Spatial layers scanned and/or digitized from published and government sources include geology, vegetation, roads, towns, hotels, lagoon features and marine protected areas from three different years. A digital elevation model is available for the western half of the island, and aerial photos provide complete coverage of the island from 1977 and 1986 and partial coverage from 1998.
C. Website design

I developed both French and English “front-ends” for the Moorea Community GIS website. Charles Harris (former Systems Administrator for the Social Science Research Laboratory at The University of Montana) and Assistant Professor Eric Edlund, Ph.D., of the University of Montana designed the layout and provided images for the home page. I adapted it and continued with the rest of the pages. The website has three main components that can be accessed from the home page (figure 11): maps (figure 12), a GIS (figure 13), and metadata (figure 14). Digital photographs of Moorea and project contact information are also available on the home page. I used several software packages to create the website. The structure of the website was developed using Macromedia Dreamweaver. This entailed the creation of the home page, the maps page, and the metadata page. ArcIMS 4.0.1 software (ESRI 2002) was used to produce the GIS section of the site.

The “Maps” section of the website is intended for those who wish to print a completed map. I designed this section with the non-technical or time-restricted user in mind. It provides several map options and format choices. These maps do not have the functionality of the GIS. They are solely images for immediate use with no ability to query or change the data.

Dynamic maps can be generated using the “GIS” aspect of the website. The GIS capabilities that are available over the Internet include zooming, panning, turning layers on and off, selecting and querying for data available in the data table associated with the specific layer, and printing out the final version of a map. (More details on the GIS tools are in section D, below).
The metadata and data page (figure 5) is an inventory with background and cartographic information on all of the data files. This page lists the formats for the data and links to a PDF file that lists details on the layers within the GIS. In the future, this page could serve as a source to download publications, shapefiles, raster and vector files, and other GIS layers for users to work from their personal computers.

Figure 11 Website home page
Figure 12 Website maps page

<table>
<thead>
<tr>
<th>Layers</th>
<th>Map Formats</th>
<th>Thumbnails</th>
</tr>
</thead>
<tbody>
<tr>
<td>Island and Lagoon Outlines</td>
<td>GIF</td>
<td></td>
</tr>
<tr>
<td>Island, Lagoon</td>
<td>GIF</td>
<td></td>
</tr>
<tr>
<td>Island, Lagoon, Towns, Labels</td>
<td>GIF</td>
<td></td>
</tr>
<tr>
<td>Island, Lagoon, Towns, Hotels, Labels*</td>
<td>GIF</td>
<td></td>
</tr>
<tr>
<td>Island, Lagoon, Channel Markers</td>
<td>GIF</td>
<td></td>
</tr>
</tbody>
</table>

* coming soon

Figure 13 Website GIS page (HTML Viewer)
For the GIS section of the website, I began with three different GIS methods for viewing the spatial data. ESRI’s ArcIMS 4.0.1 software package comes with three different viewers and other connectors to customize a GIS application. I chose the HTML Viewer, Java Viewer and the ActiveX Connector and built GIS sites to compare these viewers. Due to access limitations (discussed in the following section), I chose to use the HTML Viewer as the sole option for the website and interview analysis.

The HTML Viewer is a lightweight viewer that uses a simple yet powerful set of GIS tools (ESRI 2002). Some of these tools include the option to pan and zoom, query spatial and attribute data, create buffers around features, and measure distances on the map. Although this is not the full set of GIS tools that are provided on a desktop version of GIS software, these tools give the user control over the map that is impossible with a
static printout. This level of interaction with the spatial data allows the user to decide which layers of information he/she wishes to view and he/she can perform some basic analysis. In the end, the user can print a personalized map displaying this information.

**E. Limitations**

My original intention was to test all three of the viewers, HTML, Java, and the customized application with the ActiveX Connector, and the GIS tools they provide. Difficulties I encountered in the field made it impossible to complete this initial set of objectives. Because I anticipated (correctly) that many of the people I contacted in Moorea would not have access to the Internet during an interview, I provided the interviewees with a laptop computer with the functioning website that did not require an Internet connection. Unfortunately, only the HTML viewer would function on this computer.

Two of the interviewees from the scientific community had the opportunity to view the other GIS viewers and suggested that they were not going to work. One respondent stated that he preferred the HTML viewer because “Java and ActiveX don't work with many computers”\(^4\). The second respondent said: “I like the HTML format because I don’t have Java viewer on this computer, and my Internet connection is slow”. Because the Java viewer requires a client-side download, it is not realistic for many people with a slow connection. The ActiveX connector is streamlined and simple enough to run on slow connection speeds, but it has the drawback is that the server needs to be refreshed almost daily in order for it to work. My discussion reflects the comparison

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\(^4\) The ActiveX connector should work as widely as the HTML Viewer. The problem with the ActiveX connector lies on the server side not the client side.
between the static maps and the HTML viewer and omits the ActiveX and Java viewers due to the lack of data.
Chapter VI. Results

A. Results of Initial Exploratory Interviews

1. Local GIS interests

In my first visit to Moorea in June 2002, I interviewed three local women\(^5\). They discussed their feelings on the PGEM, their concerns for future resource management issues, and their interest in using GIS as a tool. All three women expressed great concern for the resource management of the lagoon. One woman articulated that the French government came to Moorea and held meetings for public comment on the PGEM process. “They come during the day when people are working and they speak a very technical French that many of the elders don’t understand. They also have a very French mind.” She said that her people do not understand the government’s goals in setting aside MPAs (marine protected areas). She and the other women speculated that it was to increase the number of fish.

The women expressed concerns for the future of natural resource management and the local public participation. They are interested in teaching the children about the importance of natural resources and the ancient ways of caring for them. One woman explained that there are other natural resource management issues and that the management process will only get more complicated if the community cannot communicate with the government. She said, “The population is not ready to work with

\(^5\) These women lived in Moorea in different communities and they had been actively involved in the PGEM planning process since the onset. One woman was a teacher, a mother, and an environmental activist. The second woman was a college student. The third woman was the president of a neighborhood association and a fisher. To protect the confidentiality of all interviewees they will remain anonymous.
the scientists. They are used to French scientists and they are not good with people.”

There is a communication barrier between the French and some of the natives who speak primarily Tahitian. She explained to me that the fishers who attended a conference with international scientists (International Coral Reef Fish Workshop 2002) found it much easier to communicate with scientists of other nationalities. One woman also expressed her desire to have access to the data that scientists collected around Moorea so that she could use them in support of her own specific arguments, and those of other local people.

Computers are not as prevalent in Moorea as they are in the US, and while some people have computers and access to the Internet, many do not. Residents pay for each local phone call, and they must dial out with a modem for an Internet connection; as a result, people are conservative with their time on the internet. According to a brochure of the Internet hosting company “Mana6”, prices in June 2002 were listed at 4180 Fcfp (French Polynesian Franc) for a subscription of 5 hours of Internet per month, 7590 Fcfp for 20 hours, and 14520 Fcfp for 50 hours per month. At an exchange rate of approximately 1 USD to 100 Fcfp, the cost was about 41 USD for 5 hours of Internet access per month.

I had expected to find little to no interest in GIS tools from the local community, but this was not the case. One of the interviewees was thrilled when I showed her preliminary online maps of Moorea. She had been working to alter the map that the government had created on the PGEM, and she said that she felt like her map was “childish.” She wished she had the tools to create a map of her own. She expressed interest in using a Global Positioning System (GPS) to accurately pinpoint archeological sites as well as streams. She wanted to use the GIS for environmental protection as well.

6 Mana: www.mana.pf
as cultural protection. A second interviewee said that she wants “to have a precise idea of the zones to protect, like anchor zones to tell the government.” She is not familiar with computer and GIS technology, but she believes that she could get help from the younger generation.

The youngest interviewee, 22 years old, was enthusiastic about helping the two older women use GPS to locate and label their areas of interest. I worked extensively with her to teach her how to use the GPS. The four of us drove together to sites on the island and used GPS to mark specific sites that they felt needed protection. They wished to then place these points on a map and use it in the planning process. We imported the GPS points into the GIS and created their personal maps with the previously collected data.

This study suggests that people are open to the use of GIS technology, and that they are interested in developing a GIS to store data for the future generations. An interviewee recommended that GIS be used as a tool for logging all of the traditional Polynesian names of places. She said that the children of today are losing their culture to modernization and that they must preserve it in some form so that it is not completely lost.

2. International GIS interest

I included researchers in my definition of the Moorea community because 1. They contribute a vast amount of scientific research to the island. 2. They spend an extensive period on the island. 3. There is a great potential for them to use the GIS for their personal research and presentations. 4. The researchers contribute indirectly to public
participation in natural resource management by providing data to the locals thus giving
them an opportunity to inform themselves and support their ideas in the planning process.

I initially thought that scientists would resist sharing their data with the world
through Internet-based GIS. On the contrary, this study suggests that international
researchers are quite possibly very interested in data sharing, and they are even willing to
share unpublished data. I sent an initial survey to 36 scientists who have worked on the
island, of whom seven responded (see Appendix A for survey). I feel that these data were
adequate to begin to answer the questions that I have concerning enthusiasm and
willingness to contribute data. Scientists with both terrestrial and marine specialties are
included in the respondents, with fields of specialty including ethnography, economics,
archaeology, material culture, archeofaunology, botany, entomology, and marine biology.
These diverse fields of study could add a breadth of detail to the future Moorea GIS.

Themes that emerged from this data collection process include the scientists’ level
of interest towards Internet-based GIS use, their willingness to share data with local
Mooreans, and their interest in Internet-based GIS as a model for other communities.

For the first theme, level of interest towards Internet-based GIS, respondents
discussed a range of uses including both personal use and contributions to others’ use.
The levels of interest in Internet-based GIS varied. Scientists were interested in some or
all of the following options: viewing existing online maps, printing existing maps for
personal use, printing maps for other peoples’ use, creating maps showing their own data,
and entering data to share with other users of the Internet-based GIS.

No one said that they would not use the Internet-based GIS at all. All the
respondents said they would at least view existing online maps. Five out of seven said
that they would print maps for personal use and four out of seven would use the GIS to create customized personal maps with their own data.

All but one researcher said that they would contribute data to the Internet-based GIS, and every respondent said that they are willing to share their data, including unpublished data with members of the local community of Moorea. The only concern that one person had was that her data is in English and the locals on Moorea speak French and Tahitian. One young researcher stated, “I am interested in a program in which grad students would visit local schools for outreach education.” Respondents also suggested that they could provide locals with pictures, comments, and presentations of various subject areas.

This study has the potential to spread to other islands and be a model for GIS data sharing around the globe. Six of the seven respondents have conducted research on between one to six other islands in French Polynesia, and two of these respondents inquired about duplication of this study on other islands. One interviewee stated, “I’d like to see if your GIS experiment could be implemented on other islands”. Another one said:

There is a tremendous wealth of biological and ecological data for Moorea because of the large number of researchers working here now and in the past—making it an ideal locality for the project you outline. GIS would allow more of the information to be synthesized and offer models for elsewhere.

Although exact duplication of this study is not realistic for another location, it is a positive notion to consider the possibility of other marginalized communities having access to scientific data and technology that could otherwise be extremely difficult to acquire.
B. Results of GIS Evaluation

The subjects interviewed after development of the GIS can be divided into three categories: the residents of Moorea, the scientists who work on Moorea, and government employees and research station directors. Although these groups do interact, they are mutually exclusive as far as these questions are concerned. For example, a government official answered questions as a representative of the government, not a citizen or resident of the island of Moorea (Survey questions are in Appendix B).

1. Local Residents of Moorea

In order for Internet-based GIS to work as a participatory tool for planning, members of the community must be able to use computers and the Internet. Of the ten residents interviewed, eight out of ten people used computers, and one additional person said that his wife and children did, but he personally did not. Six people of the ten used the Internet.

Figure 15 shows the frequency of respondents’ computer and Internet use. I ranked the frequencies as follows: every day, often (several times per week), rarely (about once per month), and never. Respondents also noted if this was primarily at work use or at home use of the computer and Internet. Computers are used by 40% of the respondents every day at work, 30% used the computer often at work and home, 10% rarely, and 20% never.

The respondents used the Internet less often than the computer. 30% used it everyday. 40% never used it. 20% rarely used the Internet and 10% used it often (figure 15).
The second topic relating to Internet GIS and participatory planning is the use of maps and the comfort level at which residents use maps. Seven of the ten respondents used maps and three did not. Respondents used maps for navigation, fishing, and tourism. The levels at which respondents felt comfortable reading maps varied. Several people used maps for professional use, some had no problem with maps for personal use and others could find things on maps if they were clearly marked. One person of the ten stated that he had some difficulty with maps.

I asked several of the respondents to review the Moorea Community GIS website and give me feedback regarding the static maps and the dynamic GIS. Most of the respondents stated that they liked both the maps and GIS equally for different purposes. One person stated that he would not use the site and therefore did not care for either of the online mapping resources.
Few respondents stated why they preferred the method of online mapping that they chose. Some answers are as follows: “I don’t know” (CS2), “I like the GIS because you can determine how much information you would like to have in each map. You can get precisely what you need” (CS4), “The plain maps I like for drawing things and the GIS for putting my own trails or markings” (CS5), “I prefer the printable maps for the purpose of seeing hotels or giving directions” (CS3).

In response to the question of whether respondents would ever use the site, answers ranged from “never” to “sometimes” to “I don’t know” with the majority of the people stating that they would use it sometimes.

We also discussed changes they might wish to see and things they liked or disliked about the site. Things that respondents liked about the site were also some of the things others disliked; “nothing”, “graphics”, and the “data”. Almost everyone stated something different. As far as the things people would change, I heard mostly positive feedback. One respondent explained that she would “like to see the PK markers on the map” and said, “The graphics on the home page are confusing.” PK markers are small numbered road signs at one-kilometer intervals around the island, commonly used for giving directions. The other respondents said that they would not change anything or that they did not know what to change. People liked the format of the website stating that it is “logical.” Other aspects of the website that the respondents commented positively on were the graphics, the simplicity, the logical format and the overall look and feel. CS1 said, “It is good information for the PGEM.”

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7 “CS” stands for community survey. Surveys conducted with Scientists are listed as “S” and Government or research station directors are “GOV”. A number has been assigned randomly to identify the respondent.
When asked if they had an interest in receiving more education in the use of GIS, computers or Internet tools, the response was “yes” for 80% of the respondents. However, no one was interested in more education in GIS tools. Most of the replies were for computer education. One person was interested in learning more about the Internet “as it comes” (CS4), which I interpreted to mean as necessary or as classes become available. I asked a question specifically about further interest in GIS use and found only one person interested. He (CS2) would like to learn more about GPS for navigational purposes.

The final question in my survey concerned resource management. I wanted to find out if people participate in the resource management process and explore other ways that they could become more involved in the resource management process. About 50% of respondents claimed to participate in the process and 50% did not. I realize now that their definition of participation in the resource management process is a much different picture than I had in mind. Responses like “I pay taxes” (CS5) and “I respect the land” (CS8) were not exactly what I expected. Others responded that they are a part of an association that works on resource management issues or they attend public meetings. One woman suggested, “I might participate more in the resource management process if there was something on the computer and I wouldn’t have to deal with people. I could just submit answers” (CS4).

2. Scientists

The scientists who stay at the research stations on the island of Moorea come from all over the world. This sample includes people from the US, Australia, and France. Themes that emerged from these interviews include research and educational needs
within the realm of GIS, and resource management participation. Other important facts encompass computer and map use, data contribution, and website preferences (See Appendix B).

100% of the scientist respondents used the computer and the Internet every day. They also all used maps for their research. These scientists felt quite comfortable using and finding things on maps.

GIS is used less frequently among this sample of the scientific community. Only one of the four respondents used GIS tools in their research. Three of the respondents were willing to contribute their data to the GIS and one claimed that he did not have any interesting data to contribute. As far as education, every single person was interested in GIS education. One claimed, “Some online basic GIS course would be great.”

I asked the respondents to review the website and compare the two versions of online mapping that I provided. I then asked them questions concerning their preferences between the static maps that I designed for printing purposes only and the GIS maps that were meant for interaction between the user and the maps. Two of the respondents preferred the GIS to the static maps. One person preferred both the GIS and the maps for different purposes and the final respondent preferred the maps stating, “The maps are simpler.” The reasons given for favoring the GIS are that it is complete, flexible, simple, and useful for research purposes.

One hundred percent of the respondents stated that they would use the website for personal use and research purposes. Seventy-five percent said they would use the website
sometimes and the other 25% said he would use the site often. People particularly liked the website for its simplicity, the tools, the ability to print and save maps, and the data.

Resource management is not something many of the scientists are directly involved in because of their temporary stay on the island. I posed the question concerning participation in resource management issues due to the applicability of their data toward the development of resource management plans. Two of the four respondents claimed they were involved in resource management issues related to Moorea. One of the scientists who was involved stated:

Our research on reef fish ecology might have been useful to draw MPAs around the island; I participated to public meetings and international workshops; I launched an education and public outreach program for the local kids to help them to understand the issues, the possible solutions and their potential involvement in the process.

3. Government and Research Station Directors

Two government officials from different sectors of the government working on the marine protection plan (PGEM) responded to my interview questions. I also interviewed the University of California Berkeley, Gump Research Station director Neil Davies and the directors of research at the Centre de Recherches et Observatoire de l’Environnement (CRIOBE), Yannick Chancerelle, and René Galzin. These interviews are a small but very important sample of people. These officials directly interact with the resource management plan concerning marine protection and the community.

Several important topics evolved from the discussions with this group, including three main themes: involvement of the community members in resource management; the

\[\text{\footnotesize{Some respondents recommended inclusion of a better explanation of the GIS, along with more data. The sample used for this study is only a small portion of the data available.}}\]
perception of public computer use and GIS; and providing education associated with computer technology.

Involving community members in resource management was a priority for the government officials. The research station directors did not directly involve or work with the community on this issue. Instead, they support contractual work that helps the government discern scientific information, and some have been indirectly involved in the writing of rules that were associated with resource management. The government officials; however, were directly involved with the local community through meetings and public inquiry.

As a whole, this group used computers regularly, but only one government official communicated directly with the community through the Internet. Other methods of communication included fliers sent to the homes of citizens and posters placed in public locales to advertise the status of the marine resource management planning process.

GIS and data sharing was the next theme of interest to all respondents. None of them used GIS directly in their own work. Maps and GIS data were provided by the Cartographic Department of the government, but the planners themselves did not use the GIS data or software. Many scientists who conducted research at both research stations collected spatial data used for GIS analysis.

On the subject of GIS data sharing all four respondents stated that they would share their data with the local community only but not the global community. One of the respondents would share with the local and global community, while another research station director would share data with a limited community with password privileges. The
other two respondents stated that they would share only with the local community. No
government or research station GIS data-sharing methods were in place at the time of the
survey. Of the four respondents only one felt that Internet-based GIS was a good idea for
resource management. When asked if he thought Internet-based GIS could help the
community participate in resource management, his response was

Yes, eventually. For example, it could help to show how the marine
reserves are functioning by presenting data from monitoring studies
carried out by scientists. Government agencies and even the general
public might also be able to contribute directly or indirectly (e.g., by
inputting georeferenced data on fishing catch).

The other three were not interested in web-based GIS for resource management, but when
asked if they would host an Internet-based GIS system they all said “yes.”

When the question of computer/Internet use and the idea of GIS data sharing was
addressed several respondents provided their perceptions on the Moorea community
computer use. One respondent said, “Common people do not have computers.” A second
respondent replied, “Only a certain class of people can have the Internet.” In addition, a
third respondent claimed that, “The Internet is not used by the fisherman.”

To follow up on the perception of the government and research station directors
that the community lacks computers and/or Internet access, I discussed the possibility of
the government or research stations hosting a public access computer and educational
training associated with GIS. This might increase the likelihood of community members
accessing an Internet-based GIS. The majority of the respondents supported computer
access and GIS training. Only one person said that he was not interested in hosting a
public access computer or educational computer/GIS training.
Chapter VII. Discussion

The purpose of this research is to identify which online mapping methods best serve the community of Moorea’s needs for public participation in the resource management process and to assess the extent to which the community will use such a mapping system. Implementation of the Internet-based GIS depends on several components such as cooperation from the government and public Internet access. This chapter highlights the results in connection to my research question, as well as the limitations associated with this project, and proposes future research directions.

A. Connecting the results to the research question

My preliminary results in 2002 showed that there was a role for GIS along with a need for basic computer education in Moorea. After interviewing three locals who were very interested in Internet-based GIS tools for participating in resource management issues, I determined that all of the scientific community respondents were interested in using the Internet-based GIS and that they were also willing to contribute their data to the GIS.

With the contribution of data to the Moorea GIS, and with my initial results reflecting a genuine interest on the part of community members, I proceeded with the development of an Internet-based GIS system for use by the local as well as the global community. My project can be viewed as the construction of a prototype of a future online GIS that can be used for public participation in Moorea. The challenges of Internet-based GIS development (see section B. below) led me to the conclusion that a
committed organization or government entity would have to administer this website and update software and data on a regular basis.

Results from the Internet-based GIS evaluation study indicate that an online GIS is of interest to both researchers and the public. Many of the respondents are interested in having access to both printable maps and a GIS and about a quarter of the respondents stated an interest in only GIS. More than half of the respondents are interested in using the Internet-based GIS. All of the respondents from the initial exploratory investigation and most of the respondents from the actual GIS evaluation are interested in contributing data to the GIS.

Public participation in resource management requires education, training, government, community and scientific support (Barndt 1998, Kingston et al. 2000). These necessary components stated in the literature prompted me to ask questions of the scientific, government, and local communities to determine whether the infrastructure is available for the web-based GIS to function. As stated above, several citizens and the scientists are interested in Internet-based GIS. The scientists are also interested in contributing data. The next key component is the government and the research station directors. When asked if Internet-based GIS could help the community participate in resource management most of the responses suggested that the GIS would not help the community participate in resource management. Only one person was supportive.

This reflects limited support for the idea, but opens the door for further training and education. Although many do not believe the GIS could help the community participate in resource management they were still willing to host a system and provide

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9 Total respondents include all of the people asked the questions concerning the website and which method they preferred. These are both scientists and local Moorea residents.
training and education in conjunction with the website. Several respondents said that they would also provide public access to a computer for this cause.

In conclusion, community members and scientists are interested in the application of GIS technology and its evolving online capabilities. The community members are interested in Internet-based GIS for personal use and communication. The scientists are interested in Internet-based GIS for the advancement of science, and while the resource management planners are skeptical about the use of the GIS for public participation, they are willing to involve the community in this technology to some capacity.

When planning is incorporated with meetings, personal contact, the Internet and GIS, it engages more members of the community than when only one of these components to public involvement is implemented. Planners can further increase involvement of the public by giving them ownership of the project from the onset of the planning process. While this degree of public involvement was absent at the beginning of the PGEM process (Walker 2000), nevertheless Internet-based GIS may provide a mechanism by which the Moorea community can share ownership of the final project.

B. Challenges

1. Website development

ArcIMS software presented many challenges. The installation of the software and the server setup was complex and time-consuming. This process requires the support of a skilled systems administrator. Running ArcIMS 4.0.1 in 2003, problems with system configuration required frequent manual “refreshing” of ArcIMS mapservices to permit outside Internet access. I developed three options for the Internet-based GIS interface, the
HTML Viewer, the Java Viewer, and the customized Viewer that employed the ActiveX Connector. The HTML Viewer was the preferred option by some of my interviewees, but many of the interviewees never had the opportunity to view the other options due to server-side issues. The Java Viewer offered powerful tools, but the client-side download was not appropriate for the expensive dial-up Internet connections used in Moorea. The custom viewer is a great option for a highly skilled computer programmer. I produced a simple viewer that functioned during testing but failed during implementation due to the need for daily refreshing.

2. Sustainability

Internet-based GIS presents several challenges when considering the sustainability of the site. The three considerations are the development of the website, the marketing of the site to the potential users, and finally the maintenance and updates to the site.

The sustainability of the site depends on a design that takes the community’s needs into account in the development process. The site needs to be user-friendly with a clean, uncluttered appearance and easy identification of links. Versions should be made available in several different languages depending on the target audience. I added a French-language interface but in the future, a Tahitian-language option could permit additional members of the community to participate. Help menus and contact information are important to give the user a means for further assistance when complications arise.

Once the website is up and running, it needs to be marketed to the appropriate audience. In general, a global audience can access any Internet site unless it is restricted
by password or other measures; however, the people of Moorea would have no idea that the 
Moorea Community GIS had been developed unless someone gave them that 
information. The scientific community must be informed as well. When I presented the 
GIS during my interviews, people were excited to see a site had been developed for them, 
but they had no idea it existed prior to my presentation. Education and computer access 
are essential to the marketing.

The final key to the sustainability of an Internet-based GIS site is the maintenance 
of the site. The website will only be useful if it is regularly updated with new data; in 
addition, software upgrades are often required and Internet standards and protocols 
evolve. This requires a site manager with the knowledge and time to maintain the site.

Once people develop an interest in the process, it is vital to provide them with the 
updated information and a stable environment to make Internet-based participation a 
viable option in resource management processes. In my interviews I discussed the 
possibility of the government or research stations hosting this site, and this option holds 
promise for the community of Moorea. The initial setup and configuration of this site 
would require commitment and funding. The extended commitment would require data 
maintenance, software updates, and someone with a degree of technical knowledge.

3. Language and Cultural Barriers

It was quite difficult for me to communicate effectively with the local community 
on the island of Moorea. Many of the scientists and government officials spoke English, 
but it was still difficult to understand idiosyncrasies in the language and culture. I used an 
interpreter for the initial interviews and conducted the GIS evaluation interviews with a 
survey written in both English and French.
4. Internet-based surveys

Internet-based surveys are growing in importance as a method for interview data collection, and the lessons learned in this project are an important methodological contribution to researchers who might consider email surveys. Ultimately, the group of people asked to respond to a survey online must be able to identify with the project or have a rapport with the researcher to warrant a response.

My solution to surveying the international community of scientists was to develop questions that I could email to the recipients around the globe. This type of survey could only serve a particular population. First, that population has to be online. In other words, they have to have email access and check it regularly enough to warrant a response. Second, this population has to trust the source from whence the email came. If they feel that they are receiving “spam” email, they may delete it before opening it.

The advantages to this method of surveying are few but valuable. I was able to reach out to a global community without traveling to their countries. The respondents’ countries of origin included Australia, US, France, New Zealand, as well as others. I did not have to spend time transcribing interviews as I did with the personal communications with other participants.

Internet surveying also has a few constraints. First, the richness of a personal interaction with the respondent is lacking. If a question is misinterpreted, there is no dialogue to promote a more accurate response. Second, the recipient of the email does not feel any obligation to respond, thus leading to a low response rate. Spam email is rampant in this age of Internet communication. Recipients of this email may feel that without the
face value of personal communication they can delete the email freely. Third, the survey must be short to fit within the respondent’s schedule.

I received seven replies out of 30 emailed, and the second attempt I only received two responses through email and two from personal communication out of the 40-50 emails sent out. My methods for increasing the response rate included resending the survey several times and emailing people that I had had some personal communication with and asking them to forward the survey on to others. I emailed the research station directors and asked them to send the survey to other scientists. I also spent some time on Moorea working with the scientists in order to gain a rapport and increase the likelihood that they would respond to my emails or assist me in finding others to respond to my survey. This worked to some extent, but more person-to-person contact is necessary for a higher response rate.

C. Future Research

GIS will continue to be an important element of scientific research and planning in Moorea and elsewhere, and it seems likely that Internet-based GIS will also gain in importance. In order to assess the role of Internet-based GIS, researchers working in Moorea in the future will need to define the elements that make the system a “success” or a “failure.” Once this GIS is implemented and marketed, and after people have acquired the computer access and skills to use it, it will be necessary to determine how many people are actually using it, and in what ways they are contributing to the planning process through public participation. Based on my results, an online system seems likely to facilitate involvement by citizens who are already inclined toward participation;
Internet-based GIS might be considered especially successful if it involves people who previously had no interest in the resource management process.

The key to real success of this project lies in the commitment and enthusiasm of the Internet-based GIS developers and the future users. It will be critical to the sustainability of this system to update and market it as well as provide education and training to the locals. With these elements in place the system has the potential to serve the greatest number of people and support the existing planning process.
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Appendix

A. Preliminary Research Community Survey

I am developing an Internet-based GIS for the community of Moorea. It is interactive systems that allows users to view and print maps and data, and perform GIS analyses such as overlays, buffers, and distance and area calculations. When complete, the website will offer several easy-to-use GIS tools and a form for data to be submitted.

Below are several questions regarding your research interests in Moorea. Your answers to these questions are very important in helping me develop the online interactive GIS. You may answer this questionnaire by email reply. Please feel free to expand on your answers to any of the questions and contact me with any concerns or questions. If you are open to further communication on this issue please let me know. Thank you for your cooperation.

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1. What type of research do you conduct in French Polynesia?

2. Where have you worked in French Polynesia?

3. Is your research on Moorea complete, or will you be conducting more research on Moorea?

4. How do you think your research might be relevant to efforts to protect marine ecosystems?

5. Would you be interested in sharing your research with members of the local community of Moorea (e.g. schools, community associations)? If so how would you go about this?

6. Do you have your research locations geographically recorded? Please explain.

7. Have you used a Global Positioning System (GPS) to mark your study sites? If so, what type?

8. Do you currently use GIS for your research? In what ways are you using GIS?
9. Would you be interested in adding the locations of your published and/or unpublished research sites to the Internet-based GIS (or in having me add them), along with a brief description of what research occurred there? If so, may I follow up on this survey with a telephone interview?

10. Are there any reasons why you might be reluctant to add your published and/or unpublished research data to the community GIS?

11. In which of the following ways would you or might you use the Moorea Internet-based GIS? (Please mark all that apply).
   a. Would not use the Internet-based GIS
   b. To view existing online maps
   c. To print existing maps for personal use
   d. To print maps for other peoples’ use
   e. To create maps showing my own data (including overlays of data onto existing online map layers)
   f. To enter data for sharing with other users of the Internet-based GIS.
   g. Other (please explain)

**B. Community survey questions**

Please take some time to visit the Moorea Community Geographic Information Systems (GIS) site at: [http://niaps.geog.umt.edu/mooreaproject](http://niaps.geog.umt.edu/mooreaproject). Once you have reviewed the site and all of the links from the homepage please proceed with this questionnaire. Your answers will help develop the Internet-based GIS for the community of Moorea, French Polynesia. This survey is part of a Masters Thesis project at The University of Montana and is also part of a larger project to develop a GIS for public participation in resource management planning on the island of Moorea. *Questions for researchers only.

Veuillez prendre le temps de visiter le site de systèmes d'information géographique de la Communauté de Moorea (SIG) à: [http://maps.geog.umt.edu/mooreaproject](http://maps.geog.umt.edu/mooreaproject). Une fois que vous avez passé en revue le site et tous les liens du homepage veuillez procéder à ce questionnaire. Vos réponses aideront à développer les GIS en ligne pour la communauté de Moorea, en Polynésie française. Ce sondage fait partie d'un projet de Maîtrise à l'université du Montana et est également une partie d'un plus grand projet pour développer des SIG pour la participation publique à la planification de gestion de ressources sur l'île de Moorea. *Questions pour des chercheurs seulement.

1. Do you use the computer? How often?
   *Utilisez-vous l'ordinateur ? Avec quelle fréquence?*

2. Do you use the Internet? How often?
   *Employez-vous l'Internet ? Avec quelle fréquence?*
3. To what extent do you use maps?
*Dans quelle mesure employez-vous des cartes ?*

4. How comfortable are you finding things on maps?
*Dans quelle mesure vous sentez-vous a l'aise en cherchant des choses sur des cartes ?*

5. What is your research/area of interest?
*Quel est votre domaine de recherche ou d'intérêt ?*

6. *Do you use GIS tools in your research?*
*Utilisez-vous des outils de SIG dans votre recherche?*

7. *Are you interested in contributing your research data to the GIS?*
*Vous intéressez-vous à contribuer vos données de recherches aux SIG?*

8. After reviewing the Moorea Community GIS website answer the following questions:
*Après avoir passé en revue le site Internet de SIG de la Communauté de Moorea veuillez répondre aux questions suivantes:*

   a. Which method of online mapping do you prefer: *Quelle méthode de projection topographique préférez-vous:*
      
      i. Maps *(These are printable maps, no interaction)*
      *Les cartes (ce sont des cartes imprimables, aucune interaction)*
      
      ii. GIS *(This is the system that provides tools, i.e. zoom and pan, as well as the option to select different layers and then print a map)*
      *Le SIG (c'est le système qui fournit des outils, c'est-à-dire le zoom et le panoramique, aussi bien que l'option de choisir différentes couches et puis d'imprimer une carte)*

   b. Why do you prefer this method?
   *Pourquoi préférez-vous cette méthode?*

   c. What would you use this method of mapping for?
   *Pourquoi emploieriez-vous cette méthode de projection topographique?*

   d. Which of these Internet-based GIS methods do you feel most comfortable using? And why?
   *Lesquelles de ces méthodes de SIG en ligne vous sentez-vous le plus à l'aise à employer? Et pourquoi?*
      
      i. HTML Viewer
      ii. JAVA Viewer
      iii. ActiveX Connector
e. How often do you see yourself using this website?
   *Avec quelle fréquence employerez-vous ce site Internet?*

f. What would you change about this site?
   *Que changeriez-vous dans ce site?*

g. What do you really like about this site?
   *Qu’aimez-vous dans ce site?*

9. Are you interested in obtaining more education in the use of computer/Internet or GIS tools?
   *Vous intéressez-vous à obtenir plus d'éducation dans l'utilisation de l'ordinateur/Internet ou des outils de SIG?*

10. Is there another way that you may be interested in using GIS besides this website?
    *Y a-t-il une autre manière qui vous intéresserait à employer des SIG à part ce website?*

11. Do you participate in the resource management process in Moorea? Why or Why not?
    *Participez-vous au processus de gestion de ressources dans Moorea? Pourquoi ou pourquoi pas?*

12. How do you participate in the resource management process in Moorea?
    *Comment participez-vous au processus des gestion de ressources dans Moorea?*

13. What might be a way that you could be more involved in the resource management process in Moorea?
    *De quelle manière pourriez-vous être plus impliqué dans le processus des gestion de ressources dans Moorea?*

14. Comments or Questions?
    *Remarques ou questions?*

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**C. Government/Research Station Director Interviews**

1. How do you work with the community on resource management planning issues?
   *Comment travaillez-vous avec la communauté sur des questions de planification de gestion des ressources?*

2. Do you use the Internet?
   *Employez-vous l'Internet?*

3. Do you communicate with the public through the Internet?
   *Communquez-vous avec le public par l'Internet?*
4. In what ways do you communicate with the public through the Internet?
De quelles manières communiquez-vous avec le public par l'Internet?

5. Do you use GIS?
Employez-vous des SIG?

6. Are you interested in providing GIS data to the community?
Vous intéressez-vous à fournir des données de SIG à la communauté?

7. In what ways are you interested in providing GIS data to the community?
De quelles manières vous intéressez-vous à fournir des données de SIG à la communauté?

8. Do you use Internet-based GIS?
Employez-vous des SIG basés sur Internet?

9. Do you think Internet-based GIS could help the community participate in resource management? (Yes/ No, In what ways?)
Pensez-vous que des SIG basés sur l'Internet pourraient aider la communauté à participer à la gestion des ressources? (Oui/ non, de quelles manières?)

10. Would you be interested in hosting an Internet-based GIS system?
Vous intéresseriez-vous à accueillir un système de SIG basé sur l'Internet?

11. Would you be interested in providing the community with a public access computer with Internet access for them to use the Moorea Community GIS?
Vous intéresseriez-vous à fournir un ordinateur public avec accès à l'Internet à la communauté afin qu'elle puisse employer les SIG de la Communauté de Moorea?

12. Would you be interested in providing GIS training and education?
Vous intéresseriez-vous à fournir la formation et l'éducation de SIG?

13. Comments or questions?
Remarques ou questions?