

Survey of Science Communication in Developing Pacific Island Nations

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Declaration

I certify that this thesis does not incorporate without acknowledgement any material previously submitted for a degree or diploma in any university; and that to the best of my knowledge and belief it does not contain any material previously published or written by another person except where due reference is made in the text.

Thomas James Hammond

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Abstract

The developing nations of the Pacific Islands face a number of issues as they move towards economic and environmental sustainability. The application of science and scientific knowledge can be valuable in addressing these problems, and moving the region towards a more stable future. However, science can have little impact unless it is effectively communicated to relevant audiences.

Science communication is a relatively new and developing discipline. It is concerned with the context in which information is delivered, and the processes by which knowledge is accepted by different groups in society.

I completed an introductory study of the attitudes of scientists based in the Pacific towards science communication. To study the processes by which scientists produce, and subsequently communicate, their science, I invited scientists within the region to complete a short online survey. The survey asked respondents their attitudes towards science communication, the outcomes of their science, and their opinions on the overall success and quality of science communication in the region.

Results from the survey indicate a high regard for the importance of science communication, and a general consensus that the quality and reach of science communication in the Pacific is poor. Reasons suggested for the weakness of Pacific science communication include the lack of facilities and infrastructure across the Pacific for broadcasting information, low levels of scientific literacy within the population, poorly managed networks of information exchange between scientists, and limited training and support of scientists in the communication of their work. Respondents varied in the manner in which they regarded aspects of their work to be characterised as 'practical outcomes'. This suggests a need for more long-term studies looking at the scientific process from development of concepts, through data collection, communication and ultimately implementation.

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Chapter One

Introduction & Literature Review

Background to the Pacific

The Pacific Islands cover a vast area of ocean and vary from tiny, uninhabited atolls to larger landmasses such as Fiji, Vanuatu and Papua New Guinea. The islands have a total population of approximately eight million people, and encompass considerable cultural, political, geographical and economic diversity (Chape, 2006; South et al., 2004). Sustainable development is a key issue in the Pacific; poverty is an issue throughout the islands, and the introduction of economic development to reduce poverty may come at the cost of environmental wellbeing. This pressure on the environment is exacerbated by global climate change, a growing problem to which Pacific Island nations may be particularly vulnerable (Barnett, 2001). The relationships between poverty, environment and development are complex (Nukuro, 2000), and development must be applied in a manner that will alleviate poverty and improve living conditions, while preserving the natural environment.

The appropriate application of science and technology can assist the process of achieving sustainable development (Kuijper, 2003; Perera & Lamberts, 2006; Richmond et al., 2007). Aid efforts for several decades have focused on the application of scientific discovery or the implementation of technology in the developing world. However, there is a growing consensus among commentators on the aid process that this process has largely failed (Chape, 2006; Richmond et al., 2007; Seely & Wöhl, 2004). Science and technology cannot simply be transferred into a society with its own values, cultural, and knowledge systems. Theories of communication tell us that the dissemination of knowledge should be a two-way process; successful uptake requires an understanding of how knowledge can fit into

society, how it can be of most use, and how it can be adopted to ensure its perpetuation and its dispersal through the society (Rogers, 1983). In this study, I investigate the attitudes and behaviours of scientists in the Pacific towards the communication and ultimate implementation of their work.

The term ‘Pacific Islands’ can be a source of some confusion, and will retain some ambiguity when defined. In this study, I am focusing on independent nations and territories with some degree of self-government in the southern portion of the Pacific Ocean – predominantly, but not exclusively, from the southern hemisphere. As my research has focused on the activities of intergovernmental agencies serving the Pacific Islands region, a list of nations and territories served by those agencies has been used as the basis for a functional description of what is implied by the term ‘Pacific Islands’. Put simply, independent nations and overseas territories of other countries (France, New Zealand and the United States) are included, while incorporated states such as Hawai’i are not, due to their remarkably different political and economic environments. Countries bordering the Pacific or more closely associated with Asia are not included. Member nations of Pacific intergovernmental agencies that are involved with funding and administration, rather than receiving services – namely Australia, France, New Zealand and the United States – are not considered in the description of ‘Pacific Islands’. The 22 nations and territories that are relevant to this study are displayed and listed in Table 1 and Figure 1, both following.

Table 1. Countries and territories that are considered as part of the Pacific Islands.

Name	Political association
American Samoa	Unincorporated Territory of US
Cook Islands	Nation in free association with NZ
Federated States of Micronesia	Nation in free association with US
Fiji	Independent Nation
French Polynesia	Overseas Collectivity of France
Guam	Unincorporated Territory of US
Kiribati	Independent Nation
Marshall Islands	Independent Nation
Nauru	Independent Nation
New Caledonia	Overseas Territory of France
Niue	Independent Nation
Northern Mariana Islands	Commonwealth in Political Union with US
Palau	Independent Nation
Papua New Guinea	Independent Nation
Pitcairn Islands	Overseas Territory of United Kingdom
Samoa	Independent Nation
Solomon Islands	Independent Nation
Tokelau	Colonial Territory of New Zealand
Tonga	Independent Nation
Tuvalu	Independent Nation
Vanuatu	Independent Nation
Wallis and Futuna	Overseas Collectivity of France

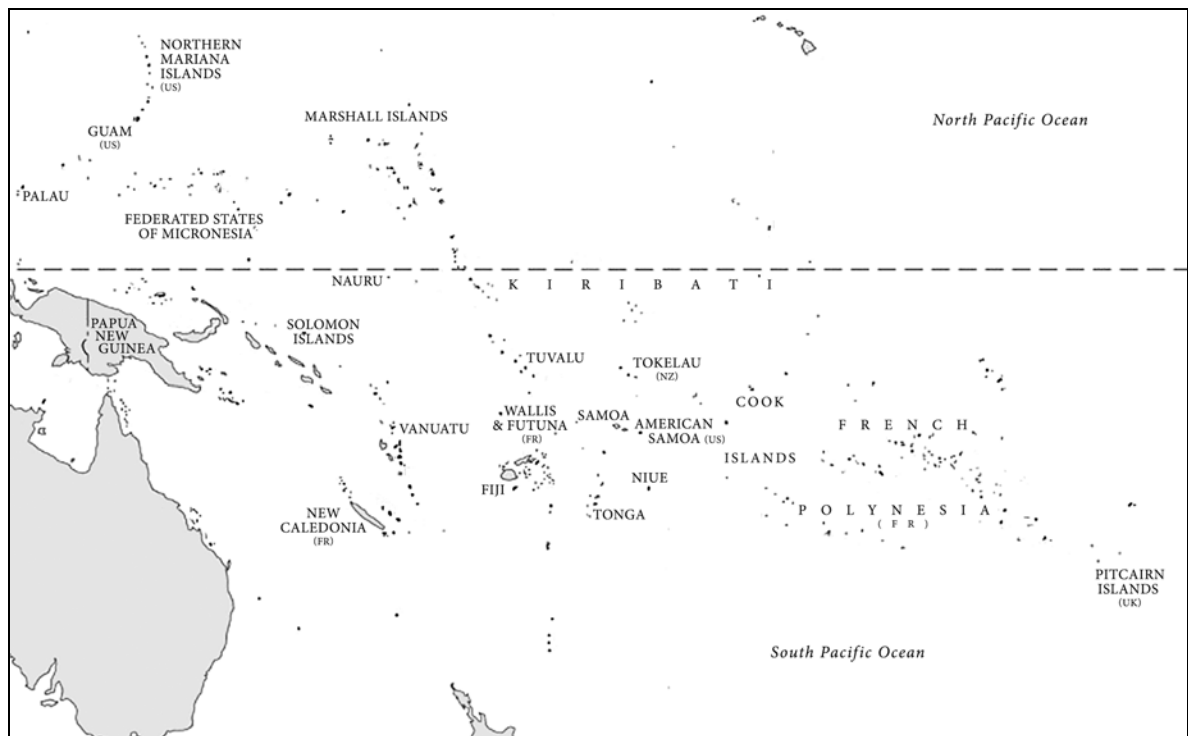


Figure 1. The Pacific Island Nations. Adapted from *The Contemporary Pacific* (2007).

The issues facing the Pacific Islands are complex and can be viewed from a number of perspectives. Central to all discussions of local problems lies the interaction between the population and the environment. Subsistence living is common in the Pacific (AusAID, 2006; South et al., 2004; Veitayaki & Novaczek, 2005), which limits the scope for economic growth from other sources and provides pressure upon the immediate environment. This complicates the relationship between environment and poverty: the population is dependent upon the immediate environment, but can also have harmful effects on it. As human pressures on the environment increase, the living that may be extracted from the environment is reduced (Nukuro, 2000). This is at the heart of sustainable development – movement towards a greater standard of living, without damaging the environment or affecting the future potential to draw a living from environmental resources (Kavaliku, 2000; Nukuro, 2000).

There has been a long-held view that when common resources – such as parts of the natural environment – are in limited supply, they will become overused and exploited (Hardin, 1968). Nadkarni (2001) refutes this theory, attributing most environmental degradation to

outside intervention – such as cattle grazing in South America for inefficient North American use, and over-fishing of oceanic fish stocks by large mechanised fleets. Nukuro (2000) points out that development in the Pacific Islands can be ‘held back’ by the pressure that it creates on the environment; a process of negative feedback, or a ‘vicious circle’ effect. Certainly, some effects of economic development, such as increased urbanisation and a removal from the traditional systems of resource stewardship, can create pressure on the natural environment if unchecked (South et al., 2004). Further understanding of the nature of poverty, different forms of poverty, different mechanisms of development, and the complexity of relationships between poverty, development and the environment must occur before policy can be fully utilised to address these issues (Hayes, 2001). Sustainable development, therefore, is development activity that fits the model of a ‘virtuous circle’ (Nadkarni, 2001), benefiting both poverty alleviation and the environment.

Sustainable Development

South et al. (2004) describe the major concerns for the Pacific Island region as global environmental change, shortages of fresh water, unsustainable fishing practices, modification of habitats, changing community structures, and pollution. Broadly, these issues can be considered within two major spheres: pressures on population health, and pressures on the environment. This classification is not intended to be mutually exclusive, as many of the individual problems facing the region arise from interactions between the two. Individual aspects of the quest for sustainable development, such as fisheries management, increased agricultural efficiency, or the conservation of a unique habitat, have implications towards the health and wellbeing of both the population and the environment. Sustainable development is a somewhat contested term that can tend towards meaningless rhetoric (Pretty, 1995). In a realistic sense, ‘sustainable development’ should perhaps be considered as the eradication of any or all of these issues, without exacerbating others.

Population Health

Health problems regularly coincide with poverty, and aspects of the two can be considered as both cause and effect of one another (Finau, 1996). Hughes and Lawrence (2005) describe three direct causes – within a greater suite of underlying causes – of poor health in the Pacific. A shift away from traditional ways of life has led to a marked increase in lifestyle diseases, particularly obesity and various related illnesses such as heart disease and diabetes. An increase in urbanisation over recent decades, and accompanying poor housing standards and hygiene, have led to problems with communicable diseases such as gastro-enteric infections, diarrhoea, and viruses. There is a lack of health services in the more remote and isolated areas of the Pacific, which leads to a greater frequency and severity of illness.

Lifestyle diseases are particularly salient to a discussion of science communication, as they are largely preventable through public awareness and education programmes. Obesity is at epidemic levels in Pacific Island nations (Hughes & Lawrence, 2005). Contributing to the obesity epidemic is a movement away from the diet and activities of traditional island life (Finau, 1996). Pacific people have become more urbanised and sedentary, and diets have been heavily compromised by the influx of high-fat foods of low nutritional value from developed markets (Hughes & Lawrence, 2005). A life of poverty can lead to stress, mental illness, alcohol and tobacco abuse, and associated violence, accidents and other misadventure.

Communicable diseases are prevalent, resulting from poor hygiene and waste management common in areas suffering from poverty (Nukuro, 2000). Sources of fresh water throughout the islands are limited and often carry disease. Diseases such as tuberculosis persist, despite being controllable and virtually absent from the developed world (Secretariat of the Pacific Community, 2007). HIV/AIDS is a problem throughout the Pacific, and is present at an alarming rate in Papua New Guinea (Rupali et al., 2007). Other sexually transmittable diseases are particularly prevalent in Kiribati, Vanuatu and Samoa (Rupali et al., 2007). Poor infrastructure for detection and communication could make the Pacific particularly

vulnerable to future epidemic outbreaks of diseases such as SARS or avian influenza (Perera & Lamberts, 2006).

While medical research continues to be dominated by the developed world, public health research in the Pacific Islands has focused on social programmes and behaviour change (Perera & Lamberts, 2006). There exists an important role for science and science communication in arresting the spread of disease and improving the health of Pacific populations. By communicating the benefits of a healthy lifestyle, obesity and related diseases can be minimised. By applying technology to infrastructure, the safety of water supplies can be increased, and waste can be managed more effectively. Greater health infrastructure and communication within the region could have benefits in preventing future outbreaks of communicable disease.

Across the Pacific there is a range of health issues, which are addressable through the implementation of technology, increased coordination and infrastructure in monitoring disease outbreak, and the communication of the benefits of a healthy lifestyle. While the developed world continues to fight disease and health problems at the forefront of science – for example, using molecular genetic techniques to fight cancer, authorities in the Pacific must rely on older technologies and simple communication and coordination to fight many of the health problems that pervade the region. Of course, many of the lifestyle issues that need to be addressed in the Pacific – such as obesity or substance abuse – are also prevalent throughout the developed world. However, such problems do appear with much greater intensity in parts of the Pacific, often occurring alongside poverty as both cause and effect.

Environment

Ever since the Pacific Islands were first colonised from Southeast Asia, humans have been changing the local environment to suit their way of life (Burt & Clerk, 1997; Chape, 2006). Along with the rest of the world, environmental impact and damage has accelerated over the past century. The geography of many Pacific Island nations, in particular the smaller atolls, predisposes them to environmental problems such as species extinction and ecosystem collapse (Chape, 2006). Local environmental impacts, combined with global

environmental change, form serious threats to the quality of life in the Pacific. Environmental issues exist in a complex interrelationship with both poverty and development (Chape, 2006; Kuijper, 2003; Nadkarni, 2001; Nukuro, 2000). In some instances, poverty causes environmental harm, such as through the use of destructive or inefficient agricultural or fishing practices. In other cases, development and a move away from a custodial relationship with the land causes greater environmental harm as pollution and poor waste management have an impact. Dealing with environmental issues as development progresses must take two approaches: dealing with and managing existing issues, and preventing further harm or degradation.

Nukuro (2000) describes population growth having environmental impacts on scales ranging from local watersheds, through to wider impacts on entire economic zones, to global effects. Local effects include pollution, poor waste management and destruction of local habitat. The wider, national or economic zone effects include overfishing and wider habitat damage. The most notable global effect of Pacific populations is their contribution to global warming – while per capita impact of Pacific peoples on carbon emissions is lower than the western world, the effects of global warming are likely to have great impact on life in the Pacific Islands.

The management of waste is a notable problem in the Pacific, arising from population growth and poor infrastructure. In this sense, ‘waste’ may refer to solid waste such as rubbish and refuse, sewage and animal wastes, and chemical pollutants from industry. Waste management becomes especially relevant to the Pacific region due to most nations’ lack of land area and the limitations of fresh water supplies (Chape, 2006). Poorly treated sewage, combined with unregulated disposal of animal waste has led to dangerously high levels of faecal coliform bacteria in island lagoons and associated inshore food sources such as shellfish (Nukuro, 2000). Programmes of recycling or reduction of solid waste are limited, and processing usually involves burning, dumping in the sea, or burying in increasingly limited land space (Nukuro, 2000). Poor treatment of both solid waste and sewage affect limited freshwater supplies, and consequently cause public health problems (South et al., 2004). Hoffmann (2002) demonstrates the harmful effect of pollutants released by agriculture and industry on the health of coral reef ecosystems in Fiji and the

Cook Islands. Hence poor waste management infrastructure and systems are a problem with particular impact in the Pacific region; the effects include ecosystem destruction and problems with public health. These problems could be minimised through effective education and the application of processing technologies.

Fisheries, both coastal and oceanic, are extremely important resources in the Pacific. Inshore fisheries play a vital role in the nutrition, health, and culture of local people (Hughes & Lawrence, 2005; South et al., 2004; Veitayaki & Novaczek, 2005). Offshore, oceanic fisheries draw only limited economic benefit to the Pacific Islands, as fish are collected by foreign vessels and processed at foreign ports (Clark, 2006). Ultimately, there is little conclusive data concerning the health of fisheries (South et al., 2004; Veitayaki & Novaczek, 2005), although there is evidence that oceanic fisheries are in decline due to non-sustainable rates of fishing (South et al., 2004). Coastal fisheries are threatened by both overfishing and habitat destruction. Given the importance of fisheries in the life, wellbeing, and economic future of Pacific Islanders, the environmental pressures on fisheries must be contained.

Offshore fisheries are in danger of collapse unless greater measures are taken to monitor their ongoing health and understand their dynamics. Pacific Island nations are afforded huge areas of ocean for exclusive economic control (Chape, 2006). Unfortunately much of this resource is harvested by foreign fishing fleets that pay minimal licensing fees to fish the areas, and then gain the economic benefits of post-catch processing and exporting (Clark, 2006). There is limited monitoring of fisheries stocks, which leads to uncertainty regarding their current status, and observation and enforcement of sustainable practices is also inadequate (South et al., 2004). Overall there is a lack of information concerning the current status and the future outlook for Pacific oceanic fisheries. With greater investment in monitoring and the development of sustainable practices, Pacific Island people could start to access the economic benefits of oceanic fisheries.

The issues facing inshore fisheries are perhaps more complex, yet simpler to control. The vast majority of coastal fishing is traditional subsistence living (South et al., 2004). Similarly to oceanic fisheries, there is a paucity of hard, scientifically reliable data to

determine the true state of inshore fisheries and develop management plans (Veitayaki & Novaczek, 2005). Inshore fisheries are under pressure from overfishing, caused by both a push to fish using more advanced techniques and equipment, and to fish for economic gain rather than simple subsistence (South et al., 2004). Waste management and pollution, as described above, can harm local marine ecosystems, and thus reduce the output level at which the ecosystem can be sustainably harvested (Hoffmann, 2002). Destructive methods of fishing, such as explosives, poisons, and physically breaking coral cause great harm to the ecosystems supporting the catch (Crosby, Brighthouse, & Pichon, 2002). This showcases the great tragedy of poverty – such habits persist out of a need to survive and to attempt to break out of poverty, but only serve to damage future prospects and hence maintain, or worsen, existing standards of living. Destructive and unsustainable practices need to be addressed through public education and the adoption of alternative, sustainable practices and technologies.

It is worth mentioning that gains have been made in recent years in improving the sustainability of some inshore fisheries. The Locally Managed Marine Areas (LMMA) Network¹ is a project that has linked science and local culture in caring for and monitoring inshore marine areas. The LMMA Network, and similar projects involving Marine Protected Areas (MPA) has used the participation of local people to combine local knowledge and traditional stewardship of marine areas with modern scientific approaches to conserving and monitoring (Aalbersberg, 2003; Aswani & Hamilton, 2004; Veitayaki, Aalbersberg, & Tawake, 2003; Veitayaki, Aalbersberg, Tawake, Rupeni, & Tabunakawai, 2003). There are indications that these projects have resulted in the re-establishment of coral reef ecosystems (Drew, 2005). Such projects are valuable in showing the means by which scientific methods can be communicated and integrated with traditional practices, for a positive outcome.

The land-based primary industries, agriculture and forestry, have environmental impacts as described above: through the effects of waste and pollutants on inshore marine ecosystems, and on fresh water supplies. The use of limited land resources for primary production

¹ <http://lmmanetwork.org/>

threatens natural forest and other ecosystems and their related biodiversity (Chape, 2006). Infrastructure associated with these developments, such as roads and dams, can be responsible for significant rates of soil erosion (South et al., 2004). These industries clearly have a role to play in the future of the Pacific Islands both for supporting the population and for earning export income, but given the scarcity of land on many islands, they can have excessive environmental and public health effects, and must be undertaken in a sustainable manner, which involves understanding, and planning for, the risks involved.

Climate change is potentially the greatest threat to the wellbeing of the people of the Pacific Islands. During the second half of the twentieth century, sea levels in the Pacific have risen by approximately 2 mm per year, with this rate expected to increase dramatically (Barnett, 2001; Church, White, & Hunter, 2006). Atoll islands, such as those of Tuvalu with a maximum elevation of only a few metres above sea level, are particularly vulnerable to sea level rise, which may result in swamping – and ultimate disappearance of entire inhabited islands. Further effects of sea level rise are the loss of large amounts of coastal land, an increase in the damage caused by storm surges, and the potential loss or serious damage to marginal coastal ecosystems such as mangroves (Gilman et al., 2006). The loss of coastal ecosystems could lead to further flow-on effects such as erosion, the loss of breeding and spawning sites for marine species, and subsequent loss of biodiversity (Gilman et al., 2006). Climate change is predicted to increase the frequency and severity of tropical storms, which can damage infrastructure, threaten food storage or supplies and cause outbreak of disease (South et al., 2004). Such effects are magnified by the isolation of islands within the Pacific. Uncertainty – amongst both scientists and the layperson – concerning climate change is one of the greatest threats to adequate preparation (Barnett, 2001). While climate change is a problem that has been caused by the entire global community, its effects may be felt particularly harshly in the Pacific. The role of science and its communication is to eliminate uncertainty as far as possible, and to engage the community and policy makers to improve resilience for what is shaping to be the greatest challenge to the Pacific region.

Chape (2006) describes the range of approaches to environmental issues in the Pacific from the 1990s until today, and concludes: “Has this analytical, strategic and policy work made a

difference to the state of Pacific environments? Unfortunately, current evaluations of environmental conditions throughout the region suggest not.” (ibid., p. 10). It is difficult to assess the root causes of this pessimistic take on the current state of Pacific environments. However, we must consider this statement and try to understand how future efforts to make positive changes can become more effective.

The Role of Communication

Many of the problems of human society and the environment that we observe in the Pacific are solvable, or at least addressable. Modern science and technology may contain some answers, and also may contain some methods and processes by which solutions can be sought. It is the application of science within society that can make a positive contribution to the problems facing the region. Science alone will not provide any solutions; they must be sought in consultation with stakeholders across the community, whether they are members of a local community, the public, business, or political leaders. At the heart of this consultative process is mutual communication of knowledge between all stakeholders. To communicate science effectively, there must be an understanding of the target audiences within society and the associated social, cultural and knowledge landscape.

Thus the role of the scientist or scientific organisation in the Pacific is to create a product that is usable and applicable to solve a problem. This involves all facets of the scientific process, from initial conceptualisation of a problem to its final implementation or communication. Audiences and stakeholders must be understood, and the cultural setting of the intended outcome must be amenable to the entire process. The role of science communication is to increase the two-way flow of knowledge and understanding between the scientist and the other stakeholders in the community. The ideal scenario is one of partnership and dialogue within the community, whereby the greatest positive outcomes may be reached.

Human society can manage environmental issues in two different ways: top-down or bottom-up management (Diamond, 2005). Top-down management is common in larger

societies, particularly in the western world, where management is achieved by the enactment of orders, or laws, to control the behaviour of citizens. Bottom-up management describes people working together to solve an issue, and is more suited to situations where individuals can be directly affected by, or at least understand, the consequences of their actions. Rogers (1983) discusses similar concepts, and raises the distinction between centralised and decentralised diffusion of innovation. Centralised diffusion requires that dissemination of information is controlled and managed by a central body or agency. Decentralised diffusion relies on ideas spreading horizontally from person to person within existing social networks. Both of these paradigms are useful in conceptualising the communication of science into outcome in the developing world.

From the perspective of science communication, top-down control, or centralised diffusion, requires effective communication of science to governing bodies. Bottom-up control and decentralised diffusion require that the population have an understanding or awareness of the issues, and how they relate to one another. The ideas of public understanding and awareness of scientific issues are discussed in greater detail following.

Science, Policy and Management

Effective communication of science to governing bodies or policy-makers is essential for top-down management to work. Kinzig et al. (2003) argue that science and policy are built upon different goals and agendas, and call for the establishment of closer ties, more common goals, and clearer communication between the two. Similarly, Delaney and Hastie (2007) describe fisheries scientists and fisheries managers as occupying different ‘cultural spheres’, resulting in communication that is typified with “frustration and conflict” (ibid., p. 662). Scientists, managers and bureaucrats all have divergent cultural understandings and institutional constraints, which affect both their actions and their ability to communicate with one another. Richmond et al. (2007) bemoan the lack of positive examples where science, policy, and management successfully work together to reverse trends of coral reef destruction. In order to produce effective top-down environmental management, greater dialogue and two-way communication must occur between scientists and governing bodies.

Differences in outlook and culture must be understood by both parties in order to achieve common goals.

Juma and Lee-Cheong (2005) discuss the need to apply recent innovations in health to the developing world. In their strategic outlook, they directly call upon government structures to become aligned with research initiatives; they call upon providers of medical knowledge to provide advice through “transparent and systematic processes” (ibid., p. 365) and to combine with other knowledge sources, including public consultations; and they call upon international organisations to expand the application of science and technology and to promote innovation.

In their study of implementation of conservation science and policy for the protection of coral reefs, Richmond et al. (2007) note that “Several Pacific islands, with intact resource stewardship and traditional leadership systems, have been able to apply research findings to coral reef management policies relatively quickly” (ibid., p. 598). Expanding on this observation, we see that the social structures within Pacific society can contribute to the implementation of science in both top-down and bottom-up management structures. In some traditional Pacific cultures, traditional resource stewardship principles tie people and their families closely with the surrounding environment. This gives them a greater understanding of their own relationship with the environment, and can assist in the process of bottom-up management (Drew, 2005). Traditional local leadership systems, often patriarchal systems based around heritable titles, have a degree of autonomy and a recognised form of governance in some Pacific Island nations. By communicating with the local leadership structures, it appears possible to implement top-down environmental management, albeit on a small scale. As mentioned earlier, traditional society in the Pacific is being lost in a gradual move towards urbanisation (Crosby, Brighthouse, & Pichon, 2002). However, the traditional society that does remain can help to facilitate local environmental management, and can lead to more effective environmental management than in developed, western nations such as Australia and the US (Richmond et al., 2007).

The science communication literature is dominated by studies of science in the public, rather than science that is communicated to non-public audiences, such as government,

business or other scientists. The conceptualisation of science within society is the key to its being accepted by society – either through top-down or bottom-up management. Noting this, I do not discount the communication of science to audiences outside of the public. For example, we can consider the communication of science-related information to governments or governing bodies to assist with management. Communication also occurs between scientists, which can take several forms, such as publishing in journals or speaking at conferences, or more informal conversations between scientists. Between-scientist communication can be represented by the networking of scientists working in a common field, or may occur between scientists from disparate fields working together in a cross-disciplinary approach to a problem (Hviding, 2003). While the following literature focus is on science communicated into the public domain, I do not imply that this is the only, or even the most important mode of science communication.

Science Communication to the Public

Science communication is a relatively recent and growing phenomenon as both an endeavour and a field of study (Burns, O'Connor, & Stocklmayer, 2003). Science communication is defined by Burns et al. (2003) as being any process that aims to produce awareness, enjoyment, interest, opinions or understanding of science. The parties involved in communication activities in this definition may include science practitioners, mediators, or members of the public. Science communication can occur between or within any of these groups. Bryant (2006) defines science communication as “...the process by which the scientific culture and its knowledge becomes incorporated into the common culture.” At present, there are many different definitions of science communication, and many varied examples of what can be characterised as science communication.

In this study, I am explicitly looking at the role of science communication in the development process in the Pacific Islands. To this end, I consider science communication to be all processes by which scientific knowledge or culture is transferred throughout society. The major groups involved in this process are the scientific community and science communicators, facilitators and extension workers; journalists; the government or governing bodies; relevant organisations such as community groups or development

agencies; and the public. For the purposes of this study, science communication is the transfer of scientific knowledge or culture between or within any of these groups.

The academic study of science communication focuses on science and its culture within the broader contexts of society, and how that can affect its uptake by the public. Clearly, ideas in science communication such as ‘uptake’ and ‘effectiveness’ exist only in the context of desired outcomes; we cannot measure effectiveness without first knowing what effect is desired. With regards to this project, and the broader attempts to use science as a key platform of sustainable development in the Pacific, we need to focus on outcomes related to the uptake or implementation of science to address sustainable development issues.

The outcomes of communicating science to the public are typically described in terms such as public understanding of science, science literacy, or public awareness of science. Public understanding of science is typified by people understanding the content of science (facts or theories), the scientific process, and the position of science in a wider social milieu (Burns, O’Connor, & Stocklmayer, 2003). Science literacy is defined by Burns et al. (2003) as an understanding of the principles of science and their application in everyday life; these authors consider it to be the result of formal schooling. Other authors (Laugksch, 2000; Treise & Weigold, 2002) consider public understanding and science literacy as different parts of a conceptual whole; Laugksch sees the two concepts as being synonymous, while Treise and Weigold consider science literacy to be one part of the wider concept of public understanding of science.

Public awareness of science has a greater focus on informal learning modes, away from the classroom of primary, secondary or tertiary schooling (Burns, O’Connor, & Stocklmayer, 2003). It may arise through day-to-day activities, hobbies, or recreational activities such as visits to a science museum, zoo, aquarium, or other similar activities (Rennie & Stocklmayer, 2003). Public awareness of science does not have the same focus on knowledge or process that is inherent in public understanding or science literacy; it is the presence of positive attitudes towards science and technology, and a willingness to adjust behaviour based on one’s knowledge of science and technology (Stocklmayer & Gilbert, 2002). There is no consensus on the ultimate aim of science communication (Lewenstein,

2003b), but we can assume that one outcome of an increased public awareness of science is a greater willingness of the public to accept science-based advice and technological solutions to problems.

Models of Science Communication

Lewenstein (2003b) describes a four-stage model of communicating science and technology to the public. They range from simplified, one-way communication designed to fill a shortfall in the receiver's knowledge, through to models of public participation, with two-way transfer of information and uptake based on hands-on experience of knowledge. The four stages of Lewenstein's model are outlined below.

The Deficit Model

One-way communication of information that will be absorbed by the audience to fill a 'deficit' or gap within their own body of knowledge.

The Contextual Model

Acknowledges that the context in which information is presented, and the social context of those receiving information, will have major influences on how a message or information is received.

The Lay Expertise Model

Holds that forms of knowledge other than scientific or technical knowledge may be equally or more relevant to solving a problem. Examples of such lay knowledge include that held by local, indigenous or vocational groups.

The Public Participation Model

Focuses on increasing public trust and involvement in science by involving the public in activities such as dialogue, planning, technology assessment, or environmental monitoring.

The deficit model has been used by a number of authors (Wynne, 1991; Ziman, 1991) to describe knowledge transfer designed to fill a shortfall in the public's knowledge base. This

concept arose from claims of a lack of understanding of science by the public. As people did not ‘understand’ science, it was seen that they had a deficit, or shortfall, of knowledge that should thus be filled (Burns, O’Connor, & Stocklmayer, 2003). This is a highly simplified model of communication: there is no scope for feedback from the receiver of the information to the sender of information, no appreciation of the psychological processes that may accompany the uptake of information by the receiver, or the context in which the knowledge is delivered (Lewenstein, 2003b).

More advanced models of science uptake recognise that communication is a two-way process, and integrate traditional teaching and learning scenarios with informal learning experiences, contextualisation, and dialogue (Rennie & Stocklmayer, 2003). The contextual model takes account of the context in which information is delivered. That is, a consideration of the social context of the information exchange, and the manner, or medium, in which the information is broadcast are all relevant to how information is accepted by audiences. The lay expertise model attempts to assimilate scientific knowledge delivered to a group with technical knowledge that they may already hold, such as indigenous knowledge regarding the local environment. The role of this model and traditional or indigenous knowledge in the Pacific Islands is expanded upon below. The final model of science communication described by Lewenstein is the public participation model, which describes a two-way process as a means of involving the public, allowing public input into science and thereby giving the public some ownership of the science and scientific decisions.

Models of science communication have also been borrowed from the public relations literature. Grunig and Hunt (1984) built a series of models based on a progression from broad-based, one-way communication through to a two-way, dialogue-based approach. Importantly in Grunig and Hunt’s schema are the one-way ‘public information’ models, where information is targeted to specific audiences, much in the manner of Lewenstein’s contextual model. Grunig and Hunt include two forms of ‘two-way’ communication models, the asymmetric and the symmetric. The asymmetric approach involves some research of audiences and their feedback to a communication event; the symmetric

approach is closer to a true dialogue or public participation approach: a theme discussed later, in the context of Pacific Island development.

As noted by Lewenstein (2003b), the models of science communication that have been suggested provide a schematic tool for understanding the communication process, and should ideally be integrated and applied to specific communication activities. It is best not to view the multitude of models and viewpoints of science communication as a series of contradictory statements; neither are they a progression towards an ‘ideal’ model. Any communication event should combine relevant pieces of the various models. Lewenstein (2003b) gives the example of the benefits of the one-way deficit model: a person travelling to China may be inclined to visit a website to find information (i.e., to fill a knowledge deficit) regarding local health precautions.

Contextual and two-way models of communication recognise that learning and assimilating information is a dynamic process. The field of constructivism presents a paradigm for understanding the learning process as interactive, rather than passive (Stocklmayer, 2001). In summary, constructivism accepts that all people have constructs and ideas of how the world works – including many misconceptions (Yager, 1991). When a person is taught or exposed to a novel concept, it may agree or disagree with previous constructs that the person has accumulated – either through previous learning experiences, cultural beliefs, or previous interactions with the world (Bencze, 2007). Cultural understandings and values, religious beliefs, traditional knowledge and simple resistance to new ways of thinking must all be considered when attempting to transfer knowledge to any audience. Thus, under constructivism, science communicators must understand the mindset of the intended audience for the information. By extension, we can see that if we are to know the knowledge base of our audience, we must first know who our audience are, and what relevant beliefs or knowledge systems must we therefore interact with.

Tacconi (1997) compares constructivism with the positivist viewpoint of western science. Positivism suggests that there is one ‘truth’ that can only be achieved through the process of science. Tacconi, applying ecological economic theory to biodiversity preservation in Vanuatu, argues that the constructivist paradigm provides the best means of approaching

environmental issues in the developing world. In practice, constructivist methodologies in sustainable development are associated with communication activities such as uptake of traditional knowledge and participatory methods.

Traditional Knowledge

Modern science cannot be considered as the only, or even the most superior form of knowledge that we have. When considering the application of science in the developing world, we must consider the often specialised traditional knowledge of the local people (Briggs & Sharp, 2004; Drew, 2005; Hviding, 2003; Johannes, Freeman, & Hamilton, 2000). Traditional knowledge often contains valuable information that can be used alongside western science in an integrated approach to a problem. Further, knowledge from a scientific study must be implemented in a manner that will not conflict with local understanding or custom.

Given the focus of this study on developing Pacific Islands, I use the term ‘traditional knowledge’ to refer to the body of knowledge held by local groups, built over many generations. Similar terms used within the literature are ‘indigenous science’ (e.g., Snively & Corsiglia, 2000) or ‘indigenous knowledge’ (e.g., Hviding, 2003). Often, the knowledge concerns environmental activities or interactions, hence the terms ‘indigenous ecological knowledge’ (e.g., Aswani & Lauer, 2006), or ‘traditional ecological knowledge’ (commonly abbreviated as ‘TEK’; e.g., Drew, 2005) are common, both referring to a specific subset of traditional knowledge. Although traditional knowledge is often associated with indigenous groups, it can be associated with other groups in society sharing a common link, such those involved in vocational or recreational fishing (Aswani & Lauer, 2006; Costa-Neto, 2000; Johannes, 2002).

A contest or competition between western science and traditional knowledge is not the best manner to approach the coexistence of the two sources of knowledge or understanding. We should not hold a presumption of the superiority of western science (Briggs & Sharp, 2004), and neither should we discount its effectiveness. Rather, we should look at the relative strengths and weaknesses of the two. Interestingly, when compared side-by-side,

we can see that the two forms of knowledge share many common features, such as their iterative nature, and their parallel yet distinct use of constructs such as ‘biodiversity’ (Hviding, 2006).

We must consider the nature of modern, western science. Manzini (2003) compares the view of science as a ‘body of knowledge’ with science as “...an ongoing rational effort to discover the workings of the physical world” (ibid., p. 192). Expanding on this, science can be seen as both the process and the resultant knowledge. Aikenhead (2001), borrowing from Plato, further divides the ‘knowledge’ created by science into ‘idealised, pure knowledge’ and ‘practical knowledge required for action’. The ‘pure knowledge’ form of science is a consequence of the paradigm of positivism, which holds that reality is governed by immutable laws (Pretty, 1994). The positivist approach to science has seen us use the process of science to unravel and formulate these laws of nature.

In order to apply science from a theoretical, positivist basis into a practical tool for solving individual problems, it must go through a process of deconstruction, followed by reconstruction within a new context (Aikenhead, 2001). It must be changed from an abstract concept removed from local context, into a process or understanding that can be applied within local conditions and context. The positivist paradigm is less applicable in a real-world context, where significant sources of uncertainty exist (Pretty, 1995). Crosby et al. (2002) suggest that as scientists address threats to the natural world:

...a paradigm shift may be occurring in the evolution of the role of scientists in society from simply observers of the natural world with tenuous links to resource managers and the public, to partners in modern society’s quest for answers to pressing questions related to sustainable use (ibid., p. 121).

Thus applied science moves away from positivism, and embraces the ability to use the scientific process within society, alongside other stakeholders.

Namudu and Pickering (2006) describe the development of a system to assess social factors across the Pacific Islands that are reliable predictors of community success in seaweed farming. This study presents an ideal example of applied science. The authors recognise that previous literature on the feasibility of seaweed farming have been based on Asian,

rather than Pacific, case studies. The previous work done on Asian seaweed farming could not be simply transferred to the social and cultural environment of the Pacific Islands. Although their work lacks the universality or rhetoric of theoretical science, they have performed a rational and scientific approach to a problem. Their science is valid within the context that they are working: the development of seaweed farming in Pacific Islands. In their process, they have incorporated information from elsewhere (e.g., historical records, information from the Asian context), and they have performed a scientific study of their own. Science in developing countries is often focused on finding applicable solutions to development issues. In a theoretical framework, this should be the application of a scientific process that incorporates relevant traditional knowledge and scientific theories. The outcome of the process should be potentially applicable in a known, real-world context.

Several authors have cited the failure of industrial, or ‘top-down’ forms of development as being caused in part by a failure to recognise and utilise the value of traditional knowledge (Briggs & Sharp, 2004; Drew, 2005; Veitayaki & Novaczek, 2005). Traditional understanding can assist western science by providing information that otherwise would not be available, such as long-term ecological data (Aswani & Hamilton, 2004; Johannes, Freeman, & Hamilton, 2000). In this way, traditional knowledge, or even traditional science can be integrated with modern science: for example, using traditional knowledge to help form hypotheses that may be tested using modern, western, scientific processes (Aswani & Hamilton, 2004; Hviding, 2003). In ways such as this, an approach of integration between modern science and traditional knowledge can help to achieve greater understanding of important processes. In effect, science must learn to accept information from other sources into its way of describing and understanding the world.

An understanding of traditional knowledge and related culture is also important in the application of scientific results and studies in the developing world. Local people gain empowerment through the implementation of information that has incorporated, and is in agreement with, local knowledge (Briggs & Sharp, 2004). By sharing knowledge and responsibility between western science and local knowledge and tradition, a greater ownership and custodianship of results and outcomes can result (Drew, 2005). Conversely,

implementation of science without considering traditional knowledge can result in a lack of ownership and ultimate rejection by the local people. This may well be indicative of many failed attempts to apply science within a local context. Scientific information can be more effectively explained and disseminated by using local cultural constructs, rather than the culture and language of western science (Heffernan, 2006). In a similar vein, Pretty (1994) points out that knowledge is often not given credibility unless framed in scientific language – however, in order to communicate it effectively to be used by any people, it must be framed in language that can be recognised and appreciated by those people. Considering traditional knowledge and culture when communicating science is an obvious extension of the principles of constructivism.

Science itself is not a cultureless entity (Aikenhead, 2001; Lewenstein, 1995; Manzini, 2003). Communication between western science and a western public is a cross-cultural event, with differences between the two groups in aspects such as language use and worldview (Aikenhead, 2001). When communicating western science in a non-western culture, the cultural gap becomes wider (Manzini, 2003). Science needs to communicate with and be able to adapt to local, indigenous understandings in order to further its own understanding of a given situation. Consultation and dialogue with locals, and an assessment of local culture is necessary as a starting point for a scientific study with local development in mind. Practitioners of western science need to understand indigenous knowledges and local traditions, ways of thinking and behaving when applying scientific results to a local community or region (Manzini, 2003). Implementation of scientific studies that call for behaviour changes of local people will not occur if the local people do not have the capacity to accept or enforce the changes. This will rely upon the effective communication of the science behind such management programmes.

Participatory Processes

Alongside an increased acceptance and understanding of the role of indigenous or traditional knowledge over recent years has been a move towards participation as a means to communicate science and enhance science awareness amongst the public, while achieving real outcomes (Chambers, 1994). Pretty (1995) describes forms of participation

within a spectrum of processes: from the inclusion of public representatives to create an appearance of participation, through functional and interactive participation, to ‘self-mobilisation’, where controlling bodies provide enabling frameworks, and community members take control of a project. Central to the concept of participatory processes is the interaction of a number of stakeholder groups, including the scientific community (Johnson & Walker, 2000). Participatory processes allow stakeholders to learn from one another. Scientists and science communicators gain understanding of local conditions, cultures, and needs. Local people can interact with the scientists and the science, and through this process will gain awareness of science and its role and applicability in their world (Keen & Mahanty, 2006).

Participatory Rural Appraisal (PRA) is a concept that has been initiated and subsequently refined by several practitioners over the past two decades. This concept originally arose in the late 1980s as an extension of the involvement of locals in the appraisal of rural problems in the developing world, particularly Africa and India (Chambers, 1994). Its aim was to facilitate collaboration between and among farmers, researchers and extension workers, to address and appraise local problems and potential solutions (Cronin et al., 2004). Put simply, PRA involves the local people in a decision-making process, through their own input of local knowledge, and assistance in data collection and the discussion process. By involving local people in the decision-making process, they become active users of the relevant science, and the science becomes more effectively communicated. Meanwhile, scientists or science communicators involved in the process receive feedback on the local community and its needs.

Cronin et al. (2004) describe the use of PRA techniques for communicating the risk, and associated hazard planning, of the eruption of a volcanic island in Vanuatu. Scientists had previously used videos and pamphlets to explain the risk posed by the volcano, and to impose an emergency management plan. This one-way transmission of information had limited success, as there was no consultation with the locals, no understanding of their community management structures, and the scientific information directly conflicted with the locals’ worldview regarding the causes behind volcanic eruption. By subsequently implementing participatory processes, the authors were able to work within the community

structures to develop an emergency management plan. Through this process, the science of volcanic eruption and risk perception and analysis could be communicated to the local people. The expanding network of LMMAs in the Pacific Islands is another example of the application of participatory methods to assist the development process (Veitayaki, Aalbersberg, & Tawake, 2003).

Science in the Pacific

As a large number of individual countries and territories with limited resources and capacity, the Pacific Island nations face a series of common problems. The Pacific Plan is an inter-governmental agreement to share resources and align policies to address common issues (Pacific Islands Forum Secretariat, 2007b). The Pacific Plan provides leadership, through the coordinating activities of the Pacific Islands Forum Secretariat (PIFS, or more commonly, Forum Secretariat), to integrate effort and strengthen national capacity to create positive outcomes to the people of the Pacific Islands (Pacific Islands Forum Secretariat, 2007a, 2007b). The Forum Secretariat oversees the activity of the Council of Regional Organisations in the Pacific (CROP) – ten major regional, inter-governmental agencies in the Pacific. Each CROP organisation has its own mandate to pursue activities to serve their member countries.

Much of the applicable science and science communication is carried out by CROP agencies. Of the ten agencies, those performing science are the Secretariat of the Pacific Community (SPC), Pacific Regional Environment Programme (SPREP), South Pacific Applied Geoscience Commission (SOPAC), and University of the South Pacific (USP; H. D. Thulstrup, personal communication, 13 September 2007). The Forum Fisheries Agency (FFA) uses scientific information in constructing fisheries management plans, but does not actively perform research or seek to communicate science. As the four CROP agencies involved with science form the basis of my research, I briefly summarise their individual goals and the work that they perform.

The aim of SPC is to provide information for the governments of the Pacific Islands to build and grow capacity, and to enable the people to make informed decisions about future development and wellbeing. The organisation has three divisions: Land Resources, Marine Resources, and Social Resources. The Land Resources Division provides advice, technical support and training related to agriculture, forestry, biosecurity and trade. The Marine Resources Division conducts research and monitoring of Pacific oceanic and reef fisheries, provides technical advice, assistance and training in the development and management of fisheries, and advises governments in the enabling of sustainable fishing industry and the development of maritime legislation. The Social Resources Division uses surveillance and preventative measures to fight communicable diseases, and health promotion to fight non-communicable lifestyle diseases. They are also active in collecting and analysing population data, and promoting the expression and the legal protection of traditional knowledge and cultures. Thus SPC is a broad organisation, using collected information and expertise to assist in the development across a number of areas of shared importance across the Pacific (Secretariat of the Pacific Community, 2003, 2006).

SPREP is mandated to protect and manage the region's environment and natural resources and to ensure sustainable development into the future. SPREP operates two programmes to achieve its goals: Island Ecosystems and Pacific Futures. Island Ecosystems focuses on assisting countries and people to manage natural resources and ecosystems to support sustainable development. Pacific Futures aims to build capacity for assessment and monitoring of environmental threats and pressures, and to plan suitable responses. Applicable threats and pressures include climate change, sea-level rise, pollution and waste management (Chape, 2006; Pacific Regional Environment Programme, 2007).

SOPAC promotes sustainable development in the region through research, monitoring, evaluation and advice related to non-living natural resources. The three key programmes that operate within SOPAC are Community Lifelines, Community Risk, and Ocean and Islands. Community Lifelines aims to improve national capacity in the fields of energy, water, health and sanitation, and information and communications technologies. Community Risk focuses on risk management of natural disasters; strengthening risk management practices to increase resilience to disasters and producing safer communities.

Ocean and Islands aims to use scientific knowledge and research to address the sustainable use and governance of non-biological resources in ocean and island ecosystems (Pacific Islands Applied Geoscience Commission, 2006b).

SOPAC actively facilitates communication between scientists through the Science Technology and Resources Network (STAR). This is an open forum, held yearly at SOPAC's annual session, which calls for the free exchange of information between geoscientists based in the Pacific and elsewhere, on topics related to SOPAC's mission and goals. The outcome or implementation of SOPAC's work is largely through the dissemination of information or scientific knowledge to policy-makers in the member nations (Pacific Islands Applied Geoscience Commission, 2006a).

The University of the South Pacific (USP) is primarily a teaching organisation based throughout the islands of the South Pacific, with the purpose of providing tertiary education to Pacific Islanders in their own geographic and cultural environment. As a scientific organisation, members of two faculties (the Faculty of Islands and Oceans, and the Faculty of Science and Technology) teach science and are involved in active research and scientific consultancy. In particular, the Institute of Applied Sciences (IAS), located within the Faculty of Science and Technology, works as an outreach organisation, interfacing the university's scientific facilities with the needs of regional organisations, governments, business and people (University of the South Pacific, 2007). The Marine Studies Programme at USP provides education on all aspects of marine studies, and performs research, development and consultancy roles to serve industries and governments of the region (South & Veitayaki, 1998).

The United Nations Educational, Scientific and Cultural Organization (UNESCO) has a Pacific office in Apia, Samoa. In the Pacific, UNESCO functions as an advisory and facilitatory body (H. D. Thulstrup, personal communication, 9 August 2007). The education sector focuses on introducing innovative learning or communication techniques to build the environmental awareness of people of all ages (Kuijper, 2003). UNESCO also provides science advice to governments, and undertakes research and development projects (West, 2004).

Since 2000, the UNESCO Pacific Office has collaborated with the Centre for the Public Awareness of Science (CPAS) at the Australian National University (ANU). The partnership has focused on improving teaching, training and communication of science in the Pacific Islands. Major activities undertaken by CPAS and UNESCO in the Pacific to date include workshops for science teachers and science journalists. There are two broad themes that the CPAS/UNESCO collaboration is attempting to address: a perceived gap between science and community life in the Pacific, and the geographical and communication-dependent isolation of science practitioners in the Pacific (West, 2004).

Statement of the Problem

The application of science and technology can assist the developing world in addressing many of their problems and issues, while reducing or minimising further environmental or social problems. As with any region, the particular problems within the Pacific exist in particular social and environmental contexts that are not replicated elsewhere. The implementation of science must also occur within these contexts.

The CROP agencies exist to address some of the region-wide issues in the Pacific. This regionalist approach allows the pooling of resources from a number of relatively small and resource-poor nations, while reducing duplication of effort. In order to be effective, the science-based CROP agencies must create practical outcomes that can be implemented in a real-world situation to address the known issues. Effective communication is essential to this process: scientists or science organisations rarely have the opportunity themselves to directly apply their knowledge or findings into tangible outcomes. More commonly, knowledge will be applied through being communicated to government, to development agencies, to communities or community groups, or to the public at large.

Theories of science communication, and an appreciation of public awareness of science are pertinent in the application of science. In order for science-based solutions to be applied within the Pacific, there must be a public inclination to accept, and perhaps ideally seek,

science and its applications. Those communicating science – science communicators, science journalists, teachers, scientists themselves – must be aware of science communication principles and to understand the contexts in which a message is delivered, and the contexts in which it can be assimilated by an audience.

West (2004), quoting Hans Thulstrup of UNESCO, outlines the barriers to effective science communication in the Pacific. As a result of the huge geographic dispersion and limited communication infrastructure, science practitioners across the Pacific feel a sense of isolation from one another, and from the rest of the world. There is also a separation between the science practised in the Pacific, and the people of the Pacific. The local people are largely unaware and uninterested in formal science. Meanwhile, formal science, with cultural roots firmly placed in western tradition, is largely ignorant of local tradition and knowledge systems.

Over the past decade or two, the effectiveness of technology-based aid in the Pacific, and across the globe, has been questioned. Problems facing the Pacific have not been alleviated – perhaps they have simply been held at bay – and a new suite of issues heralded by climate change could lead to further suffering of both the environment and the people. Such concern or uncertainty ultimately works to make the job of the scientist harder, as the people and governments lose faith in the ability of science to have a positive effect. The lack of trust in the efficacy of science and technology to solve population and environmental problems must be addressed. I argue here that more strategic approaches to communication, a push for greater science awareness or literacy in the population, and attempts to create dialogue between scientific institutions and the public can all assist the process of science-based development.

Thus there is a need for science communication efforts to work towards narrowing the divide between science and society, and to connect scientists, science communicators and allied professionals such as teachers and journalists. This has been the focus of the CPAS/UNESCO partnership: enhancing networking, advocating science communication ideals to the science-based agencies, and working with teachers and communicators to increase the public awareness of science.

Over the history of the CPAS/UNESCO partnership, there has been little formal feedback from science practitioners on science communication in the Pacific. The Pacific Science Exchange (PSE) initiative that was run on a trial basis in 2003 received positive feedback from Pacific scientists (West, 2004), but has since ceased to operate. Taking from the premises of science communication espoused by CPAS, we must attempt to characterise our audience. In this case, there is a clear need for more information regarding the scientists in the Pacific and their opinions on science communication.

This Project

The importance of science communication in international development has been recognised by many authors and commentators (Hviding, 2003; Juma & Yee-Cheong, 2005; Leach & Scoones, 2006; Lewenstein, 2003a; Seely & Wöhl, 2004; Veitayaki, Aalbersberg, Tawake, Rupeni, & Tabunakawai, 2003). However, examples of the successful application of science communication to address sustainable development appear more rarely. The aim of this project is to investigate how scientists and science organisations in the Pacific Islands communicate their science, their attitudes to science communication, and how they consider their work to have practical outcomes.

Central to this thesis is the concept that communication ideals must pervade the entire scientific process, from conceptualisation of a problem or a question, through data collection, analysis and final reporting and implementation. Communication is the vital link between the production of knowledge using science, and its implementation. While scientists alone cannot be expected to ensure the communication of their work, they should acknowledge communication goals and adapt their own science to fit practical communication outcomes. Further, the environment in which they are performing science and producing knowledge should be conducive to the broader dissemination and communication of that knowledge, in its appropriate context.

This project is approached as a pilot study, intended to broadly gauge how Pacific scientists view communication as it relates to their science. Alongside gathering data, the project also

functions as a test of its methodology and approach. Scientists from the four CROP agencies with a science focus in the Pacific were invited to complete an online survey, asking what field of science they worked in, what practical outcomes their science had produced, and what forms of communication they had used to disseminate their science. The following chapter describes the methods in detail.

Chapter Two

Methods

Introduction

The aim of this study was to produce preliminary data regarding the attitudes of Pacific scientists towards the communication of their scientific work, and to test the feasibility of the methodology for future, more expansive, studies. No previous studies have addressed these questions in the Pacific. As a result, this project is angled towards extracting preliminary data, upon which further studies may be based.

An online survey was used to collect data from scientists working in the Pacific. Scientists from four inter-governmental agencies that operate as Pacific regional organisations were invited by email to complete the survey, which ran during November and December, 2006. The questions were designed to provide some broad understanding of how science and its communication occur in the Pacific region, as well as how scientists perceive their own science and its communication.

Sampling Process

Scientists from four regional, inter-governmental organisations were asked to complete the survey:

- South Pacific Applied Geosciences Commission (SOPAC),
- Secretariat of the Pacific Community (SPC),
- South Pacific Regional Environment Programme (SPREP),
- University of the South Pacific (USP).

This selection was made in accord with advice from Hans Thulstrup of UNESCO, Apia. The decision to target scientists within these organisations was based on a number of reasons, detailed below.

Boundedness

Creating a clear definition of the population to be studied, with rigid boundaries, allowed the study to be undertaken and completed within a short time frame.

Comparisons

By limiting all cases to those within these four organisations that are independent, yet related under the CROP banner, I allowed for the possibility of performing within- and between- organisation comparisons in my analysis.

Known goals

These four organisations are well established and information on them is easily accessible. We can easily retrieve information regarding their mandate, their goals and the member countries to which they are answerable.

A range of scientific functions or duties

Each of the targeted organisations employs scientists that perform diverse scientific roles – researching, environmental (or other) monitoring, offering expert advice, communicating, and teaching.

A range of scientific disciplines

The organisations include a range of disciplines, including environmental sciences, geosciences, biology, agricultural science, fisheries, health and medicine.

Contacts

Personal contacts were available in these agencies that could be used as ‘seeds’ to quickly spread the link through the organisation and to lend credibility to my research to potential respondents.

I invited members of the target group to complete the survey by email. With the support of Rod Lamberts², Hans Thulstrup³ and Sarah Grimes⁴, I was provided with names and email addresses of people who would encourage the project within each organisation. I sent emails to these primary contacts, asking that the email, containing a link to the survey, be forwarded through the organisation. As a protocol, this is similar to the ‘snowballing’ method used by many social scientists to contact hard-to-reach respondents (Faugier & Sargeant, 1997; Streeton, Cooke, & Campbell, 2004).

I attempted to reach respondents using these contacts for two purposes: firstly, to extend my survey to as many people as possible, with up-to-date contact details. Secondly, the delivery of the invitation email by a known person lent credibility to the study in an environment where junk email is commonplace. After receiving ten completed surveys in the first ten days, recruitment and reminder emails were sent directly to a complete list of email addresses gathered from the agencies’ websites.

Copies of standard forms of emails that I sent for recruitment and for reminder are shown in Appendices A and B. I allowed for the option of a hard copy being mailed or faxed for completion, but no one requested this. Upon clicking on the link to the survey, the survey frontpage, shown in detail in Appendix C, was opened in a web browser. The frontpage gave some simple background information and a privacy statement, as required under ANU ethics guidelines. To continue, the respondent could click the ‘Begin’ button and access the main body of the survey.

The language used in the recruitment emails and the survey itself was deliberately unspecific regarding the prerequisite of being a ‘scientist’ to complete the survey. Recruitment emails mentioned that the survey was targeting ‘scientists’ and ‘science

² My supervisor in this project, with experience promoting science communication in the Pacific Islands as Deputy Director of CPAS.

³ Programme Specialist in Sciences, UNESCO Office, Apia, Samoa.

⁴ A former employee of SOPAC, with experience and contacts in Pacific science.

workers', without any further elaboration on what defined these groups of people. The survey probes more detail as to the nature of their work, and the field in which they work. Simply, I was aiming to recruit as many people as possible who considered himself or herself under the broadest banner of 'scientist'. That is, anyone who works within science and is involved in information creation, interpretation, or communication. Three questions were used to further define the respondent's role in science, and these are presented later in this chapter.

The presence of a selection bias is unavoidable in a survey distributed in this manner (Wright, 2005). The sample that completed the survey is likely to contain disproportionately more people who support science communication, are involved in science communication or otherwise hold a stake in science communication, than in the general target population. This effect cannot be controlled for in this situation, and thus must be taken into account when considering the results. Further discussion on selection bias and other limitations imposed by the methodology are outlined in Chapter Four.

The Survey

I used the Apollo system supplied by the Division of Information at the ANU to design and host the survey. Wright (2005) discusses advantages and disadvantages of the online survey method. For my purposes, the online survey was ideal, as it allowed me to access a maximum number of potential respondents, with a minimal investment of time and money. It allowed me to cheaply and easily survey people based throughout the Pacific while I was based in Canberra, Australia. The online survey design and the selection process do introduce some sampling errors. However, the study was designed to gather some baseline data on general mood, opinions and behaviour, rather than produce data for rigorous statistical analysis. In essence, it is a pilot study, designed to produce exploratory data and methodological outcomes.

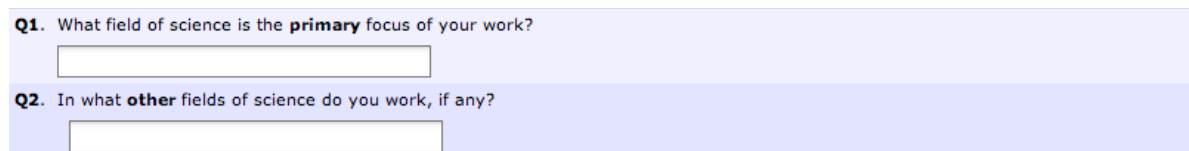
No identifying questions were included in the survey or the sampling mechanism by which any respondents could be identified. The survey and methodology were approved by the

ANU Research Office Human Research Ethics Committee as protocol number 2006/264. A letter confirming this approval is included as Appendix E.

I outline the questions in the survey below. The main areas covered by the survey were:

- the respondent's field of science,
- their opinions on the importance of communication to a number of different audiences,
- one practical outcome of their work,
- methods by which they had communicated their work,
- how well their science has been communicated, and
- any comments they had on science communication in the Pacific.

I followed these main questions with a few demographic questions: what organisation they worked for, their current position, how long they had worked in their position and their field of science, and their nationality. I concluded the survey with a general, open-ended question, asking for remarks on the survey, or the research project. The survey is shown in full, as it appeared to respondents, in Appendix D.



Q1. What field of science is the **primary** focus of your work?

Q2. In what **other** fields of science do you work, if any?

Figure 2. Survey questions 1 and 2, enquiring into the field or fields of science in which the respondent works.

The aim of Questions 1 and 2, shown above in Figure 2, is to identify if responses to other questions were related to the respondent's field of work. This also gave me some indication as to whether I was receiving results from the range of disciplines practised within the four agencies, or whether some were more strongly represented than others.

How important do you believe it is to communicate the results and outcomes of your science to:					
	Very important	Moderately important	Neither important nor unimportant	Moderately unimportant	Very unimportant
Q3. Other scientists within your organisation?	☐	☐	☐	☐	☐
Q4. Scientists from other organisations?	☐	☐	☐	☐	☐
Q5. Government representatives?	☐	☐	☐	☐	☐
Q6. Industry groups?	☐	☐	☐	☐	☐
Q7. The media?	☐	☐	☐	☐	☐
Q8. Community groups?	☐	☐	☐	☐	☐
Q9. The public?	☐	☐	☐	☐	☐

Figure 3. Survey questions 3-9, judging the importance of communication of science to a range of audiences.

Figure 3 shows Questions 3-9, which attempt to evaluate the opinion of the respondent towards the importance of different audiences of their science. The question asks about communication outcomes of the respondent's science rather than science in general. The question was phrased in this manner to get a variation of responses that would apply to the diversity in scientific disciplines throughout the Pacific.

Q10. Please briefly describe **one** practical outcome of your work from the past three years.

Figure 4. Survey question 10, the practical outcomes of the respondent's work.

In Question 10, shown in Figure 4, I was looking for a brief description of a practical outcome of the respondent's work. Communication of scientists' work is intrinsically connected with its potential or real practical outcomes, particularly in the developing world. Enough space was left for the response to cover several lines of text – although responses could be longer than the space shown. I used the time frame of three years to ensure that the results would be at least relatively recent and still be applicable today. The aim of this question was twofold: to determine the nature of the outcomes that were being produced in Pacific science, and to investigate how individual scientists or researchers regarded the concept of 'practical outcomes' of their work.

Q11. By which of the following methods have you communicated your work over the past three years?

Please tick all that apply.

- ☐ Research papers
- ☐ Conferences
- ☐ Meetings or formal discussions
- ☐ Newspaper or magazine articles
- ☐ Radio
- ☐ Television
- ☐ Brochures or pamphlets
- ☐ Advertising campaigns
- ☐ Workshops or training
- ☐ Lectures or teaching
- ☐ Community consultations
- ☐ Public lectures or forums
- ☐ Websites
- ☐ Email lists
- ☐ Others (please list)

Comments

Figure 5. Survey question 11, forms of communication that had been used by the respondent.

Question 11, displayed in Figure 5, was included to determine the forms of communication that had been used by the scientist. The answers were provided by ticking the check box beside each method, and the text box below was provided for respondents to fill in any other methods they may have used.

Q12. Considering the activities described in Question 11, how well do you feel your science has been communicated?

☐ Very well
 ☐ Well
 ☐ Reasonably
 ☐ Poorly
 ☐ Very poorly

Figure 6. Survey question 12, how well the respondent felt their own science had been communicated.

After creating a context for their communication activities, respondents were asked in Question 12 (Figure 6) how well they believed these activities had been performed.

Obviously general in approach, this question was included to measure the attitude of the scientist towards the communication efforts of their own work.

Q13. Do you have any comments or suggestions relating to the quality of communication of science in the Pacific region?

Figure 7. Survey question 13, general comments on Pacific science communication.

The second open-ended question, Question 13, shown above in Figure 7, was designed to extract any opinions or ideas on science communication that had not already come from the previous questions. Given the status of this project as collecting pilot data, answers given in this question could be used to refine and direct any future studies of this type. Basically, this question gave the survey some scope to receive ideas that were missed by the previous, more structured, questions.

Q14. Which organization do you currently work for (eg SOPAC, SPC, USP)?

Q15. How would you describe the **nature** of your current position? (eg management, research, assistant)

Figure 8. Survey questions 14 and 15, the respondent's place of work and the nature of their work.

Determining the organisation for which the respondent worked allowed comparisons of the communication culture between the four organisations. Question 15 (Figure 8) allowed further segmentation of the sample by the nature of their position. The suggestions (management, research, assistant) are given in an attempt to clarify the type of answer that was sought. This was to obtain greater homogeneity of responses, to facilitate analysis and comparison between different answers.

Q16. For how long have you worked in your current position?	Years	Months
Q17. For how many years have you worked in your current field of science?	Years	Months

Figure 9. Survey questions 16 and 17, the time the respondent has spent working in their current position, and their current field of science.

Questions 16 and 17, in Figure 9, are further demographic questions, allowing some comparisons between older and younger workers, and workers who have spent more or less time in their position.

Q18. What nationality do you consider yourself to be?	
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Figure 10. Survey question 18, the respondent's nationality.

Science workers in the Pacific come from a range of backgrounds – from across the Pacific, from various countries in Asia, and from western nations such as Australia, New Zealand and the US. Question 18 (Figure 10) was included to determine respondents' backgrounds and to determine if background and cultural identity had any effect on the respondent's views on communication.

Q19. Please note any comments you have on this survey or this research project.

Figure 11. Survey question 19, general comments on the survey or the project.

Question 19, displayed in Figure 11, was a final open-ended question for comments directed towards the research project. This served to probe any concerns about the survey design or the questions asked, and could potentially assist any further, similar studies. It also allowed the respondent to have some degree of feedback after completing the survey.

Protocol

I opened the online survey and sent distribution emails to key contacts on Tuesday November 7, 2006. Emails were sent to contacts within SOPAC (Shane Fairlie), SPC (Mary Taylor, Luigi Guarino, and Ben Ponia), and SPREP (Tamara Logan and Dean Solofa). To distribute the survey throughout USP, emails were sent to nine contacts collected from the USP website, covering heads of departments, departmental and school secretaries, and business managers. As USP is much more scattered geographically throughout the Islands, as well as being divided into smaller schools and institutes, I needed to contact more sources for distribution than for the other three organisations.

Ten days after first sending emails, on November 17, I had received only ten completed surveys. I then decided to take a different approach, and on that day sent emails to a list of 253 addresses that I had collected from the websites of the relevant organisations. I had removed addresses from this list that I knew had received survey invitations from one of the previous distribution contacts. Of the emails sent, 22 were undeliverable or had various delivery errors.

On Friday December 1, I had planned to send reminder emails to all recipients who had received an invitation email. However, in the weeks leading up to the end of November 2006, there had been increasing political unrest in Fiji, particularly the capital Suva, where the offices of SPC and SOPAC, and the main campus of USP are located. This had escalated to the point of a noon deadline being set by coup leaders for military action, on the planned day of my reminder email (Fiji military extends coup deadline, 2006). As a result, I chose to send the reminder to SPREP and USP employees only, and to delay reminders for SOPAC and SPC until the political issues became further resolved. The surveys that I had received were all unidentifiable, and so those who had completed the survey also received a reminder. To allow for this, I included a short thankyou to those who had completed the survey in the reminder email. The reminder email is shown in detail in Appendix B.

On the following Tuesday, December 5, a military coup occurred in Fiji (Fijian military chief declares coup, 2006). As this occurred without violence, and the tensions were unlikely to dramatically increase following this event, I sent a reminder to SPC and SOPAC staff on the following day.

I eventually closed the survey on Sunday, December 17. At that stage, a total of 45 surveys had been completed. This is from a total sample of 324 valid email addresses to which invitations were sent by myself or by contacts. This number does not include email attempts that failed due to the address being unknown, inactive, or with a full mailbox – all indicative of a person no longer working in that position. An additional three surveys were returned from people working outside the four target organisations. These were removed from the sample in order to maintain the bounds of the study outlined in Chapter Two. The completed surveys thus represent a 14% return rate. The delivery protocol and number of surveys completed over the time that the survey was open are detailed below in Table 2.

Table 2. Breakdown of the invitation emails sent and responses received over time.

Date	Actions	Emails sent	Cumulative responses received
7 Nov 2006	Survey opened	15 sent to contacts in four agencies for distribution	0
17 Nov 2006		253 sent directly to potential respondents	10
1 Dec 2006		Reminder sent to SPREP & USP	30
5 Dec 2006		Reminder sent to SOPAC & SPC	35
17 Dec 2006	Survey closed		45

Analysis

As discussed, the collected data is used for descriptive and exploratory purposes rather than hypothesis testing. Accordingly, basic descriptive statistics were used to analyse the numerical data. Basic content analysis was used to process answers to the open-ended questions.

The survey contains two open-ended questions which required content analysis to group each response into a series of more general categories. These questions are those regarding practical outcomes of the respondents' work, and general comments or opinions on science communication. An inductive process of qualitative analysis was performed (Creswell, 1993). In brief, this process involves extracting major themes from the textual data and grouping similar themes together in categories. These categories then form the basis of further interpretation, leading to the building of overarching theory that can describe the qualitative data.

The responses to the open-ended questions varied in length from two words to several sentences. To analyse them, all responses were copied into a single document file. Each answer was read, and the main themes in the answer were noted down, as I interpreted them, from each individual answer. I then read through all of the cases again, along with my first-pass summary, with an eye to linking connected themes. Thus I could reduce the information given in 45 different answers by extracting the main theme of each answer, and grouping similar themes found across different answers into distinct groups.

In its role as a pilot study, the methods used and their effect on the study are important when considering future projects that may develop. Ultimately a sufficient number of responses were received to perform descriptive data analysis and qualitative analysis of open-ended questions. If a similar project was to attempt to perform more in-depth quantitative comparisons, then a greater number of returns would be required. This may require the survey to be left open for longer, or for more intensive methods in approaching and sampling potential respondents. The results and their analysis are described in the following chapter.

Chapter Three

Results

Introduction

A total of 45 surveys were completed over six weeks. With this number of responses, the data analysis is focused upon qualitative and descriptive results. Several factors may have contributed to limit the return rate, which are discussed later with limitations of the study in Chapter Four. Data analysis has been approached as a process of describing who answered the survey and summarising their responses.

Who Answered the Survey

Questions 1 and 2, and 14 to 18 all provided information – demographic and otherwise – about those who answered the survey. Questions 1 and 2 asked what main field, and any other fields of science, the respondent works in. I grouped the responses from Question 1 into six categories, shown below, in Table 3. Only 28 of 45 respondents answered Question 2, and those answers given were considerably diverse and tended to describe processes, rather than fields of science. Accordingly, I discarded these answers from further analysis. The groups that each respondent was categorised into are mutually exclusive; no single case was placed in more than one category.

I used some information from Question 10, concerning practical outcomes of the respondent's work, to assist classifying some cases into their main field of science. For example, a choice was required between the groups Conservation & Biology and Fisheries, when a respondent mentioned their field as “Estuarine and freshwater fish”. In this

example, the respondent mentioned “...the freshwater fish that they [local people] have around their place”, leading to the coding of their field of science as Conservation & Biology, rather than Fisheries.

Table 3. Categorisation of the respondent’s main field of science.

Category	Summary	Count
Fisheries	Fisheries, fisheries science, fisheries management.	7
Agriculture	Agriculture, plant pathology, plant protection, agricultural entomology.	5
Conservation & Biology	Conservation biology, conservation-related work, biology, marine biology (not fisheries), biochemistry, microbiology	11
Environmental Science	Hydrology, oceanography, climatology, resource management, environmental management.	10
Physical Science	Physics, engineering, energy research.	7
Health	Health, epidemiology.	2
Other	Computing, hazard analysis, education.	3

It is notable that only two of 45 respondents worked in the area of health; the remaining 43 work in areas that are associated with addressing environmental issues. This appears to reflect the proportion of health workers in the wider sample: only one division of SPC is related to health, while the remainder of SPC and all of the other organisations are focused on environmental issues.

The summary of returns from each organisation, as based on the respondent’s answer to Question 14, is shown below, in Table 4. The number of responses from each organisation is displayed, along with a comparison in the percentage breakdown for those that answered the survey and for the entire target population. Although there were only three responses in total from SPREP, the percentage of responses from SPREP in the survey is similar to the percentage of SPREP workers in the target population. SOPAC workers were over-represented in the final data, and USP were marginally under-represented. The success

within SOPAC may have been due to the support received from their communication manager, Shane Fairlie. Conversely, the low response from USP may have due to the lack of personal networks in this agency.

Table 4. Response rate from each of the four CROP agencies.

Organisation	Count	%age of survey	%age of population
SOPAC	12	26.7%	20.0%
SPC	15	33.3%	31.4%
SPREP	3	6.7%	6.4%
USP	15	33.3%	42.2%

The analysis of the respondent's position was treated in a similar fashion to that of their field of science. Many respondents mentioned more than one position or duty in their work – for example ‘research and advisory’, or ‘management and technical officer’. Accordingly, some cases are grouped into more than a single category. Table 5, below, shows the categories, and the count of how many cases fit into that position or role. As some responses mentioned more than one answer, the total count is greater than the total number of completed surveys.

Table 5. The nature of the respondent's work.

Position	Count
Technical Support	4
Teaching	8
Research	23
Advice	8
Engineering	1
Management	17

A brief analysis of the respondents that claimed more than one primary role in their work was performed. Of 13 cases that identified two aspects to the nature of their work, research and teaching were associated five times, and research and management were associated

three times. Research and teaching are commonly associated in academia, and each of these cases reflect people working in the academic environment of USP.

The majority of respondents indicated that they had worked in their current position from one to eight years. The time spent in their current field of science had a wider range, from two to 34 years. Approximately half of the respondents identified themselves as various Pacific Islander nationalities (predominantly Fijian), and half as various western or European nations (mainly Australian and New Zealander).

Thoughts and Opinions on Science Communication

Questions 3 through to 9 asked the respondents how important they consider communication to be to a series of different audiences. Overwhelmingly, the results were positive towards the importance of communication: 89% of all responses across all of the categories were ‘Moderately important’ or ‘Very important’. When divided into the separate audience targets and compared, there is little difference between the groups, although there may be tendencies towards higher ratings for ‘Scientists within your organisation’ and ‘Scientists from other organisations’, and lower ratings for ‘The public’, ‘Community groups’ and ‘The media’. It must be noted that although these groups had slightly lower ratings, more than 80% of respondents still ranked communication to these groups as moderately or very important. Each audience group and the proportion of respondents that rated them as moderately or very important are outline below in Table 6.

Table 6. The importance of communicating the respondent's science to different audiences. The results are presented as the percentage of respondents that rated communication to each group as either moderately or very important

Audience group	Percentage (moderately or very important)
Scientists in same organisation	100%
Scientists in other organisations	96%
Government representatives	91%
Industry groups	89%
The media	80%
Community groups	84%
The public	84%
Total across all groups	89%

Practical Outcomes

Respondents were asked to outline a recent practical outcome of their scientific work. This question is based on assumptions that science in the Pacific, particularly that performed by the CROP agencies, occurs with real-world, applicable results in mind. Thus, I was looking to find out what these applicable results and their applications are: what practical outcomes of science are produced? Given the nature of the question, it can also show how the respondents view the concept of practicality in their work. That is, the answers may show not only what practical outcomes are produced, but also what the respondents consider practical outcomes to be.

Due to the one-way process of communication that is imposed by the online survey method, unclear responses cannot be clarified. As a result, some responses were ambiguous and difficult to interpret. For example, one answer given was "Finding solution to the taro beetle problem in the Pacific". In coding answers, I was looking for achieved outcomes,

rather than intended outcomes. This response is thus open to a number of different interpretations: is a solution currently being *sought* – is it a work in process with data currently being gathered? Has a solution been *found*? Has a solution been found and *communicated* to a relevant audience such as farmers, managing bodies, taro-growing cooperatives, or village communities? Or has a solution been found and implemented, thus eliminating or reducing the problem of taro beetle? Ultimately this example was deemed uncodable.

The final categorisation of practical outcomes was into five groups: advice, communication to public, data collection, professional network building and implementation. This was based on outcomes had been achieved, rather than intended future outcomes. I outline the rationale and a brief description of each of these categories below. One respondent did not answer this question, one stated ‘no outcome’, and there were two other cases (including the ‘taro beetle’ case described above) that were uncodable. Table 7 lists the number of cases that were in each of the categories.

Table 7. The number of cases grouped into each practical outcomes category.

Category	Count
Advice	12
Communication to public	7
Data collection	8
Network building	7
Implementation	7

Advice

This category contains communication of information to government or governing bodies, for the purpose of assisting with decision-making processes. It is therefore associated with top-down management, as discussed in Chapter Two. The information communicated may be the results of research, specialist knowledge or expertise. Examples of responses included in this category are:

- “Setting up of a framework for improved water governance in several Pacific Island Countries”
- “Development of a Regional Energy Policy Document”
- “Stock assessment of tuna species to provide management advice to national fisheries agencies and WCPFC [Western and Central Pacific Fisheries Commission] tuna commission”.

Communication to public

This includes various forms of communication to members of the wider public, community members, and specific sectors of the community, such as farmers or fishermen. This group includes forms of communication such as education, public awareness, risk communication, and community training. Examples include:

- “Publication of educational and awareness materials for Pacific Islands primary and secondary school students”
- “Development of community-based monitoring DVD”
- “We have developed, and are now publicising, a management package for the worst disease of kava which is one of the Pacific's most important crops”.

Data collection

A number of respondents stated either directly or indirectly that the collection of data or information was the practical outcome of their work. In such cases, there was no mention of using, implementing or communicating the data. Examples include:

- “Sea Level Rising Trends around Fiji Islands”
- “A survey of energy usage (with particular interest in biomass energy) in rural Fiji”
- “Summarised available data on known HIV and AIDS cases across the Pacific”.

Professional network building

Based on the concept of communication between scientists, this category includes the creation of networks for communication between scientists at the regional or international level, the use and submission of information to such networks, and publishing formal articles or reports. Examples of this category include:

- “Production of maps and reports of the bathymetry of the South Pacific Island countries”
- “Increased info sharing and knowledge exchange through e-mail network”
- “Establishment of a regional network”.

Implementation

This group encompasses the process of turning data, information or scientific expertise into a tangible entity that delivers a beneficial product or process. This category involves the application of science for the creation of measurable outcomes or effects. Examples include:

- “Power Generation using coconut oil blends with diesel in Samoa and Vanuatu”
- “Development of freshwater prawn ... farms in Fiji”
- “We have eradicated rats (which are an introduced invasive pest species that predate upon endemic plants and animals) off an island in Fiji”.

Forms of Communication

In Question 11, respondents were asked to select from a list the methods that they had used to communicate their science. All of the methods suggested were used by at least some of the respondents. Usage ranged from only four people who claimed to have used advertising, while 42 of 45 respondents had used meetings to communicate their work. A summary of the methods and the number of respondents that selected each is presented below in Table 8.

Table 8. Number of respondents that used each form of communication.

Form of communication	Count
Meetings	42
Conferences	38
Workshops	35
Research papers	29
Websites	28
Email lists	28
Printed media	27
Lectures or teaching	25
Brochures or pamphlets	24
Community consultation	23
Radio	17
Television	14
Public lectures or forums	13
Advertising	4
Other	8

Thus the most common methods used are conferences and meetings, while advertising, public lectures, radio and television are more rare – although far from absent in the sample.

When asked how well they believed their work had been communicated, the most common response was ‘reasonably’, followed by ‘well’. Table 9, below, outlines the frequency of these responses.

Table 9. Rating of the quality of communication of the respondent's own science.

Response	Count
Very Poorly	0
Poorly	5
Reasonably	26
Well	13
Very well	1

General Opinions

In a second open-ended question, respondents were asked to add whatever comments they had about science communication in the Pacific. In effect, I used this question as a form of ‘fishing’ for any further thoughts or ideas, and for possible inspiration for future research. Most used the opportunity to make a comment on the state of science communication in the Pacific, and to offer suggestions by which communication could be improved.

The first process of grouping responses into themes was to categorise each response as either ‘positive’ or ‘negative’. That is, comments stating or implying that science communication was either done well or done poorly. This analysis proved to be overwhelming: 32 of 34 responses suggested that the quality of science communication was typically poor. Note that not all respondents answered this question.

Of the responses that were negative, most included reasons for the poor state of communication or means by which it could be improved. Looking for common elements among these comments, I arrived at four themes: poor facilities, a lack of scientific literacy, poor networking, and a lack of communication skills and support for scientists. The number of cases that mentioned each theme are displayed below in Table 10. These data arise from 27 responses that mentions reasons for poor quality of communication or suggestions for improvement. Several responses mentioned more than one such issue.

Table 10. The number of responses that included each of the general comments themes.

Category	Count
Facilities	6
Scientific literacy	10
Networks	14
Skills & support	5

Facilities

Several responses mentioned the lack of facilities or infrastructure that support communication, and the difficulty of improving communication facilities across the geographical range of the Pacific. This includes limited reach of television and telecommunications, including telephone and internet, the difficulties imposed by geographical distance on face-to-face communication, and problems caused by political instability and the unwillingness or incapacity of governments to provide more sophisticated facilities. Specific examples from the survey include:

- “Communication facilities in the Pacific may not be as great. Unreliable at times and not very accessible by rural communities”
- “often difficult to get face to face communication e.g. conferences etc due to associated costs which also makes networking difficult”.

Scientific literacy

As discussed in Chapter One, the definitions of terms such as ‘scientific literacy’ or ‘public awareness of science’ are somewhat contentious. The term ‘science literacy’ is used here to group the cases that mention a lack of understanding or awareness of science and its relevance. In responses grouped under this category, respondents noted the lack of understanding of science by journalists and the media, which leads to misreporting of scientists’ work and a level of mutual distrust between science and the media. Others noted the lack of quality science teaching in schools and a lack of science awareness by schoolteachers. Deficiencies in science awareness by both the media and the teaching

profession are perpetuated as poor science awareness in the public at large. Examples include:

- “One of the big problems in this region is the generally abysmal standard of media reporting - I speak as someone who has been misquoted or misrepresented just about every time I have let myself get into their clutches”
- “The issue at the heart of improving the quality is in the long term investment into the improvement of science education in the Pacific”.

Networks

This category comprises criticism of the capacity to transfer information around networks in the Pacific: between scientists, and from scientist to policy-makers or to potential end-users. This category includes comments suggesting that data or information tend to stay within organisations, criticism that too many organisations ‘communicate’ merely by posting information on a website, and the difficulty in having local, Pacific-based science published in the larger international journals. Examples include:

- “There is a lot of interesting work going on but it tends to ‘hang’ in the institutes themselves and not go out to interested parties and potential beneficiaries”
- “Very often scientific work from Pacific Island nations is critically assessed in international journals. And it happens that generally they are not accepted”.
- “Too many reports and none or little action is ever taken upon their release. In essence, much of the scientific research is wasted as it does not reach the people it should and even when it does, little or nothing is done about it”.

Skills & support

Comments suggested that scientists are too busy doing science to take time to focus on the communication of their work, and that many scientists lack the skills to communicate successfully to the public, and even the skills to publish their work in scientific journals. In summary, there is a requirement for more skills training of scientists for communication, more time set aside for communication, or more support, such as communication specialists. Examples include:

- “Improvement in the non technical presentation of science by scientists”

- “Not a lot of effort is put into public dissemination of the science we do. Perhaps it is because we are all too busy doing it! But doubtless there might be more support for our work if we did more kind of outreach communication, press releases etc.”

Summary of Results

Overall, the analysis of the data that has been collected is descriptive: who completed the survey, the types of science they do, and some general comments about the practical outcomes of their work and how they view science communication. While it is difficult to draw concrete conclusions from much of this data, answers to questions such as that concerning practical outcomes certainly encourage further investigation. As part of a wider effort to promote science communication in the developing Pacific, this project is a process of testing survey methodology and building a provisional data set. The results do suggest that the methodology was at least in part successful, and a similar approach in the future could be justified. From the results, I would infer that there is real concern about the state of science communication, and a desire to improve its effectiveness across the Pacific region. Discussion of this and other conclusions from this study appear in the following chapter.

Chapter Four

Discussion

Summary of Key Results

In considering this project as pilot data for further studies and ongoing involvement of CPAS in the Pacific, a number of noteworthy concepts arise. In summary, the data give some perspective on the attitudes towards science communication in general and the way in which individual scientists approach the ideas of having practical outcomes of their work, and communicating their work to achieve outcomes.

The study was set up to be quick, cheap and simple to run. The sampling process was designed to obtain as many responses as possible, and participation could clearly not be made compulsory. As a result, the sample that did complete the survey was self-selected: by the availability of the potential respondent over the active phase of the survey, and their willingness to complete the survey. Accordingly, I must place all discussion and interpretation of the data within the context that those who completed the survey are those who may be more concerned with the subject matter: science communication in the Pacific Islands.

The other caveat that must be placed on analysis of this data is that respondents were told in the introductory email that the survey was about science communication. Thus all respondents were prepared for questions regarding science communication, and would have been put in a frame of mind where they may represent more positive attitudes towards science communication than they otherwise would have. That is to say, many respondents may report positive attitudes towards communication, but that may not represent their day-

to-day behaviour. Overall, the results can be considered to be indicative rather than representative.

With these considerations in mind, it is interesting that there were no explicit references to ‘communication’ when respondents were asked the nature of their position. The most common responses to this question were ‘research’ or ‘management’. Teaching and advice are both communication-related activities, albeit very specific, directed forms of communication. All respondents who mentioned ‘teaching’ as a position were from USP, so it is reasonable to assume that this refers to formal tertiary teaching. Advice is a communication role that involves top-down management: the communication of information to assist governments in their decision-making. Thus there is no direct reference to communication to the public as a primary role of any respondent.

Responses indicate that scientists believe that the communication of science to a number of different audiences is important. The proportion of respondents rating communication as very or moderately important ranged from 80% to 100%. Even when considering the predisposition for respondents to answer positively towards science communication, there is strong cause to infer that a significant number of scientists in the CROP agencies believe in the importance of communication of their work.

There was suggestion of a trend towards a higher rating of the importance of some audiences over others. Respondents were less supportive of communication to the media, community groups and the public, while communication amongst fellow scientists was rated as the most important. While the differences are small and certainly not statistically significant, the fact that similar audiences received similar ratings suggests the presence of a trend: that scientists are rating communication between scientists as particularly important, while considering communication to community groups, the public and the media (a means of accessing the public) as less important. On the evidence, this trend appears to warrant further investigation.

Some of the most interesting results of the study came in from the open-ended enquiry into the practical outcomes of the scientist’s work. This question is reliant on both the outcomes

that they have achieved and how the respondent interpreted the question and the phrase ‘practical outcomes’. As such, the results are indicative of both the practical outcomes that are produced in Pacific science, and of how the scientists view the practicality, or lack thereof, of their work.

The responses regarding practical outcomes were grouped into five categories: advice, communication to public, data collection, network building, and implementation. It is likely that the context of the survey had put communication at the forefront of the respondents’ minds, and as such the communication outcomes (advice, communication to public, and network building) may be over-represented. However, it is worth noting that a range of communication outcomes are mentioned. Communication to the public and network building both entail a communication process, to two fundamentally different audiences. Implementation implies some form of communication process, as the science must be constituted into a usable and accessible form in some way in the process of implementation.

The prevalence of responses grouped as ‘data collection’ was an intriguing outcome of this question. Cases were placed into this category when the collection of data or information was the only thing mentioned in the response. It is unclear for several of these cases if further implementation or communication was done with the information once collected. For example, in a response such as “Sea level rising trends around Fiji Islands” the data may have been summarised and communicated – either in the formal science literature, informally to other scientists, or to governments to assist with decision-making on these important, pressing issues. However, without mention of communication or implementation of data, we are left with the answer we are given: the collection of data. Again, without further investigation, it is difficult to conclude a great deal from this, but it is interesting to note that the collection of data is considered a ‘practical outcome’, where it surely must be implemented or communicated somehow to create any true benefit to the environment, to society or to the region.

Communication outcomes to government and to public audiences were mentioned alongside several cases of networking, the improvement of communication channels between scientists. This enlightening result – somewhat amplified by the context of the

survey – shows that work is being done to communicate science through several channels. There does appear to be a prevalence of advice to governments as a form of communication ahead of communication to the public. This shows the dominance of top-down ahead of bottom-up management, despite recent suggestions in the literature that bottom-up management or decentralised diffusion may be more effective, especially given the social constructs within the Pacific Islands (Richmond et al., 2007). Nevertheless, a range of communication outcomes were mentioned in the survey, which does indicate that scientists are pursuing communication as a means of translating their work into real-world effects.

The most common forms of communication that respondents claimed to have utilised were those involved with high-level, formal communication between scientists or between scientists and government: conferences and meetings. Despite this 23 respondents (approximately half the sample) indicated that they had used some form of community consultation to communicate their work. Question 12 asked how well their work had been communicated – the majority answered ‘reasonably’ or ‘well’. This answer contrasts interestingly with the largely negative comments made to describe science communication in general; that is, communication of others’ work.

When asked for general comments on the state of science communication in the Pacific, most took it as a forum for outlining the problems or difficulties with communication, and means by which it may be improved. Interestingly, most respondents had rated their own science to have been communicated ‘reasonably’ or ‘well’, but the opinions towards communication in the Pacific were overwhelmingly negative. The major problems outlined by respondents were grouped into four categories – the lack of facilities or infrastructure, the lack of scientific literacy amongst the public, the lack of networks for sharing of information between scientists and between organisations, and the lack of communications skills or support for scientists.

These answers are strongly aligned to the problems being addressed by the collaboration of CPAS and UNESCO in advancing science communication in the Pacific. Science teacher and science journalist workshops have been implemented to improve science literacy and awareness in the public, and to assist the transfer of scientific understanding through the

media. CPAS and UNESCO are working to establish a network of Pacific scientists, and to develop a journal dedicated to Pacific science and science communication. These two initiatives address the problems that have been categorised as networking difficulties. That is, the difficulty in sharing information between scientists from different organisations, and the difficulty in having work published by international science journals that have a more global focus.

Further involvement may include communications training or the provision of communications support for scientists. The barriers presented by the lack of communications facilities or infrastructure across the Pacific may not be easily addressable. However, assistance can be provided in identifying the barriers that exist and working towards methods to broadcast or disseminate information in spite of the barriers.

Limitations of the Study

As a pilot study, this was not necessarily going to produce representative results, but rather to identify concepts for future study and to guide more research in this area. The greatest limitation was the sample size: had more people completed the survey, then a more detailed analysis could have been performed and more conclusions could have been drawn. A number of factors may have contributed to limit the return rate, and are discussed below.

The original count was an overestimate

The total number of potential respondents (324) was calculated from personnel data retrieved from organisations' websites. As information was not always available as to the nature of each person's position, some potential respondents may have selected themselves out of the survey by not considering themselves as 'scientists'. Information on the websites may also have been out of date.

Difficulty in contacting some respondents

The nature of science work in the Pacific results in people travelling regularly to remote destinations, where email access can be limited or absent. The survey was open for a

relatively short time, and some people may have been absent for the entire time, especially given the time of year was November-December, typically holiday time for many cultures.

Political strife in Fiji

For the entire time that the survey was open, there was political tension in Fiji, culminating in a coup in early December 2006. The offices of SOPAC and SPC, and large portions of USP are in the Fijian capital, Suva, where most of the military action occurred. Evacuation of foreign nationals, advice to others to stay at home and general concerns for personal safety may have reduced the response rate.

The Fiji coup not only affected my data-gathering procedure, but also was timely in reminding me of the barriers to productivity in science presented by an unstable political situation. In the months leading up to the events in Fiji that coincided with my data collection, there had been political unrest in both Tonga and the Solomon Islands. Such cases serve as valuable reminders of the difficulties in working in such an environment, and must be considered when we analyse the scientific work that is performed in the Pacific.

Recommendations for Further Study

As a pilot study, the aim of this project was to gather information that could be used for further research in this field. Given the data that was collected by this limited, pilot process, we can conclude that this methodology has merit in being used on a larger scale. By gathering more data regarding science communication in the Pacific, we can build theory describing the process and outcomes of communication, and can find ways in which the problems can be most effectively addressed. I suggest that three approaches could be used to continue this research: a shallow but broad-ranging investigation similar in approach to this survey, in-depth interviews with a smaller sample of participants, and long-term, longitudinal case studies.

A shallow but broad investigation could follow a similar design to this survey – aiming to survey as many people as possible regarding their approach to science communication.

With greater time and resources, such a project could be run to incorporate more Pacific scientists, and possibly include other partner groups within the Pacific. By running the survey over a longer time, with more intensive sampling and distribution techniques, a much greater coverage and response rate could be possible.

The need for in-depth interviews are suggested by the results from the two open-ended questions. Both of these questions – regarding practical outcomes and scope for improvement in science communication – provided interesting results, although with a degree of ambiguity. Through a more detailed interview process, possibly in a one-on-one setting, many of the uncertainties encountered in this study could be removed. By performing such a study, a much clearer picture could emerge of how science communication and the pursuit of practical outcomes are approached by the practitioners.

A case-study approach to these issues would allow a more detailed mapping of what does occur – as opposed to peoples’ opinions or ideas of how things occur. A longitudinal study could monitor the scientific process through conceptualisation, research and development, communication, and ultimately implementation. Such a study could produce valuable information regarding the scientific process in the developing world, the role of communication, and the means by which tangible and practical outcomes occur.

Conclusions

The major outcome of this research is highlighting some issues that invite further investigation, in order to maximise the effectiveness of science communication initiatives in the Pacific region. Of particular interest are the results concerning the manner in which scientists consider their work to represent practical outcomes. Many respondents noted the poor state of science communication in the Pacific, and identified areas that prevent better communication, and processes that may increase its effectiveness.

To put all of the results together in context, it appears that scientists are supportive of the push for greater communication of their work. They also see communication as the most

common form of practical outcome of their work. However, they rarely see any form of communication as their primary role, and they appear to value more formal processes of communication over less formal dissemination to communities or the public. Scientists generally believe that their own work has been communicated well; however, they believe that the quality of communication across the Pacific is poor.

The major problems facing the Pacific in terms of environmental issues (Chape, 2006; South et. al, 2004) and population health issues (Hughes & Lawrence, 2005) must be addressed alongside poverty in a process of sustainable development (Nukuro, 2000). The application of science is important in the development process but to date has largely been ineffective (Chape, 2006; Richmond et al., 2007). A number of mechanisms to communicate science throughout society are being adopted across the Pacific to approach development issues: the acceptance of traditional knowledges (e.g., Hviding, 2006), the linking of science to policy (e.g. Veitayaki et al., 2003) and the use of participatory processes (e.g. Cronin et al., 2004). These science communication efforts must become more streamlined and adopted throughout the scientific process to maximise the effectiveness of science on sustainable development.

CPAS has been involved alongside UNESCO in the Pacific region since 2000. The organisations have worked to promote and integrate the application of science communication towards sustainable development. The simplest articulation of the science communication message is that without communication to someone or some audience, science can never have a real effect. In order to be successful, communication must be considered throughout the scientific process, including an appreciation of the audiences and the means and context of communication. Results gathered from the survey suggest that there is an appreciation of the importance of communication, and an understanding that it has not been performed effectively.

There are several recent examples of an embrace of communication ideals in the Pacific: a willingness to promote community consultation and participation in schemes such as the locally-managed marine areas, a readiness to incorporate traditional knowledge, and the expansion and uptake of information networks such as the Pacific Environment Information

Network (PEIN) and the Pacific Invasives Learning Network (PILN). Into the future, we must continue to monitor these initiatives and map the changes in communication behaviours and outcomes.

The acceptance of science by the community – a move towards science awareness – will continue to be a slow process. With further promotion of participatory action, and acceptance of traditional knowledge by formalised western science, science will become closer to the community and science uptake and science awareness will surely increase. The principle of science awareness is a distant goal, but a goal that can be achieved incrementally, by scientists understanding communication as outcome, and communication in context. These results show that there is awareness of the need for better communication in the scientific community. However, there is perhaps a lack of support or otherwise a lack of capacity to tackle the barriers that exist to the success of science communication in advancing sustainable development.

References

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- Aalbersberg, W. (2003). *The role of locally-managed marine areas (LMMAs) in the development of ecotourism in Fiji* (No. 2003/03). Suva: Institute of Applied Sciences, University of the South Pacific.
- Aikenhead, G. S. (2001). Science Communication with the Public: a Cross-Cultural Event. In S. M. Stocklmayer, M. M. Gore & C. Bryant (Eds.), *Science Communication in Theory and Practice*. Dordrecht: Kluwer Academic.
- Aswani, S., & Hamilton, R. J. (2004). Integrating indigenous knowledge and customary sea tenure with marine and social science for conservation of bumphead parrotfish (*Bolbometopon muricatum*) in the Roviana Lagoon, Solomon Islands. *Environmental Conservation*, 31(1), 69-83.
- Aswani, S., & Lauer, M. (2006). Incorporating fishermen's knowledge and behavior into geographical information systems (GIS) for designing marine protected areas in Oceania. *Human Organization*, 65(1), 81-102.
- AusAID. (2006). *Pacific 2020: challenges and opportunities for growth*. Retrieved 5 March 2007 from http://www.ausaid.gov.au/publications/pubout.cfm?ID=219_173_9143_7522_6433&Type=
- Barnett, J. (2001). Adapting to climate change in Pacific Island countries: the problem of uncertainty. *World Development*, 29(6), 977-993.
- Bencze, J. L. (2007). Constructivism. Retrieved 9 August 2007 from <http://leo.oise.utoronto.ca/~lbencze/Constructivism.html>
- Briggs, J., & Sharp, J. (2004). Indigenous knowledges and development: a postcolonial caution. *Third World Quarterly*, 25(4), 661-676.
- Bryant, C. (2006). What is Science Awareness? Retrieved 6 July 2007 from http://info.anu.edu.au/CPAS/005PP_What_is_Science_Communication_QQ/_What_is_science_awareness_QQ.asp
- Burns, T. W., O'Connor, D. J., & Stocklmayer, S. M. (2003). Science communication: a contemporary definition. *Public Understanding of Science*, 12, 183-202.

- Burt, B., & Clerk, C. (1997). Environment and development in the Pacific Islands: introduction. In B. Burt & C. Clerk (Eds.), *Environment and Development in the Pacific Islands* (pp. 1-21). Canberra: National Centre for Development Studies.
- Chambers, R. (1994). The origins and practice of participatory rural appraisal. *World Development*, 22(7), 953-969.
- Chape, S. (2006). *Review of Environmental Issues in the Pacific Region and the Role of the Pacific Regional Environment Programme*. Paper presented at the Workshop and Symposium on Collaboration for Sustainable Development of the Pacific Islands: Towards Effective e-Learning Systems on Environment, 27-28 February 2006, Okinawa, Japan. Retrieved 23 July 2007 from http://www.sprep.org/publication/pub_detail.asp?id=542
- Church, J. A., White, N. J., & Hunter, J. R. (2006). Sea-level rise at tropical Pacific and Indian Ocean islands. *Global and Planetary Change*, 53, 155-168.
- Clark, L. (2006). *Pacific 2020 Background Paper: Fisheries*. Retrieved 5 March 2007 from http://www.ais.gov.au/publications/pubout.cfm?ID=219_173_9143_7522_6433&Type=
- Costa-Neto, E. M. (2000). Sustainable development and traditional knowledge: a case study in a Brazilian artisanal fishermen's community. *Sustainable Development*, 8, 89-95.
- Creswell, J. W. (1993). *Research Design: Qualitative & Quantitative Approaches*. Thousand Oaks, California: Sage Publications.
- Cronin, S. J., Gaylord, D. R., Charley, D., Alloway, B. V., Wallez, S., & Esau, J. W. (2004). Participatory methods of incorporating scientific with traditional knowledge for volcanic hazard management on Ambae Island, Vanuatu. *Bulletin of Volcanology*, 66, 652-668.
- Crosby, M. P., Brighthouse, G., & Pichon, M. (2002). Priorities and strategies for addressing natural and anthropogenic threats to coral reefs in Pacific Island Nations. *Ocean & Coastal Management*, 45, 121-137.
- Delaney, A. E., & Hastie, J. E. (2007). Lost in translation: differences in role identities between fisheries scientists and managers. *Ocean & Coastal Management*, 50, 661-682.
- Diamond, J. (2005). *Collapse: How Societies Choose to Fail or Succeed*. New York: Penguin.

- Drew, J. A. (2005). Use of traditional ecological knowledge in marine conservation. *Conservation Biology*, 19(4), 1286-1293.
- Faugier, J., & Sargeant, M. (1997). Sampling hard to reach populations. *Journal of Advanced Nursing*, 26, 790-797.
- Fiji military extends coup deadline (2006, 1 December). *ABC News Online*. Retrieved 1 December 2006 from <http://www.abc.net.au/news/newsitems/200612/s1802222.htm>
- Fijian military chief declares coup (2006, 5 December). *ABC News Online*. Retrieved 5 December 2006 from <http://www.abc.net.au/news/newsitems/200612/s1804858.htm>
- Finau, S. A. (1996). Health, environment and development: towards a Pacific paradigm. *Pacific Health Dialog*, 3(2), 266-278.
- Gilman, E. L., Ellison, J., Junblut, V., Van Lavieren, H., Wilson, L., Areki, F., et al. (2006). Adapting to Pacific Island mangrove responses to sea level rise and climate change. *Climate Research*, 32, 161-176.
- Grunig, J. E., & Hunt, T. (1984). *Managing Public Relations*. New York: Holt, Reinhart & Winston.
- Hardin, G. (1968). The tragedy of the commons. *Science*, 162(3859), 1243-1248.
- Hayes, A. C. (2001). Poverty Reduction and Environmental Management. In A. C. Hayes & M. V. Nadkarni (Eds.), *Poverty, Environment and Development: Studies of Four Countries in the Asia Pacific Region* (pp. 253-270). Bangkok: UNESCO Principal Regional Office for Asia and the Pacific.
- Heffernan, C. (2006). *The Livestock Guru: demand-led knowledge transfer for poverty alleviation*. Paper presented at the International Conference on Information and Communication Technologies and Development, 25-26 May 2006, Berkeley.
- Hoffmann, T. C. (2002). Coral reef health and effects of socio-economic factors in Fiji and Cook Islands. *Marine Pollution Bulletin*, 44, 1281-1293.
- Hughes, R. G., & Lawrence, M. A. (2005). Globalisation, food and health in Pacific Island countries. *Asia Pacific Journal of Clinical Nutrition*, 14(4), 298-306.
- Hviding, E. (2003). Between knowledges: Pacific studies and academic disciplines. *The Contemporary Pacific*, 15(1), 43-73.
- Hviding, E. (2006). Knowing and managing biodiversity in the Pacific Islands: challenges of environmentalism in Marovo Lagoon. *International Social Science Journal*, 58(187), 69-85.

- Johannes, R. E. (2002). The renaissance of community-based marine resource management in Oceania. *Annual Review of Ecology and Systematics*, 33, 317-340.
- Johannes, R. E., Freeman, M. M. R., & Hamilton, R. J. (2000). Ignore fishers' knowledge and miss the boat. *Fish and Fisheries*, 1, 257-271.
- Johnson, A., & Walker, D. (2000). Science, communication and stakeholder participation for integrated natural resource management. *Australian Journal of Environmental Management*, 7, 82-90.
- Juma, C., & Yee-Cheong, L. (2005). Reinventing global health: the role of science, technology, and innovation. *The Lancet*, 365, 1105-1107.
- Kavaliku, L. (2000). Culture and sustainable development in the Pacific. In A. Hooper (Ed.), *Culture and Sustainable Development in the Pacific*. Canberra: Asia Pacific Press.
- Keen, M., & Mahanty, S. (2006). Learning in sustainable natural resource management: challenges and opportunities in the Pacific. *Society and Natural Resources*, 19, 497-513.
- Kinzig, A. P., Starrett, D., Bolin, B., Dasgupta, P., Ehrlich, P., Folke, C., et al. (2003). Coping with uncertainty: a call for a new science-policy forum. *Ambio*, 32(5), 330-335.
- Kuijper, M. W. M. (2003). Marine and coastal environmental awareness building within the context of UNESCO's activities in Asia and the Pacific. *Marine Pollution Bulletin*, 47, 265-272.
- Laugksch, R. C. (2000). Scientific literacy: a conceptual overview. *Science Education*, 84(1), 71-94.
- Leach, M., & Scoones, I. (2006). We need a 'slow race' for science-based development. *SciDevNet*. Retrieved 25 July 2006 from <http://www.scidev.net/Opinions/index.cfm?fuseaction=readOpinions&itemid=513&language=1>
- Lewenstein, B. V. (1995). From fax to facts: Communication in the cold fusion saga. *Social Studies of Science*, 25, 403-436.
- Lewenstein, B. V. (2003a). A developing-world take on science literacy. *SciDevNet*. Retrieved 13 April 2006 from <http://www.scidev.net/Features/index.cfm?fuseaction=readFeatures&itemid=99&language=1>

- Lewenstein, B. V. (2003b). Models of public communication of science and technology. Retrieved 2 August 2007 from <http://communityrisks.cornell.edu/BackgroundMaterials/Lewenstein2003.pdf>
- Manzini, S. (2003). Effective communication of science in a culturally diverse society. *Science Communication*, 25(2), 191-197.
- Nadkarni, M. V. (2001). Poverty, Environment and Development in India. In A. C. Hayes & M. V. Nadkarni (Eds.), *Poverty, Environment and Development: Studies of Four Countries in the Asia Pacific Region* (pp. 25-92). Bangkok: UNESCO Principal Regional Office for Asia and the Pacific.
- Namudu, M. T., & Pickering, T. D. (2006). Rapid survey technique using socio-economic indicators to assess the suitability of Pacific Island rural communities for *Kappaphycus* seaweed farming development. *Journal of Applied Phycology*, 18, 241-249.
- Nukuro, E. (2000). *A glimpse at the Pacific Island Countries' Population, Development and Environmental Issues*. Paper presented at the Millennium Media Conference on the Environment, Nadi, Fiji, 24-28 July 2000.
- Pacific Islands Applied Geoscience Commission. (2006a). Science, Technology and Resources Network (STAR). Retrieved 31 July 2007, from <http://www.sopac.org/tiki/tiki-index.php?page=STAR>
- Pacific Islands Applied Geoscience Commission. (2006b). What is SOPAC? Retrieved 31 July 2007, from <http://www.sopac.org/tiki/tiki-index.php?page=SOPAC>
- Pacific Islands Forum Secretariat (2007a). About Us. Retrieved 13 August 2007, 2007, from <http://www.forumsec.org/pages.cfm/about-us/>
- Pacific Islands Forum Secretariat (2007b). The Pacific Plan. Retrieved 13 August 2007, from <http://www.forumsec.org/pages.cfm/about-us/the-pacific-plan/>
- Pacific Regional Environment Programme (2007). About SPREP. Retrieved 31 July 2007, from <http://www.sprep.org/sprep/about.htm>
- Perera, S., & Lamberts, R. (2006). *Review of existing literature on formal science policy in the Pacific Islands: A project for the UNESCO Apia's programme on science policy development in the Pacific Islands*. Report prepared for UNESCO Apia, by the Centre for the Public Awareness of Science, Australian National University, Canberra.

- Pretty, J. N. (1994). Alternative systems of enquiry for a sustainable agriculture. *IDS Bulletin*, 25, 37-48.
- Pretty, J. N. (1995). Participatory learning for sustainable agriculture. *World Development*, 23(8), 1247-1263.
- Rennie, L. J., & Stocklmayer, S. M. (2003). The communication of science and technology: past, present and future agendas. *International Journal of Science Education*, 25(6), 759-773.
- Richmond, R. H., Rongo, T., Golbuu, Y., Victor, S., Idechong, N., Davis, G., et al. (2007). Watersheds and coral reefs: conservation science, policy, and implementation. *BioScience*, 57(7), 598-607.
- Rogers, E. M. (1983). *Diffusion of Innovations* (Third ed.). New York: The Free Press.
- Rupali, P., Condon, R., Roberts, S., Wilkinson, L., Voss, L., & Thomas, M. G. (2007). Prevention of mother to child transmission of HIV infection in Pacific countries. *Internal Medicine Journal*, 37, 216-223.
- Secretariat of the Pacific Community (2003). Secretariat of the Pacific Community Corporate Plan 2003-2005. Retrieved 7 August 2007 from <http://www.spc.int/AC/publication.htm>
- Secretariat of the Pacific Community (2006). SPC and its role in the region: helping to safeguard the resources of the Pacific Islands. Retrieved 7 August 2007 from <http://www.spc.int/AC/publication.htm>
- Secretariat of the Pacific Community (2007). Public Health Programme: Tuberculosis. Retrieved 29 August 2007, from <http://www.spc.int/tb/>
- Seely, M., & Wöhl, H. (2004). Connecting research to combating desertification. *Environmental Monitoring and Assessment*, 99, 23-32.
- Snively, G., & Corsiglia, J. (2000). Discovering indigenous science: implications for science education. *Science Education*, 85, 6-34.
- South, G. R., Skelton, P. A., Veitayaki, J., Resture, A., Carpenter, C., Pratt, C., et al. (2004). The global international waters assessment for the Pacific Islands: aspects of transboundary, water shortage, and coastal fisheries issues. *Ambio*, 33(1-2), 98-106.

- South, G. R., & Veitayaki, J. (1998). Capacity building in the South Pacific and the role of the marine studies programme at the University of the South Pacific. *Ocean & Coastal Management*, 41, 103-113.
- Stocklmayer, S. M. (2001). The Background to Effective Science Communication With the Public. In S. M. Stocklmayer, M. M. Gore & C. Bryant (Eds.), *Science Communication in Theory and Practice* (pp. 3-22). Dordrecht: Kluwer Academic.
- Stocklmayer, S. M., & Gilbert, J. K. (2002). New experiences and old knowledge: towards a model for the personal awareness of science and technology. *International Journal of Science Education*, 24(8), 835-858.
- Streeton, R., Cooke, M., & Campbell, J. (2004). Researching the researchers: using a snowballing technique. *Nurse Researcher*, 12(1), 35-46.
- Tacconi, L. (1997). An ecological economic approach to forest and biodiversity conservation: the case of Vanuatu. *World Development*, 25(12), 1995-2008.
- The Contemporary Pacific. (2007). The Pacific Islands. Retrieved 10 September 2007 from http://muse.jhu.edu/journals/contemporary_pacific/toc/images/pacific_islands.jpg
- Treise, D., & Weigold, M. F. (2002). Advancing science communication: a survey of science communicators. *Science Communication*, 23(3), 310-322.
- University of the South Pacific. (2007). Institute of Applied Science: Background. Retrieved 31 July 2007, from <http://ias.fst.usp.ac.fj/>
- Veitayaki, J., Aalbersberg, B., & Tawake, A. (2003). Empowering local communities: Case study of Votua, Ba, Fiji. *Ocean Yearbook*, 17, 449-463.
- Veitayaki, J., Aalbersberg, B., Tawake, A., Rupeni, E., & Tabunakawai, K. (2003). *Mainstreaming Resource Conservation: The Fiji Locally Managed Marine Area Network and its Influence on National Policy Development* (Working Paper No. 42): Resource Management in Asia-Pacific Program, Research School of Pacific and Asian Studies, The Australian National University.
- Veitayaki, J., & Novaczek, I. (2005). Voices, Lenses and Paradigms: Understanding Fisheries Development in the Pacific. In I. Novaczek, J. Mitchell & J. Veitayaki (Eds.), *Pacific Voices: Equity and Sustainability in Pacific Islands Fisheries*. Suva: Institute of Pacific Studies Publications.

- West, M. C. (2004). *Evaluating the Pilot Pacific Science Exchange*. Unpublished Masters Subthesis, Centre for the Public Awareness of Science, Australian National University, Canberra.
- Wright, K. B. (2005). Researching internet-based populations: advantages and disadvantages of online survey research. *Journal of Computer-Mediated Communication*, 10. Retrieved 17 August 2007 from <http://jcmc.indiana.edu/vol10/issue3/wright.html>
- Wynne, B. (1991). Knowledges in context. *Science, Technology, & Human Values*, 16, 99-105.
- Yager, R. E. (1991). The constructivist learning model: towards real reform in science education. *The Science Teacher*, 58(6), 52-57.
- Ziman, J. (1991). Public Understanding of Science. *Science, Technology, & Human Values*, 16, 99-105.

Appendix A

Invitation Email

From: Tom Hammond
Subject: Pacific Science Communication Study
Date: 7 November 2006 3:23:27 PM
To: Shane Fairlie

Dear Shane,

My name is Tom Hammond and I am a Masters student at the Centre for the Public Awareness of Science (CPAS) at the Australian National University.

I am running a short research project investigating the science communication activities that are performed by scientists in the Pacific region, and their general attitudes towards science communication. I am approaching people working within intergovernmental agencies, specifically SPC, SOPAC, SPREP, USP and FFA.

You may be aware of the work that Dr Rod Lamberts, Deputy Director of CPAS, is performing in conjunction with Hans Thulstrup of UNESCO to further and promote communication between scientists and science reporters in the Pacific region. Rod is my supervisor in this project, and your contribution will provide valuable information for the setting up and running of a comprehensive Pacific science web portal (PacSciNet) in 2007.

I am asking Pacific scientists to complete a brief online survey to briefly describe their scientific work and how it is communicated. The survey should take less than five minutes to complete.

The survey is accessible online at:

<https://apollo.anu.edu.au/default.asp?pid=1684>.

The survey is text-based and should be accessible over a basic internet connection through any common browser. If any respondents would prefer, I can mail or fax a hard copy of the survey to be completed.

The survey will only be online until Friday November 24, 2006.

I would be most grateful if you could distribute this message and the survey link to scientists within SOPAC.

If you have any questions or comments, please reply to this email, or contact my supervisor, Rod Lamberts (rod.lamberts@anu.edu.au).

Regards,

--

Tom Hammond

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Canberra ACT 0200

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tom.hammond@anu.edu.au

Appendix B

Reminder Email

From: Tom Hammond
Subject: Pacific Science Communication Study - Reminder
Date: 1 December 2006 1:05:03 PM
To: Tom Hammond

This is a reminder that the Pacific Science Communication Survey is still open, and I ask all who are involved in Pacific science to participate.

To those who have already completed the online survey, I extend my thanks.

If you have not completed, or are unaware, of the survey, I will take this opportunity to remind you. I am a Masters student at the Centre for Public Awareness of Science (CPAS) at the Australian National University. I am doing a short research project investigating communication of science by Pacific-based scientists.

My project supervisor, Dr Rod Lamberts, is currently working with Hans Thulstrup of UNESCO to promote communication between scientists and science reporters in the Pacific region. Your contribution to my survey will provide valuable information for the setting up and running of a comprehensive Pacific science web portal (PacSciNet) in 2007.

The survey should take only five minutes to complete, and all responses are anonymous and non-identifiable. It is accessible online at:

<https://apollo.anu.edu.au/apollo/default.asp?pid=1684>

If you have any questions or comments, please reply to this email or contact my supervisor, Rod Lamberts (rod.lamberts@anu.edu.au).

Regards,

--

Tom Hammond

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Appendix C

Survey Front Page

**CPAS - Pacific**

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Pacific Science Communication Survey

Welcome to the Pacific Science Communication Survey.

This survey will take only five minutes to complete and will provide assistance for CPAS and UNESCO in determining how best to allocate resources to enhance communication of science in the Pacific islands.

If you have any queries about this survey or project, please contact Tom Hammond on tom.hammond@anu.edu.au.

Alternatively, or if you would like more information about CPAS, UNESCO and science communication in the Pacific, contact Rod Lamberts, CPAS Deputy Director on rod.lamberts@anu.edu.au, or +61 2 6125 0747.

Privacy Statement

Security of the website
Users should be aware that the World Wide Web is an insecure public network that gives rise to a potential risk that a user's transactions are being viewed, intercepted or modified by third parties or that data which the user downloads may contain computer viruses or other defects.

Purpose of data collection
This information is being sought for a research project entitled Survey of Science Communication in Pacific Island Developing Nations. The researcher is Dr Tom Hammond, Centre for the Public Awareness of Science. The project aims to evaluate the execution and attitudes towards communication of science by Pacific-based scientists. The information you provide will only be used for the purpose for which you have provided it. It will not be disclosed without your consent.

Security of the data
The data will be kept secure within a password-protected file. At the completion of the research project the data will be maintained within this secure file. No names or any other identifying features will be taken from respondents, thus all data will remain non-identifiable. As the web can be an insecure medium you may choose to complete this survey by mail.

You can view the ANU's privacy statement [here](#).

If you encounter any ethical concerns while accessing this survey or participating in this research project, please contact the Secretary of the ANU's Human Ethics Research Committee.

Mailing address:
Secretary (Human Ethics Officer)
Human Research Ethics Committee
Research Office
Chancery 10B
The Australian National University
ACT 0200
Telephone: +61 2 6125 7945
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Begin »

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Please direct all enquiries to: tom.hammond@anu.edu.au
Page authorised by: Director, CIS as relevant officer

The Australian National University
CRICOS Provider Number: 00120C - ABN: 522 34063906

Appendix D

Main Survey Form

ANU
THE AUSTRALIAN NATIONAL UNIVERSITY

CPAS - Pacific
Pacific Science Communication Survey

[Skip Navigation](#) |
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 [Staff](#)

Q1. What field of science is the **primary** focus of your work?

Q2. In what **other** fields of science do you work, if any?

How important do you believe it is to communicate the results and outcomes of your science to:

	Very important	Moderately important	Neither important nor unimportant	Moderately unimportant	Very unimportant
Q3. Other scientists within your organisation?	☐	☐	☐	☐	☐
Q4. Scientists from other organisations?	☐	☐	☐	☐	☐
Q5. Government representatives?	☐	☐	☐	☐	☐
Q6. Industry groups?	☐	☐	☐	☐	☐
Q7. The media?	☐	☐	☐	☐	☐
Q8. Community groups?	☐	☐	☐	☐	☐
Q9. The public?	☐	☐	☐	☐	☐

Q10. Please briefly describe **one** practical outcome of your work from the past three years.

Q11. By which of the following methods have you communicated your work over the past three years?

Please tick all that apply.

☐ Research papers

☐ Conferences

☐ Meetings or formal discussions

☐ Newspaper or magazine articles

☐ Radio

☐ Television

☐ Brochures or pamphlets

☐ Advertising campaigns

☐ Workshops or training

☐ Lectures or teaching

☐ Community consultations

☐ Public lectures or forums

☐ Websites

☐ Email lists

☐ Others (please list)

Comments

Q12. Considering the activities described in Question 11, how well do you feel your science has been communicated?

☐ Very well
 ☐ Well
 ☐ Reasonably
 ☐ Poorly
 ☐ Very poorly

Q13. Do you have any comments or suggestions relating to the quality of communication of science in the Pacific region?

Q14. Which organization do you currently work for (eg SOPAC, SPC, USP)?

Q15. How would you describe the **nature** of your current position? (eg management, research, assistant)

Q16. For how long have you worked in your current position?

Years
 Months

Q17. For how many years have you worked in your current field of science?

Years
 Months

Q18. What nationality do you consider yourself to be?

Q19. Please note any comments you have on this survey or this research project.

Submit

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Please direct all enquiries to: tom.hammond@anu.edu.au
 Page authorised by: Director, CIS as relevant officer

The Australian National University
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Appendix E

ANU Ethics Approval



THE AUSTRALIAN NATIONAL UNIVERSITY

RESEARCH OFFICE

Ms Yolanda Shave
Secretary, Human Research Ethics Committee

CANBERRA ACT 0200 AUSTRALIA

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6 October 2006

Mr Thomas Hammond
Postgraduate Student,
Centre for the Public Awareness of Science
Faculty of Science
The Australian National University
ACT 0200

Dear Mr Hammond,

Protocol 2006/264

Survey of science communication in developing Pacific Island nations

On behalf of the Human Research Ethics Committee I am pleased to advise that the above protocol has been approved as per the attached *Outcome of Consideration of Protocol*.

For your information:

1. Under the NHMRC/AVCC *National Statement on Ethical Conduct in Research Involving Humans* we are required to follow up research that we have approved. Once a year (or sooner for short projects) we shall request a brief report on any ethical issues which may have arisen during your research and whether it proceeded according to the plan outlined in the above protocol.
2. Please notify the Committee of any changes to your protocol in the course of your research, and when you complete or cease working on this project.
3. The validity of this current approval is five years' maximum from the date shown on the attached *Outcome of Consideration of Protocol* form. For longer projects you are required to seek renewed approval from the Committee.

Yours sincerely,

Ms Yolanda Shave
Secretary, Human Research Ethics Committee

