Marine resource dependence, resource use patterns and identification of economic performance criteria within a small Indo-Pacific island community

L. C. Cullen

leanne_cullen@yahoo.co.uk

A thesis submitted for the degree of Doctor of Philosophy

Department of Biological Sciences

University of Essex

2007

Dedicated to all my family, for everything, always

Summary

Marine resources in the Wakatobi Marine National Park (MNP), Indonesia, are heavily relied upon for food, raw materials and income. Most of the marine ecosystems in the region are regarded healthy, but there is concern over the rapid deterioration of some of the more accessible areas of reef, mangrove and seagrass. Several management initiatives have been attempted but with little success.

A major reason why past conservation management initiatives have failed to reach their goals is lack of compliance of local communities to management rules and regulations. This is due largely to actual, perceived, or even just expected, economic losses to these communities utilising natural resources for their own sustainability. Hence a key role of management should be to maintain or improve the economic status of local people.

The development of a simple series of economic performance criteria, i.e. testable parameters through which changes could be identified would allow economic status to be assessed. If appropriate methods can be developed, values generated could be used to implement economically and ecologically sound management practices with stakeholder support. To work towards this aim we need to understand local resource use patterns and economic importance, quantify local dependence, and describe existing livelihood strategies.

This study used the example of the Kaledupa sub-district, Indonesia, to provide a detailed case study of a small island community with high natural resource dependence. The study details natural resource use patterns and the extensive local complexities that must be understood for any chance of management success, it also highlights the importance of marine resources to the local economy. A series of potential economic performance criteria were developed which could be used in the development of appropriate management plans that aim to maintain ecological wealth and develop sustainable utilisation, whilst maintaining or improving the economic status of local user groups and maintaining local participation and support.

Acknowledgements

I would like to acknowledge the contribution my supervisors Dr. David Smith and Prof. Jules Pretty for their advice and support throughout the project. I would also like to thank Dr. Julian Clifton for initial advice concerning fieldwork on Kaledupa. I acknowledge and thank Operation Wallacea for funding and for all field logistics and provisions.

It was a pleasure working in the Wakatobi and the experience was made even more enjoyable and memorable by all the fantastic staff who work for Operation Wallacea out there. From the amazing kitchen staff who always make you feel better to the incredible engineers and maintenance staff that keep the field bases ticking over, you're all fantastic. Maliani, Alisa, Ilu, I'll miss you. As well I want to thank Jean and John Coop for all of their background support in the field and making many things easier. I especially acknowledge my translators, and would like particularly to say a huge thank you to Saniati who it was a complete pleasure to work with – you were a breath of fresh air. I want to thank Sarah Pilgrim and Francis Binney for their company on Kaledupa in 2005, it was a long season and you guys were great. I also want to thank my sister Becky for her amazing support that season too, I'm so glad you got to experience the wonder of Hoga and it was so great to have you there.

I want to thank my family for always giving so much support and encouragement, and especially for all the letters and parcels that kept me going for so long in Indonesia, I really hope you know how much they meant. Mum and Bex, you are and always have been brilliant and I couldn't ask for more support, encouragement and friendship than you always give. You always know what to say at the right times to make me feel better and to encourage me so thank you especially to the two of you. I love you. And Dad, I doubt you realise how important your support has been too. I love you too. You have all always made me feel that I can achieve my goals and that means so much.

Finally I want to acknowledge and thank Richard. It's been hard work, but it's been fantastic and I'm so glad I got to share Hoga with you. Thank you for your continual love and support and again for making me smile when it all got a bit much. Here's to the next adventure!

And of course…how could I forget the coral reef coffee club! You know who you are and you're all fantastic xx

Contents

List of Publications

Cullen LC, Smith D, Pretty J (2006) Economic Importance of Marine Resources in the Wakatobi Marine National Park, Indonesia Ninth Biennial Conference of the International Society For Ecological Economics: Ecological Sustainability and Human Well-being. ISEE, New Delhi, India, p 22

Cullen LC, Smith DJ, Pretty J, Pilgrim SE (In press) Links between Local Ecological Knowledge and Wealth in Indigenous Communities of Indonesia: Implications for Conservation of Marine Resources. International Journal of Interdisciplinary Social Sciences

Pilgrim SE, **Cullen LC**, Smith DJ, Pretty J (2007) Hidden Harvest or Hidden Revenue? Local resource use in a remote region of Southeast Sulawesi, Indonesia. Indian Journal of Traditional Knowledge 6:150-159

Smith DJ, Pilgrim SE, **Cullen LC** (in press) Coral Reefs and People. In: Pretty J, Ball A, Benton T, Guivant J, Lee D, Orr D, Pfeffer M, Ward H (eds) Sage Handbook on Environment and Society. Sage Publications, London, p 1081-1117

List of Conference Presentations

International Society for Reef Studies: European Meeting, Bremen, Germany. 19th-22nd September 2006. Oral presentation: A comparison of the financial value of coral reefs and alternative incomes within the Kaledupa sub-region of Wakatobi Marine National Park, Indonesia.

Reef Conservation UK, Zoological Society London, UK. 9th December 2006. Oral presentation: Analysis of the economic value of marine resources within a small island community.

Ninth Biennial Conference of the International Society for Ecological Economics: Ecological Sustainability and Human Well-being. ISEE, New Delhi, India. 16th-18th December 2006. Oral symposia presentation: Economic Importance of Marine Resources in the Wakatobi Marine National Park, Indonesia

List of Figures

List of Tables

List of Abbreviations

AB	Averting Behaviour
CV	Contingent Valuation
CoV	Coefficient of Variation
CVM	Contingent Valuation Method
EP	Economic Performance
EPC	Economic Performance Criteria
FR	Financial Revenue
GDP	Gross Domestic Product
HDI	Human Development Index
MDG	Millennium Development Goal
MEA	Millennium Ecosystem Assessment
MNP	Marine National Park
MPA	Marine Protected Area
NGO	Non-Government Organisation
NOAA	National Oceanic and Atmospheric Administration (United States)
PF	Production Function
PRA	Participatory Rural Appraisal
REA	Rapid Ecological Assessment
Rp	Indonesian Rupiah
RRA	Rapid Rural Appraisal
TC	Travel Cost
TEV	Total Economic Value
TNC	The Nature Conservancy
UNEP	United Nations Environment Programme
US$	United States Dollars
WTA	Willingness to Accept
WTP	Willingness to Pay
WWF	Worldwide Fund for Nature

Chapter 1. General Introduction

All humanity depends entirely on Earth's ecosystems and their associated services such as the provision of food, water and raw materials, their role in global biogeochemical cycling, climate regulation and storm protection (Dixon 1986, Barbier 1994, Costanza *et al*. 1997b, Balmford *et al*. 2002, Wackernagel *et al*. 2002, Wilson 2002, MEA 2005, Millennium Ecosystem Assessment 2005, UNEP 2006b). An ecosystem can be classified as a geographically specified system of organisms, environment and processes controlling its dynamics. Human beings are an integral component of the ecosystems in which they live and on which they depend (Wilson 2002, Puglise & Kelty 2007), and healthy ecosystems can be characterised by their ability to sustain healthy human populations (Rapport *et al*. 1998).

Over the past 50 years humans have changed these ecosystems more swiftly and comprehensively than in any other comparable human period, largely to meet the growing demands of a growing population for food, water and raw materials (MEA 2005, Millennium Ecosystem Assessment 2005, UNEP 2006a). These changes have resulted in significant gains in economic development and well-being for some people, but as a result others and the environment have suffered. Human beings are significantly changing the diversity of life on Earth and most of these changes represent a loss of biodiversity which is crucial to our continued well-being and survival (Norse 1993, MEA 2005, Millennium Ecosystem Assessment 2005, Sala & Knowlton 2006).

It is clear that economic advances are unsustainable without maintaining the health of the environment (Norse 1993, Le Quesne & McNally 2005). Hence one of the Millennium Development Goals (MDG's) is to ensure environmental sustainability (UN 2006, 2007). This was derived from the United Nations Millennium Declaration, adopted by 189 nations in the year 2000, set to be achieved by the year 2015. This will involve integrating the principles of sustainable development into country policies and programmes and reversing the loss of environmental resources

To accomplish ecosystem survival in the face of global environmental problems such as climate change and sea level rise, we must address the manageable immediate threats that face our resources from damaging anthropogenic activities (Wilkinson 1996, Tomascik *et al*. 1997b). In order to understand and potentially mitigate for the impacts of global environmental change we must understand the impact of such changes on systems in which humans play an important role

(Haber *et al*. 2006). Humans are a part of the ecosystem and we need to move beyond seeing human activities simply as disturbances to previously well functioning ecosystems (Haber *et al*. 2006, Schutkowski 2006). Integration of ecological, social and economic disciplines and inclusion of the human element in all monitoring and management activities is the only reasonable way to move forward in the task of environmental, ecological and socioeconomic sustainability.

1.8. Importance of tropical marine ecosystems

The sea is rich in genetic, species and ecosystem diversity and the marine environment provides products and services that are important or vital to human existence (Norse 1993, Uychiaoco *et al*. 2004, Sala & Knowlton 2006). Marine and coastal ecosystems are among the most productive on the planet (Geider *et al*. 2001). In tropical regions in particular, marine and coastal ecosystems harbour some of the most important and impacted habitats including coral reefs, seagrasses and mangroves, which house incredible productivity and biodiversity (Wilkinson 1996, Tomascik *et al*. 1997b, Berg *et al*. 1998, Hoegh-Guldberg 1999).

Coral reef ecosystems are particularly highly valued for their biological, ecological, cultural, and economic resources, as well as their aesthetic qualities (Spurgeon 1992, Cesar 2000a, Puglise & Kelty 2007). Coastal areas and small islands make up only 4% of the Earths total land area but are home to more than one third of the worlds population, the vast majority of whom depend on marine and coastal ecosystems for their survival and well-being (Whittingham *et al*. 2002, UNEP 2006a). Unfortunately such high dependence also means that the ecosystem services provided are being degraded and overexploited and are deteriorating at a rate much faster than other terrestrial ecosystems (UNEP 2006a). Coral reefs are probably the most endangered marine ecosystem on earth and human activities continue to be the primary cause of the global coral reef crisis (Wilkinson 1996, Wilkinson 2004, UNEP 2006a).

In 2002 the World Summit on Sustainable Development in Johannesburg confirmed that global sustainable development and poverty reduction requires a healthier and more sustainably managed ocean. The summit paid special attention to coral reefs and the role of mangroves and other shallow water ecosystems, as these are critical to many countries (UN 2002, Wilkinson 2004). The Convention on Biological Diversity has also consistently recognised coral reefs as a major focus for its work on marine and coastal biological diversity. Ensuring healthy coral reefs for future generations is a vital component of the Convention's target to achieve a significant

reduction of the current rate of biodiversity loss by 2010 as a contribution to poverty alleviation and human well-being (UNEP 2006b). The Millennium Ecosystem Assessment (MEA) has also recognised the importance of coral reefs to the livelihoods and well-being of millions of poor people and the threats of climate change and anthropogenic activities (UNEP 2006a). One of the Millennium Development Goals (UNDP 2005) was to halve world poverty by 2015 and the sound management of coral reefs was identified as critical to this aim.

1.8.1. *Ecological importance*

Marine and coastal ecosystems are highly productive and rich in biodiversity, nearly 50% of all animal phyla only occur in the sea (Sala & Knowlton 2006). A vital marine ecosystem service is the marine biological "pump" which decreases atmospheric concentrations of CO_2 (Smith & Kinsey 1976, Kinsey & Hopley 1991, Norse 1993, Hubbard 1997, Kuntz *et al*. 2005). Many influential ecological theories originated from the marine environment which have provided insights for sound conservation and resource management theories (Norse 1993). Coral reefs are particularly well distinguished for their beauty, biological diversity and high productivity (Hoegh-Guldberg 1999). They support 32 of the 34 known animal phyla (in a wider context, 9 of these phyla are found in tropical rainforests) (Wilkinson 2002), but it is their high productivity, within otherwise unproductive waters, that makes them critical to the survival of tropical marine ecosystems and local people (Wilkinson 1996, Berg *et al*. 1998, Hoegh-Guldberg 1999).

Seagrass habitats are also of high importance for their ecological functions and ecosystem services such as their role in food web dynamics, seascape interactions and ecological resilience (Duarte 2000, Gunderson 2001, Valentine *et al*. 2002, Moberg & Ronnback 2003). Seagrasses are distributed across the globe and despite low floral diversity (globally only approximately 60 species) they provide critical habitat for diverse faunal assemblages including 360 species of fish (Tomascik *et al*. 1997b). They are also an important source of food for megaherbivores such as dugongs, turtles and manatees, and they stabilise sediments whilst producing large quantities of organic carbon, thus they have an important function in the food web (Tomascik *et al*. 1997b, Orth *et al*. 2006).

Mangrove forests are characteristic of tropical coastlines, there are around 19 common species of tree supporting around 20 additional species of epiphytes and providing habitat for other higher plants, algae, mosses and liverworts, and they are highly productive (Whitten *et al*. 1987, UNEP-WCMC 2006). They provide important habitat for many species', hence also support

biodiversity through the provision of habitat, they protect land areas from storms, trap sediments, stabilise coasts and support the food chain through production of leaf litter and detritus (Melana *et al*. 2000, UNEP-WCMC 2006). Mangal forest also provides essential nursery grounds for many species of fish, prawns and crabs (Mumby *et al*. 2004, Dorenbosch *et al*. 2005). Additionally they produce organic carbon and reduce organic pollution in nearshore areas through trapping or absorption (Ruitenbeek 1994, Gilbert & Janssen 1998, Rönnbäck 1999, Melana *et al*. 2000, UNEP-WCMC 2006).

1.8.2. *Economic importance*

Marine and coastal ecosystems provide numerous goods and services that are essential to human existence and well-being. A large percentage (in some countries in excess of 60%) of the animal protein consumed by human populations comes from the sea, the marine environment has the greatest prospects for new medicine development (including antiviral and anti-tumour drugs), and some ecosystems such as mangroves and coral reefs, provide physical protection to coastal communities from storms (Norse 1993, UNEP-WCMC 2006). Seagrass and mangrove habitats can also provide a sink for limited domestic, industrial and agricultural waste (Dixon 1989, Melana *et al*. 2000, de la Torre-Castro & Rönnbäck 2004, UNEP-WCMC 2006).

Coral reefs represent an important economic resource with benefits for local and global economies (Cesar 2000b). Locally, reef fisheries are a vital source of protein for millions of people, reef-related tourism is a major foreign currency earner, and reefs provide natural coastal protection from wave action and potential storm damage (Cesar 2000a). On the global scale, reefs are valued for their role in the carbon and calcium cycles', and for bioprospecting which can benefit developments in agriculture and the food, pharmaceutical and chemical industries (Spurgeon 1992, Pendleton 1995, Cesar 2000b). The mean global value estimated for the ecosystem services provided by coral reefs is US$ 6,075 $ha^{-1}yr^{-1}$ or globally US$ 375 $billionyr^{-1}$ (Costanza *et al*. 1997b). This is reflected by the fact that worldwide, fisheries and fish products provide employment for more than 38 million people; the coastal tourism industry is also growing rapidly, providing direct employment and generating local incomes. Coral reef-based tourism alone is estimated to generate approximately US$1.2 billion annually in the Florida Keys (UNEP 2006a).

Seagrasses also provide important ecosystem goods and services which have high economic importance; these include the provision of critical habitat for many commercially and

recreationally important fish species (Dorenbosch *et al*. 2005, Dahlgren *et al*. 2006). They are an important resource base for rural human populations (Gullstrom *et al*. 2002) contributing significantly to their welfare through the provision of fishing grounds, bait collection grounds, substrate for seaweed cultivation, traditional medicines and food as well as the social and cultural services and aesthetic value that they provide (de la Torre-Castro & Rönnbäck 2004). Seagrasses and algae beds combined have an estimated value in terms of ecosystem goods and services of US$ 19,004 $ha^{-1}yr^{-1}$ or globally US$ 3,801 $billionyr^{-1}$ (Costanza *et al*. 1997b). However, once again, seagrasses and these associated ecosystem services are under direct threat from numerous anthropogenic impacts (Orth *et al*. 2006).

Mangrove habitats also have recognised and valuable consumptive and non-consumptive economic values, and play an important role in global biogeochemical cycles (Farber & Costanza 1987, Aylward & Barbier 1992, Barbier 1994, Ruitenbeek 1994, UNEP-WCMC 2006). They support coastal fisheries production, provide fish and shellfish for consumption, are a source of traditional medicines, tannin, honey and alcohol. They provide shoreline protection for local human communities and have recreational, spiritual and cultural importance. Mangroves are a source of wood and for housing materials, firewood and charcoal, and poles for fish traps. Mangrove seeds and propagules can be harvested and sold, and aquaculture and commercial fisheries depend on mangroves for juvenile and mature fish species (Melana *et al*. 2000). (Dixon 1989) estimated that mangroves had a value in terms of the ecosystem services they provide of US$ 500 to US$ 1550 $ha^{-1}yr^{-1}$. More recently mangroves and tidal marshes have been given an estimated combined value in terms of ecosystem goods and services of US$ 9,990 $ha^{-1}yr^{-1}$ or globally US$ 1,648 $billionyr^{-1}$ (Costanza *et al*. 1997b).

1.8.3. *Ecosystem decline*

In the past few decades, competing demands on coral reef and associated ecosystems and increasing threats from both natural and anthropogenic stressors, have contributed to a significant decline in ecosystem health (Tomascik *et al*. 1997b, Wilkinson 2002, 2004, MEA 2005, Millennium Ecosystem Assessment 2005, UNEP 2006a, Puglise & Kelty 2007). It has been estimated that 20% of the world's coral reefs have already been damaged beyond recovery, that 24% are under imminent risk of collapse and 26% at risk of collapse in the longer term (Wilkinson 2004). Reported cases of seagrass loss have increased almost tenfold over the last 40 years, largely due to increasing anthropogenic stresses (Orth *et al*. 2006) and approximately 35%

of the worlds original mangrove cover has already been lost with some countries having lost up to 80% (UNEP-WCMC 2006).

The major drivers of change, degradation and loss however have been identified as largely anthropogenic (Wilkinson 1996, Orth *et al*. 2006, UNEP-WCMC 2006, UNEP 2006a). Coral reefs, seagrasses and mangroves worldwide are being degraded or destroyed by human activities and more damage will occur as anthropogenic impacts, particularly as a result of population growth and economic activities continue to increase. This degradation of habitats and associated resources will result in severe ecological and economic losses (Wilkinson 1996).

1.9. Threats to marine and coastal ecosystems

Humans directly harm marine ecosystems in five major ways: 1) overexploitation of biota; 2) alteration of the physical environment; 3) introduction of pollutants; 4) introduction of alien species; and 5) addition of atmospheric substances which induce climate change. The effects of overexploitation and pollution are most well known and the majority of marine species driven to extinction in recent times were the victims of overexploitation (Norse 1993).

The *Status of the World's Coral Reefs: 2004* report (Wilkinson 2004) outlines that the major coral reef stressors include natural forces that they have coped with for millions of years and more recent direct human pressures. Important anthropogenic stressors include sediment and nutrient pollution from the land, over-exploitation and destructive fishing practices, shoreline modification; and the global threats of climate change which can result in coral bleaching, rising sea levels which can threaten the ability of corals to form skeletons in more acid waters. For successful reef conservation, local action must be taken to reduce the direct human impacts and, globally, to combat greenhouse emissions, the former may result in an inability of coral reefs to withstand natural disturbance events and the impacts of global climate change and can accelerate associated degradation (Wilkinson 2004).

Anthropogenic pressures are continuing to rise in almost all coral reef areas of the world, as human populations increase, their demands for natural resources is also increasing and resulting in the overexploitation of coral reefs and associated resources. Some of the most significant impacts include overfishing, destructive fishing, coral mining, sedimentation and nutrient enrichment (Grigg 1984, Wells & Alcala 1987, White 1987, Dulvy *et al*. 1995, McManus 1997, Pet-Soede *et al*. 1999, Öhman & Cesar 2000, Wilkinson 2004, Crabbe & Smith 2005). Indirect

anthropogenic impacts include rising poverty, reduced capacity for management and a lack of protective political will (Wilkinson 2004). The continuation of destructive practices is often justified by their short-term financial benefits, but a more balanced cost-benefit analysis provides sufficient reason to stop the current destruction of reefs in this way (Cesar 1996, Berg *et al*. 1998, Cesar & Chong 2004).

According to Norse (1993) there are five root causes underlying the direct human threats to marine resources: 1) overpopulation; 2) excessive consumption and inequitable resource distribution; 3) centralisation of control; 4) a lack of knowledge; and 5) the failure of economic systems to adequately value the environment. Without addressing these root causes, efforts to reduce ecosystem degradation will simply delay the inevitable destruction.

1.9.1. *Overexploitation*

People extract a huge variety of marine plants and animals for use as food, raw materials, pets, curios and medicines. Theoretically all species could be extracted sustainably if no more individuals were taken than reproduction could replace (Spurgeon 1992, Norse 1993) which was historically the case for many indigenous peoples (Norse 1993, Langton *et al*. 2003, Shepherd & Terry 2004). Today's exploiters are more numerous, with efficient technological advances and the cultural restraints ruling traditional peoples are generally lacking in modern cash based economies (Norse 1993, Evans *et al*. 1997).

Marine overexploitation is the harvesting of fish, invertebrates and plants beyond sustainable yields and is largely related to increasing human populations and associated increased demands for seafood (Wilkinson 2004). Virtually all commercially valuable marine populations are now overexploited, in at least part of their range (Norse 1993), the greatest impact of which is being felt within marine fisheries. Overfishing does not directly destroy ecosystems, but it reduces the abundance of fish and invertebrates and can lead to phase shifts on reefs from coral dominated to algal overgrowth and dominance (Mumby 2006), additionally, reefs without fish are more susceptible to plagues of coral predators and increased disease (Cesar *et al*. 1997, Wilkinson 2004). Most coral reefs within the range of small fishing boats are now over-fished (Wilkinson 2004).

1.9.2. *Destructive fishing methods*

A large number of the practices used by fishers may be regarded as destructive either through the damage they do to the environment, especially the corals, or through the collapse of local trophic structure through indiscriminate targeting and overfishing (Pet-Soede *et al*. 1999, Tun *et al*. 2004). Destructive fishing methods like bomb and poison fishing have been heavily used in recent years and have resulted in the destruction of large areas of coral reef. Although such methods have been banned in all countries, illegal fishing continues almost unabated in many areas (Tun *et al*. 2004). Destructive practices and their effects have been widely described e.g. (Johannes & Riepen 1995, Cesar 1996, Pet-Soede & Erdmann 1998, Pet-Soede *et al*. 1999, Fox *et al*. 2003)

Bomb fishing involves the detonation of small, usually home-made bombs in shallow reef areas to kill targeted schools of fish. The blasts also kill large numbers of larvae and juveniles, and reduce coral reefs into fields of rubble (Cesar *et al*. 1997).

Poison fishing is the practice of using poisons (often potassium cyanide) to stun and capture live fish for the aquarium or live fish food trades. The poison is usually squirted into live coral heads which also kills the coral and tools may be used to break open the coral structure to retrieve the stunned fish which causes extensive physical damage to the reef (Cesar *et al*. 1997). The trade in live reef fish in Asia in particular is driven by the intense market demand for live-food fish from Asian restaurants and the trade is a multi million dollar industry (Wilkinson 2004).

1.9.3. *Coral and sand extraction*

Coral mining is the practice of removing coral directly from the reef. Coral stone is used as a cheap building material, for the production of lime, and sometimes for ornamental purposes (Berg *et al*. 1998). Sand extraction involves the removal of sand directly from beaches for use in building. As the reef structure is the habitat of associated fish communities, the reduction of live coral cover and structural variation associated with coral mining, reduces fish abundance and diversity, as well as reducing the tourist attraction function and the physical structure function (coastal protection) of the reef resulting ultimately in an irreversible collapse of the whole reef ecosystem (Berg *et al*. 1998). The continued removal of sand also results in reduced protection function and tourist attraction function as beaches are slowly reduced. As a result, these activities have been made illegal in many countries but mining and extraction continue where there are

limited sources of sand, limestone and building materials on land and where there is no governmental enforcement, for example in Southeast Asia (Wilkinson 2004).

1.9.4. *Sedimentation and nutrient enrichment*

Sedimentation and pollution occur as a result of deforestation, erosion, release of untreated sewage, costal development and in some areas industrial discharges (Cesar *et al*. 1997). Sediments reduce light penetration required for the photosynthesis, increase rates of disease and bioerosion, and slowly bury corals (Crabbe & Smith 2005).

Reefs and associated habitats can also be damaged by excess nutrients that favour the growth of macro-algae and result in increased phytoplankton growth in seawater which again reduces light penetration (Crabbe & Smith 2005, Smith *et al*. 2007). All reefs near human populations or adjacent to large land masses suffer degradation from sedimentation and nutrient enrichment (Wilkinson 2004).

1.9.5. *Indirect human pressures*

Rising poverty and increasing human populations puts increasing pressures on natural resources, and this coupled with a poor capacity for management in most coral reef countries is allowing natural resources to be pushed beyond sustainable use limits (Wilkinson 2004). There is a lack of trained personnel, awareness, monitoring and enforcement which is largely related to a lack of adequate funding and logistics for management. In many countries there is also a lack of political will for conservation which in many instances stems from the fact that the economic benefits and potential of natural resources is not recognised (Spurgeon 1992).

1.9.6. *Additional threats to seagrasses*

Threats to seagrasses include those related to global climate change such as increases in sea surface temperatures, sea level rise, and frequency and intensity of storms, as well as more direct anthropogenic impacts (Orth *et al*. 2006). Direct anthropogenic impacts include the discharge of agricultural, industrial and domestic effluent and the associated reduction of water quality, increased sedimentation and nutrient loading, dredging and other mechanical damage, and overexploitation of seagrass fauna (Whitten *et al*. 1987, de la Torre-Castro & Rönnbäck 2004, Orth *et al*. 2006). The environmental effects of excess nutrients or sediments are the most

common and significant causes of seagrass decline (Orth *et al*. 2006). The direct influence of other organisms (e.g. urchin overgrazing, and disease) however, has also led to large-scale losses as has direct mechanical damage from trampling and anchors. Recently, greater attention has focused on the role of top-down control in seagrass declines and outlined the impact of overfishing (Orth *et al*. 2006). The destruction of seagrass has wide ranging consequences, the most significant of which include a reduction of detritus production, which changes the fish community and alters the food web, beach erosion due to the loss of the binding grasses, and loss of structural and biological diversity (Whitten *et al*. 1987, Valentine *et al*. 2002). Many seagrass-associated species, including commercially important fish species are also threatened or vulnerable to extinction (Orth *et al*. 2006).

1.9.7. *Additional threats to mangroves*

Mangroves have been degraded through conversion to aquaculture, extraction of wood for fuel and charcoal production, disease and storms (UNEP-WCMC 2006). The direct human impacts include conversion of mangrove area to fish ponds and salt beds, reclamation of land for development, pollution and sedimentation, coastal construction resulting in altered tidal flow, overexploitation of wood and other direct physical damage during collection of fish and invertebrates. Logging mangroves illustrates the multiple causes and consequences of human induced physical environmental alteration. Logging eliminates the permanent residents of the mangrove habitat and the nursery grounds upon which wild fish and shrimp stock depend, it also eliminates mangrove detritus and increases coastal vulnerability to erosion from wind and wave action (Norse 1993). Additionally loss of mangrove can result in up to a 50 percent reduction in nearby reef fish biomass (Mumby *et al*. 2004).

Natural threats to mangroves include outbreaks of pests and disease, typhoons, and sea level rise due to global climate change, which could also be considered an indirect anthropogenic affect (Melana *et al*. 2000). Once again the direct anthropogenic impacts can result in a reduced capacity of mangroves to show resilience to natural threats and global threats such as climate change.

1.10. Natural resource management

There has been a growing movement to understand, protect and sustainably utilise marine and coastal ecosystems but there remain significant obstacles to successful conservation. These include scientific or technical constraints such as limited knowledge of the value and vulnerability of the sea; inadequate dissemination of information; cultural issues such as the replacement of diverse human cultures adapted to sustainable living in diverse coastal ecosystems by wasteful, consumer oriented world culture; economic issues, the main consequence being the tragedy of the commons; political constraints such as fragmented decision making and centralisation; and legal constraints (Norse 1993). Regardless of the obstacles, conservation and sustainability must be achieved hence some form of management is essential. Management is a logical process it is about people and is a method through which goals can be achieved (Worboys *et al*. 2005). Hence environmental management has been emphasised within the Millennium Development Goals (UNDP 2005) and a key target is to halve world poverty by 2015, using sound, integrated management of the environmental and social dimensions of coral reefs and associated habitats (Wilkinson 2004, UNDP 2005).

Complete and detailed quantitative data on marine and coastal ecosystems are rarely available, hence decisions about their management are often made without good quantitative data or the involvement of local user groups (Fernandes *et al*. 1999). Effective ecosystem management requires scientifically-based information on ecosystem state and the causes and consequences of this state as well as predictions of future changes, and the costs and benefits of proposed management actions. The identification and characterisation of ecological and socioeconomic aspects of ecosystems are essential and baseline information on the economic, cultural, institutional, and social values, as well as human use patterns of ecosystems must be determined (Puglise & Kelty 2007).

1.10.1. *The need for marine and coastal resource management*

The highly threatened nature of marine and coastal ecosystems and the demand for their goods and services highlights the urgent need for management which includes local, regional and global responses. Critical marine areas having the highest priority for protection and management include those with high diversity, endemism and productivity, spawning areas, nursery grounds migratory stopovers and bottlenecks (Norse 1993). *Various response options are available, for example regional and global agreements or local capacity development and*

stakeholder participation, but addressing uncertainties and elaborating trade-offs is a useful mechanism for operational responses (UNEP 2006a). The task is complicated though and there are many conflicting arguments to consider, particularly the impact that management actions will have on local dependent human communities. Because many of the world's richest ecosystems and poorest people are found together in the tropics it's not surprising that the understandable human aspiration for improved living conditions often clashes with biodiversity objectives (Randall 1991). This conflict of interest between economic development and the environment has created worldwide problems. In 1983 the United Nations appointed an international commission to propose strategies for "sustainable development" defined as "development which meets the needs of human well-being in the short term without threatening the local and global environment in the long term" (Brundtland 1987). This means that trade-offs must be made between the protection and use of natural resources and ways must be found to produce economic benefits from ecosystems whilst maintaining protection benefits (Dixon *et al*. 1993). Major constraints to the sustainable development of coastal resources however are poverty and a lack of sustainable livelihoods for people in coastal communities who often rely on the sale of fish and other marine resources to support their families (Elliott *et al*. 2001).

1.10.2. *Current management failings and challenges*

Many established protected areas are threatened because of the economic impact they place on local communities (Wells *et al*. 1991). One of the major problems of management currently is lack of local compliance (Elliott *et al*. 2001), and one of the major reasons for this is the actual, perceived, or even just expected, economic losses to those communities utilising marine natural resources for livelihoods and subsistence. So a key role of management should be to improve the economic status of local people, which means that any management strategies must consider economic impacts on local people. Monitoring of economic status should be included, in addition to biological monitoring, to ensure no losses occur due to economically inappropriate management schemes. Alternative income streams must also be made available where incomes begin to, or are expected to, be negatively impacted. Additionally, economics could, and should, be used as a tool to encourage conservation and sustainable utilisation efforts, as the economic benefits of a healthy natural environment will far outweigh those of an impacted and biologically limited system. We need to focus on the interactions between socioeconomic and ecological systems and make the links between changes in each clear to human society. We also need to improve communication between the different scientific disciplines and the public users.

1.10.3. *Changing approaches to natural resource management*

Approaches to natural resource management have been varied and continue to be adapted (Smith *et al*. 2007). In the past, natural resource management focused on understanding and managing ecosystems from a biological viewpoint with very limited user group consultation. Currently, however, management strategies have started to incorporate the wider social and economic factors, specific user groups are encouraged to participate in various management actions, and cost benefit analyses, environmental impact assessments, and bio-economic models, are used to support decision making. In the future local user groups must be actively engaged in the management process (figure 1.1.) (Spurgeon 2001). Traditionally, coral reef ecosystem research has focused on the impacts that human activities have on the ecosystem as measured by one or more environmental metrics. Now we are beginning to understand the ecology of these systems, we are still lacking information on the social, cultural, and economic aspects of coral reef ecosystems (Puglise & Kelty 2007). In this changing management approach, local use patterns and quantification of the levels of financial dependence of local communities on these resources is essential to avoid significant economic errors that will lead to increased ecological destruction.

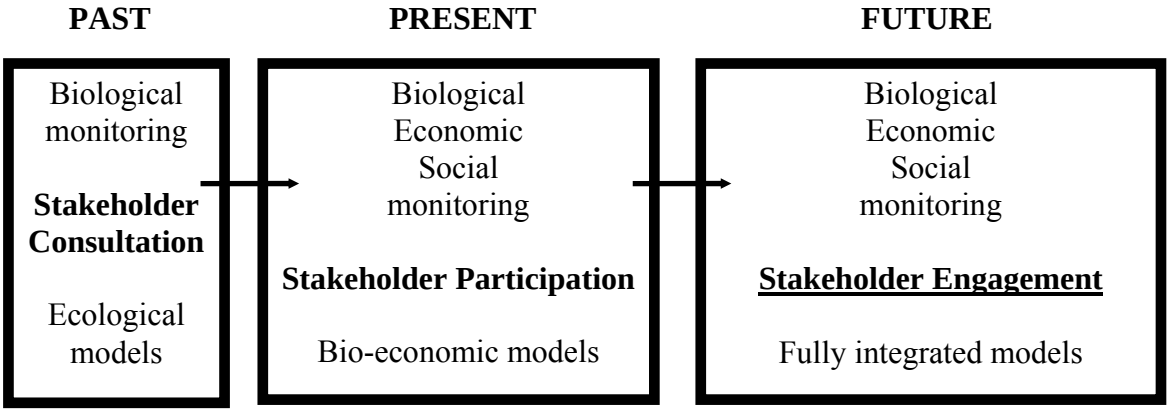

Figure 1.1. Changing approaches to natural resource management. Adapted from Spurgeon (2001)

1.11. The role of ecological economics in natural resource management and conservation

Economics is the dominant force in governments' and international bodies' decision making process's and economic ministries have far more power than environmental ministries in most nations, unfortunately existing economic systems are inadequate in providing environmental

protection (Norse 1993, Nadeau 2003). Economics does however have an important contribution to make to the identification and solution of the global problem of overexploitation and degradation of natural resources (Perrings *et al*. 1992), but an integrated approach combined with an ecological discipline is more appropriate. Ecology can be used to establish the amount and availability of natural resources and habitats, and identify and monitor population dynamics and system changes, whereas economics can be used to understand resource use and degradation patterns which can help to design appropriate policies to fight degradation (Pearce & Mäler 1991, Dixon 1997, Le Quesne & McNally 2005). The explanatory role of ecological economics is that we need to understand why resource degradation occurs and how economic mismanagement through wrong pricing, ill defined property rights and incentive structures, contributes to environmental loss. Ecological economics can be used within a policy development role to devise the best practicable solutions for sustainable development (Pearce & Mäler 1991).

1.11.1. *Economic versus financial analysis*

There is often confusion between economic and financial analyses, although the difference is fundamentally important. A financial analysis is carried out from a private perspective and is concerned only with narrowly defined profits and losses. Economic analysis is conducted from the standpoint of society's welfare and reflects social opportunity costs and benefits of various actions (Dixon 1986). For public developments government decision makers use economic analyses with economic values to determine the overall net economic benefit to society as a whole (Spurgeon 1992). Both methods are valid, given the different perspectives involved, e.g. a government may wish to do both a financial and economic analysis to determine the narrow profitability of a project as well as the wider social costs and benefits. The economic input is an aid and a necessary tool for decision making (Dixon 1986). However, on the local scale where direct differences can be made, it is the direct financial (monetary) values that are important to local people who require income. In many cases there may not be a direct translation of the direct value of the resource so vital it also equates to economic status and wellbeing. Valuation therefore is not a purely financial concept; it is an economic concept with monetary units used for ease of comparison (Robbins 1935, Pearce & Turner 1990, Green & Tunstall 1991).

1.11.2. *Why value the natural environment?*

Worldwide economies would come to a stop without the services of ecological life support systems, so it is thought by some that their value to human welfare is infinite (Costanza *et al*. 1997b). However, it can be instructive to estimate the marginal value of ecosystem services i.e. the estimated rate of change of value compared with changes in ecosystem services from their current levels. Ecosystem valuation 'at the margin' consists of determining the differences that relatively small changes in services will have on human welfare. Changes in quality or quantity of ecosystem services have value in that they will change the benefits or costs of particular activities. These changes may impact human welfare through established markets or through non-market activities. For example coral reefs provide habitats for fish, one aspect of their value is to increase and concentrate fish stocks. A change in reef quality or quantity would be observable in commercial fisheries markets or in recreational fisheries. However, other values of coral reefs, for example SCUBA diving and biodiversity conservation, do not show up completely in markets therefore various methods have been employed to estimate both market and non-market components of ecosystem services (Costanza *et al*. 1997b).

It is generally accepted by both environmental economists and ecologists that environmental resources should be valued in economic terms when decisions are made involving the loss or conservation of such resources (Green & Tunstall 1991). The main argument for this is that without valuation, when other consequences of the decision are compared in monetary terms, if the environmental consequences have not been valued, they will be treated as having zero value (Green & Tunstall 1991). Those who disagree with the economic evaluation of natural resources, often misrepresent economics as being about money, which it is not. Money is just the means of measurement to compare the relative values of different goods and services (Pearce & Turner 1990). In economics all values of all goods are subjective and the environmental or ecological economist is seeking to derive a method of measuring the values different individuals place on different goods so that they can be compared (Green & Tunstall 1991). Money is used as the basis for comparison because an individuals subjective values are unobservable and often incomparable (Robbins 1935), however, as a yardstick, money has the disadvantage that individuals have different amounts available to them (Green & Tunstall 1991). This disadvantage should be considered when valuing non-market goods and services.

Additionally there are direct financial gains to be made from natural resources and people tend to respond to monetary price signals, hence we need to identify the direct financial values of natural

resources. These values must be communicated to local dependents to highlight the increased direct value of healthy rather than degraded ecosystems.

Despite recent advances in environmental valuation techniques and the advantages of using them, full analyses are rarely carried out (Spurgeon 1992). To place a value on some environmental benefits requires detailed economic and biological information, and perhaps even international coordination, and still some techniques will have inconsistency and bias (Pearce & Turner 1990). Inaccuracies will exist because of incomplete understanding of complex environmental processes and biological uncertainties (Spurgeon 1992).

1.12. Valuation methods: Total Economic Value

Various methods exist to value ecology and the environment and the information gathered within a Total Economic Value (TEV) calculation utilises many of the available methodologies (Phillips 1998). TEV can be characterised differently according to the type of economic value arising (Bateman *et al*. 2002). It is calculated as a measure of the current or potential economic worth of any resource, and is usually the sum of all of the direct, indirect and non-use values of that resource (Alcamo *et al*. 2003, Common & Stagl 2005). Direct use values relate to actual use (consumptive and non-consumptive) of the resource in question (e.g. fisheries and diving), indirect use values usually relate to functional uses or services provided (e.g. coastal protection). Non-use values relate to the value of maintaining resources intact for future use (option value); for use by future generations (bequest value); or simply for existence with no actual, planned or possible human use (intrinsic value) (Bateman *et al*. 2002, Alcamo *et al*. 2003). Environmental valuation for resource accounting requires techniques to value direct, indirect and non-use benefits accruing from resources and habitats. Their economic value is essentially the difference in current and/potential net economic benefit to society in situations with and without the resource or habitat in question, once determined the economic implications of environmental impacts can be assessed in the overall change in TEV (Costanza *et al*. 1997a).

Many of the benefits associated with coral reefs are not exchanged in markets and are therefore hard to value, hence they have often been ignored or grossly underestimated in the past (Spurgeon 1992, Cesar 1996). Complete and detailed quantitative data on coral reef ecosystems are rarely available so decisions are often made without good quantitative data or the involvement of local user groups (Fernandes *et al*. 1999). Economics can play a key role in understanding the reasons for this and how benefit estimation can be improved (Dixon &

Sherman 1991). The economic information contained in a TEV calculation can be very powerful in making the case for the benefits of protecting and managing coral reefs in a sustainable manner (Dixon 1997). The direct use values, in particular the direct financial benefits of coral reefs could be an extremely valuable tool in making the case to local user groups and dependent for maintaining coral reefs and associated ecosystems in a healthy state and promotion of sustainable utilisation.

Coral reefs provide many goods and services that support and promote life within the biosphere and their full potential economic value is enormous (Costanza *et al*. 1997b). When valuing coral reefs and their associated habitats it is acceptable to identify a small number of key aspects for which a monetary value can be calculated to determine the minimum value of the reef in question (Cesar 1996). As an example, the values that would be included in a TEV for coral are summarised in table 1 and most significant values discussed below.

Table 1.1. Components of coral reefs that contribute to their Total Economic Value.

Use values			**Non-use values**		
Direct		**Indirect**	**Option**	**Existence and Bequest**	**Intrinsic**
Consumptive	***Non-consumptive***				
• Fisheries • Aquarium trade • Curio trade • Pharmaceuticals • Construction materials	• Tourism • Research • Education • Recreation • Culture • Religion	• Biological support • Coastal protection • Global life support	Maintenance of system for future use	Knowledge of system existence and continued existence for enjoyment by future generations	• Biodiversity • Species richness Existence with no human use

1.12.1. *Indirect use values*

The indirect values of coral reefs and associated ecosystems are the associated functional benefits, or services, provided by reefs which include coastal protection, bioprospecting potential, and biological and global life support (Costanza *et al*. 1997a, Common & Stagl 2005).

Coastal Protection

The physical structure of coral reefs provides people with indirect economic benefits without requiring direct resource extraction (Cesar 2002). An actively growing reef is a dynamic ecosystem under continuous influence from biotic and abiotic factors that may alter reef structure (Smith & Kinsey 1976). Reefs that fringe the shore provide a natural wave breaker and protection from potential storm damage and provide large amounts of beach material essential for the preservation of tropical sandy shores, which is important for the prevention of land loss and for the maintenance of important tourist beaches in some areas (Spurgeon 1992). Coral reefs and the physical structure they hold may hold back coastal erosion and protect economically important constructions and land uses (Berg *et al*. 1998). The coastal protection function of coral reefs can be described through the preventative expenditure approach (or replacement cost method), defined as the cost of replacing the coral reef with protective constructions, e.g. groynes or underwater offshore wave breakers (Spurgeon 1992). Alternatively the coastal protection function can be described by looking at the loss of property value, defined as the cost of land loss (price of lost land, buildings, roads etc) as a result of coastal erosion, this method also includes the loss of income resulting from lost land use opportunities (e.g. agriculture) (Berg *et al*. 1998).

Bioprospecting potential

Coral reef organisms, particularly corals, gorgonians and sponges, contain biologically active compounds therefore they have potential for pharmaceutical and industrial applications. Most species are yet to be catalogued and systematically evaluated for their commercial potential, but as most known species have proven useful it is reasonable to expect that many presently unknown species will also be of use, additionally, new uses for known species may also become apparent in the future (Randall 1991). There has recently been a sharp increase of interest in bioprospecting i.e. the search among the genetic codes contained in living organisms for the development of chemical compounds of commercial value in agricultural, chemical or pharmaceutical applications (Simpson *et al*. 1996). Attempts have been made to quantify these values by assessing the willingness to pay of pharmaceutical industries for genetic diversity as input into commercial products (Simpson *et al*. 1996). The marginal value of such input, often translated in terms of genetic information for medicinal purposes, is measured by its contribution to the improvement of healthcare (Nunes & van den Bergh 2001)**.** Registrations and applications

of bioprospecting contracts also represent important benchmarks of monetary indicators for these types of biodiversity values (Simpson *et al*. 1996).

Scientists are just beginning to understand the potential diversity of coral reefs, it is thought that only 10 percent of marine species associated with coral reefs have been identified and described and corals themselves possess an as yet uncalculated value as biochemical material for pharmaceuticals and other products (Burke *et al*. 2002).

Biological Support

Coral reefs interact in a variety of ways with other ecosystems providing biological support which has indirect economic implications (Nybakken 1997, Osborne 2000). Accurate valuation of such support systems is difficult but estimations of a rough value may be possible using a change in productivity approach (Phillips 1998), which is the difference in value of a reef supported economic activity with and without the reef.. Alternatively the biological support value is effectively the value of the supported activity multiplied by an estimated percentage dependence of that activity on the reefs presence, referred to as the 'percentage dependence technique' (Spurgeon 1992).

Global life support

Biochemical processes occurring within coral reefs have an important role on the global scale, for example in the calcium and carbon cycles. Shallow, seaward portions of modern coral reefs produce about 4 kilograms of calcium carbonate per square metre per year, and protected areas produce about 0.8 kilogram per square metre per year (Smith & Kinsey 1976). Corals fix around 50 % of the total calcium that enters the sea every year and act as a carbon sink removing the equivalent of around 2 % of the present output of anthropogenic CO_2 per year, which may rise to 4 % in the event of global warming and predicted increases in reef production (Kinsey & Hopley 1991). Therefore the carbon storage function of coral reefs may be of significant economic value. There is some concern that corals are also releasing CO_2 through the natural breakdown of calcium carbonate and respiration and that they are in fact a small net source of CO_2, nevertheless their role in the overall cycle is an important and valuable one (Spurgeon 1992).

1.12.2. *Non-use values*

The non-use values of coral reefs refer to the perceived benefits of reefs outside of the value of any goods or services they provide us with. Non-use values include the existence type values placed on reefs by humans, which is measurable, and the intrinsic value of coral reef and associated organism existence and biodiversity (Randall 1987, 1991, King 1995, Dixon 1997, Gustavson 1998, Cesar 2002, Newcome *et al*. 2005).

Existence, Bequest and Option

Existence and bequest are simply the values that people place in the knowledge that a natural resource or individual organism exists and that it will continue to do so for future generations to enjoy (Common & Stagl 2005). Existence and bequest values have not been determined for coral reefs but have been measured for individual species (Pearce & Turner 1990) and for ecosystems. The only method of valuation is the contingent valuation method (CVM) using peoples stated willingness to pay for an area or species to be preserved (Phillips 1998). The willingness to pay (WTP) (or willingness to accept (WTA) compensation for loss of the thing to be valued) is based on hypothetical scenarios. Measurement of the existence and bequest value of coral reefs and associated habitats would require an extensive CVM survey that included local, national and international population representations (Spurgeon 1992). The greater the quality and the uniqueness of the reef on a national and global scale, the greater its existence value will be. On the local scale, population size, level of income, education and environmental perception will influence the overall value (Spurgeon 1992). Option value is the value people place on maintaining the natural environment in a state suitable for utilisation in the future if utilisation became favourable or necessary, again CVM is the only available technique to determine this value (Phillips 1998).

Intrinsic value

The valuation of ecosystem existence and biodiversity in its own right, i.e. as removed from any association with human welfare, is complicated, controversial and incredibly difficult to achieve (Randall 1991). It is controversial because many people feel it is wrong for humans to place a value on biodiversity as it is of infinite value, both to human welfare and in its own right (Spash *et al*. 2000). However making public or private decisions that effect biodiversity implicitly means attaching a value to it (Cesar 2002, Brauer 2003). Hence monetary valuation can be used

as a democratic approach to make decisions about public issues, including biodiversity ones (Nunes & van den Bergh 2001).

Biodiversity also has an instrumental value to human society and the maintenance of biodiversity has become a popular argument for ecosystem protection for this reason (Dixon & Sherman 1991). There are potentially enormous welfare implications related to biodiversity loss. Individual organisms have direct value in terms of consumption or production, whereas communities of organisms, and their role in sustaining biophysical cycles, within a framework of ecosystems, makes them of indirect value in satisfying human needs for the services of those ecosystems (Perrings *et al*. 1992).

To value biodiversity, CVM is the most used technique as it is able to identify and measure passive or non-use values (Spurgeon 1992). Existing monetary value estimates seem to give explicit support for the belief that biodiversity has a significant positive social value, but most studies lack a uniform clear perspective on biodiversity as a distinct concept separate from biological resources i.e. the instrumental value of biodiversity. Monetisation of benefits is possible but will always lead to an underestimate of the 'real' value, since the primary (intrinsic) value of biodiversity cannot be translated into monetary terms (Nunes & van den Bergh 2001), therefore any calculated value may be used to justify protection measures, but will constitute only a small portion of the total value of biodiversity (Gowdy 1997).

Brief Critique of the CVM

The CVM stirs much debate (Portney 1994) as it is imprecise and highly subjective whilst influenced by factors such as time to think, differing information levels and the opportunity to deliberate in a group setting (MacMillan *et al*. 2006). However it is the only method capable in providing monetary estimates of the magnitudes of losses involved in instances of environmental accidents such as oil spills and associated lawsuits for example (Portney 1994). Direct elicitation of non-use values requires the combined skills of social scientists, survey research specialists, cognitive psychologists, political scientists, market specialists, sociologists and philosophers (Portney 1994). Hence accurate valuation is not simple. It is further confused by factors such as lexicographic preferences and is highly subjective (Spash *et al*. 2000). Some critics believe that the artificiality of the laboratory setting results in meaningless findings within studies (Diamond & Hausman 1994, Portney 1994). CV is currently unable to provide reliable estimates of existence values and it is thought by some that it will never achieve this, however, others believe

that even casual applications produce results reliable enough to be used as the basis of potentially significant damage awards, both these views have previously been rejected by NOAA (Portney 1994).

1.12.3. *Direct use values*

The direct use values of natural resources are the most meaningful to those communities highly dependent on natural resources this means they are only truly quantifiable elements that can be directly translated and understood by all stakeholders. Within the direct use values, the most important factors locally are provision of income (direct financial value), food and raw materials. Direct use values consist of consumptive and non-consumptive values.

Consumptive

Marine and coastal ecosystems are a haven for thousands of organisms, many of which could be harvested sustainably. A large number are edible and regularly collected for consumption, others are used extensively in the aquarium and curio trades. Direct consumptive uses usually generate marketable commodities, so determination of economic value is relatively simple (Costanza 1991, Spurgeon 1992, Edwards-Jones *et al*. 2000, Common & Stagl 2005).

The harvest of coral reef products usually generates both financial and wider socioeconomic benefits, the price consumers pay for a product is the financial value and any additional amount they would be willing to pay relates to additional social benefit, or consumer surplus, which is any additional satisfaction gained in excess of the payment made (Spurgeon 1992, Costanza *et al*. 1997a). Products used on a subsistence level, with no sale involved, it can be argued are of purely social benefit with no financial value attached (Spurgeon 1992, Common & Stagl 2005). CVM can be used to measure consumer surplus, and where money is not perceived in the same way as in the western world, the costless choice method can be used when the hypothetical bidding uses commonly exchanged goods (Dixon & Sherman 1990). However, there is direct financial value to the subsistence collection of these products which can be estimated by the price that would have to be paid to replace the item if it had to be bought in a market (Costanza *et al*. 1997a).

Fisheries: Fish are just one of many edible reef organisms. At low tide, nearly every accessible coastal reef flat in Asia is picked over by women and children gathering a major portion of their daily nutrition from seagrass, algae and coral reef flats and in many cases for fishing families this

"gleaning" activity provides more essential nutrition than fishing itself (McManus 1988). Most fisheries reports underestimate the contributions of small scale fishermen and activities such as gleaning and the direct financial value of these activities for specific communities is yet to be quantified (McManus 1988). In the case of commercial fisheries, maximum sustainable yield (MSY) can be used as a proxy for maximum economic yield (Berg *et al*. 1998).

Raw materials: Coral is used extensively as a building material and can be used in the production of lime (Spurgeon 1992), the coral is mined directly from the reef flat or smaller whole colonies in massive or sub-massive growth forms can be picked up from shallow subtidal or intertidal areas. Coral mining is completely unsustainable and illegal, but it has the potential to be a profitable activity and so is still practiced in many areas. The harvest of mangrove wood is essential for many coastal communities as a source of fuel for cooking and as a building material for houses and fish traps for example. The harvest of mangrove wood can be a sustainable activity with the introduction of re-plantation schemes and maximum harvests, however in most areas this is currently not the case and exploitation continues where alternatives are lacking (Melana *et al*. 2000).

Non-consumptive

Direct uses of natural resources which are non-consumptive include tourism, research, education and social benefit.

Tourism: For coral reefs, tourism generally yields the greatest financial benefit and many small island nations depend on reef related tourism for economic development (Cochrane 1993, White *et al*. 1997, Walters & Samways 2001, Cesar *et al*. 2002, Patterson *et al*. 2004). Revenues generated directly by reef-related tourism range from SCUBA diving and marine park entrance fees to accommodation, food, travel costs and tourist money spent in local shops and on local souvenirs (Spurgeon 1992, Cesar *et al*. 2002). Tourism value depends largely on the level of development near a particular coral reef, but even if no development is currently in place, there still exists the potential for deriving economic benefits from tourism in the future (Berg *et al*. 1998). The current value of tourism can be defined using the financial revenue approach (FR), the contingent valuation method (CVM), or the travel cost method (TCM) (Phillips 1998). The FR approach calculates the direct financial profits provided by reef related tourism (Berg *et al*. 1998). However, in addition to the financial benefits of tourism, there is often a large tourist consumer surplus value, which is the additional satisfaction gained by tourists in excess of what

they paid for their trip (Phillips 1998). To determine the extent of this additional value the contingent valuation method can be used to determine willingness to pay for certain reef activities. TCM assumes that the number of people travelling to a site is inversely related to the distance travelled to get there. If the number of people visiting the site and their travel costs are known, regression analysis can be used to estimate the value of that site to visitors (Spurgeon 1992). As CVM includes social values, this approach could yield a higher value than FR or TCM (Berg *et al*. 1998) but again the subjectivity within CVM must be considered.

Research and education: Like tourism, scientific research can generate significant quantifiable revenues for local economies. Immediate financial benefits can be determined through analysis of annual expenditures or budgets of on site marine research centres or research expeditions to reefs (Phillips 1998), money spent locally on food, accommodation and souvenirs can also be calculated and included in the research and education value. An associated value of research is the social benefit that can be gained in terms of local experience and knowledge development which may result in an increased sense of environmental awareness for both researchers and local people who may be involved with research activities or have the opportunity to meet and converse with research tourists, an adapted form of CVM can be used to determine this value (Spurgeon 1992).

Social: Local communities gain additional social benefits from reefs in a way similar to tourist consumer surplus, this value may include cultural and heritage values representing the benefit to communities of traditions and customs that have evolved based on reef associations, or spiritual, religious and aesthetic benefits (Dore & Webb 2003). No quantifications currently exist for the extent of social value, but estimations could be made using an adapted CVM, surveying locals on their willingness to pay to maintain the reefs in their current condition, but care would have to be taken to base this only on their social importance and not other direct benefits (Spurgeon 1992).

1.13. Biodiversity and human well-being

The protection of biodiversity is one of the most pressing issues in both conservation and development (Furze *et al*. 1996). Biodiversity, a central component of Earth's life support systems, is directly relevant to human societies (Myers 1996, Dirzo & Raven 2003). Aside from philosophical or moral reasons, there are potentially enormous welfare implications related to biodiversity loss, biological conservation implies the maintenance of sufficient biodiversity to assure the resilience of ecosystems delivering ecological services of fundamental value to human

society and existence (Myers 1996). There is a threshold of biodiversity below which most ecosystems will not be able to carry out these functions (Perrings *et al*. 1992). Biological diversity satisfies human needs in two ways 1) individual organisms have direct value in terms of consumption or production 2) the combination of organisms, and their role in sustaining biogeochemical cycles, within a framework of ecosystems, makes them of indirect value in satisfying human needs for the services of those ecosystems (Perrings *et al*. 1992).

Marine biodiversity provides most of the goods and services we obtain from the sea, including food security, protection against coastal erosion, recycling of pollutants, climate regulation, and recreation and biodiversity loss impairs ecosystem services from local to global scales (Sala & Knowlton 2006).

Humans clearly have good reason to place high value on biodiversity; but there is strong evidence that a mass extinction of species is underway due mainly to anthropogenic impacts, however, there also exists the capacity to reduce its severity with decisive and immediate action (Randall 1991).

1.13.1. *Biodiversity loss*

Humans have directly caused the global extinction of more than 20 described marine species, habitat destruction being one of the major drivers of this loss (Dulvy *et al*. 2003). It has been estimated that this includes approximately1% of coral reef species (Carlton *et al*. 1999). It is thought by some that biodiversity loss is the only global environmental change faced today that is irreversible (Dirzo & Raven 2003).

Functional extinction, occurs before species disappear, and is an early sign of extinction which occurs when a species is rare enough that it no longer fulfils its ecological role in the natural ecosystem (Carlton *et al*. 1999). Species that become commercially extinct, i.e. that are no longer profitably harvested, are likely to be ecologically extinct (Sala & Knowlton 2006) and one of the most important indicators of population depletion is global fisheries catch, which, has been declining since the 1990s (Watson & Pauly 2001), with the commercial loss of many species already apparent. Fishing preferentially targets larger species or species high in the food web and sequentially shifts to smaller species, typically in lower trophic levels once the former are no longer commercially profitable (Pauly *et al*. 1998). In the case of coral reefs and associated habitats, biodiversity decline began with the loss of large herbivores such as sea cows and green

turtles, followed by large carnivores such as seals and large fishes, followed by smaller fish and invertebrates (Pandolfi *et al*. 2003). Human activities are the strongest drivers of change in marine biodiversity so future trends will depend largely on human-related threats (Sala & Knowlton 2006).

1.13.2. *Valuation of biodiversity*

Most valuation studies of species preservation have focused on single species and estimates are derived from CVM and individual WTP to avoid the loss of a particular species (Hanley *et al*. 2001). Most welfare gains accrue to the individual and are based on recreational activities such as watching an endangered species in its natural habitat, or reflect the satisfaction of knowing that such a species exists (Nunes & van den Bergh 2001).

CVM has been widely used for valuing biodiversity benefits in terms of both species diversity and natural habitat protection (Phillips 1998), however, when it comes to the monetary valuation of ecosystem functions, CVM may not be the best choice because ecosystem functions are not an issue the general public are familiar with. Also the complexity of the relationship involved makes it difficult to describe accurately in a survey (MacMillan *et al*. 2006). Often valuation methods based on travel cost (TC), averting behaviour (AB) or production function (PF) may be more suitable in the case of biodiversity valuation (Nunes & van den Bergh 2001).

1.14. Integration of ecology and economics: the aims and challenges

Ecosystem services provide an important portion of the total contribution of human welfare on Earth and we must give the natural capital stock that produces these services adequate weight in decision making processes or current and future human welfare, and the welfare of the plant may suffer greatly (Costanza *et al*. 1997b). To do this we need firm integration of ecological, economic and social scientific disciplines to provide a full picture of the dynamic processes affecting these ecosystems and their components and the impact that management actions will likely have. Various trade off's are inevitable when trying to meet management aims but policy implementation could be enormously improved by balancing economic development, ecosystem preservation and human well-being objectives (UNEP 2006a).

Because one of the major problems of management currently is lack of local compliance (Elliott *et al*. 2001), and one of the major reasons for this is the actual, perceived, or even just expected,

economic losses to those communities utilising reefs for livelihoods and subsistence, a key role of management should be to improve the economic status of local people. Monitoring of local economic status should be included, in addition to ecological monitoring, to ensure no losses occur due to economically inappropriate management schemes. Economics could, and should, be used as a tool to encourage conservation and sustainable utilisation efforts, as the economic benefits of a healthy reef system will clearly far outweigh those of an impacted and biologically limited system (Cesar *et al*. 2003).

Information on the state of natural ecosystems is vital for informed and effective management, however it is now recognised that there is a need for associated social, cultural and economic assessments (Wilkinson 2002). Further applied multidisciplinary research is required, in particular research focused on ecosystem function, socioeconomic impacts and effectiveness of management actions will help decision makers minimise and mitigate for loss and degradation of habitats. Better economic estimates and financial valuations are also required to understand the full importance of marine and coastal ecosystems (UNEP 2006a).

1.14.1. *The need for development of appropriate economic performance criteria*

Clearly natural resources must be managed, management strategies must be acceptable to local communities and provide environmental protection whilst maintaining or improving the economic status of local communities. Both the practice of environmental management and the politics of environmental protection demand a clear, concise, and understandable standard of ecosystem health, the definition of which requires terms that are both quantifiable and measurable (Norton 1991). Because the success of managed areas in biodiversity conservation depends largely upon how and why regulations are enforced and on the level of compliance of local human communities who are inherently a part of the protected ecosystem, we also need quantifiable and measurable terms to monitor the economic status, and associated well-being, of local communities. To track both environmental and economic change, economic in addition to ecological assessment techniques must be applied. To do this a simple series of economic performance criteria, i.e. testable parameters through which changes could be identified, could be used to measure the success of management schemes and such criteria would be invaluable. To begin to develop appropriate methodology we first need first identify key economic metrics and locally applicable economic benchmarks.

Chapter 2. Study Site

A small Indo-pacific island was the chosen location for the study. The area chosen represented an area with its own local level governmental administration; hence it has the potential to encompass a suitable management unit for conservation including sustainable utilisation. The inclusion of an entire potential management unit is a new approach and few studies have achieved this in the past. The study site was in Southeast Asia in an area known to some as the coral triangle due to its location at the global centre of marine biodiversity (Tomascik *et al*. 1997b, Pet-Soede & Erdman 2003, TNC 2007). The area is one of the world's top priorities for marine conservation (TNC 2007).

2.1. Marine and coastal resources of Southeast Asia

Southeast Asia contains nearly 100,000 km^2 of coral reefs, almost 34 % of the world total (Burke *et al*. 2002). It is a region of high biological significance, as it contains some of the most extensive coastlines and diverse coral reefs in the world, with Indonesia, Malaysia and the Philippines (together with Papua New Guinea and the Solomon Islands) forming the centre of global coral and fish diversity. In addition to its role as the centre of coral reef diversity, Southeast Asia also contains 51 of the world's 70 mangrove species and 23 of the 50 seagrass species (Burke *et al*. 2002). Unfortunately, all of these habitats are threatened. The reefs of Southeast Asia are the most threatened and damaged in the world, with unprecedented rates of coral reef destruction (Tun *et al*. 2004). It has been estimated that around 88% of Southeast Asia's reefs are now at risk from human activities, with overfishing and destructive fishing methods being the most prevalent threats putting 64% and 56% of reefs at risk respectively (Burke *et al*. 2002). In addition, dredging, landfill, sand and coral mining, coastal construction, discharge of sewage and other activities associated with coastal development threaten about 25 percent of the region's coral reefs (Burke *et al*. 2002).

Significant ecosystem degradation in Southeast Asia began in the second half of the 20th century with an economic and population boom resulting in rapid growth and development in all sectors of society and the economy. Population growth expanded from 178 million in 1950 to 522 million in 2000. There was rapid modernization and development, but poverty remained prevalent with most countries classed as 'developing'. More efficient ways to harvest resources were developed which led to unregulated over-exploitation and often serious ecosystem degradation. In particular, in the 1970's and 80's as fish catches diminished, more destructive

methods of harvesting emerged which included the use of bomb and cyanide fishing, and which further accelerated the destruction of marine and coastal habitats (Tun *et al*. 2004). Destructive fishing practices, overfishing, and other activities that are damaging to coral reefs may be lucrative to individuals in the short-term, but the net economic losses to society from diminished coastal protection, tourism and sustainable fisheries usually outweigh the short-term benefits (Cesar *et al*. 2003).

The economic value associated with coral reefs in Southeast Asia is substantial. Coral reefs are vital to food security, employment, tourism, bioprospecting, and shoreline protection. The potential economic value of well-managed marine resources in Southeast Asia is estimated at 42.5% of the global total of US$29.8 billion attributed to coral reef values. The potential value of coral reef fisheries is 38.5% of the global total of US$5.7 billion, while the potential value of tourism is 50% of the global total of US$9.6 billion. This reflects the continued high dependence of Southeast Asian countries on coral reefs for food security and increasing tourism-related revenue (Tun *et al*. 2004).

The most prevalent threat to coral reefs in Southeast Asia is overexploitation. Lacking other sources of income, fishers have no incentive to leave the industry or reduce fishing pressure. In addition, the enticing profits to be made in the live reef food fish and aquarium trades have led to widespread target species overfishing by both local and foreign vessels and to the proliferation of destructive fishing techniques. Even without these destructive methods, current fishing levels and methods are unsustainable in most areas. If fishing in Southeast Asia is not reduced to more sustainable levels, both coral reefs and food security will be further imperilled. A major challenge for the region in the coming years will be to restrict growth or manage development in ecologically sensitive areas before further degradation occurs.

Various management actions have been trialled but so far there has been limited success. The region has 646 marine protected areas (MPA's) but these combined cover only 8% of the regions reefs and only 14% of MPA's where management effectiveness could be assessed are considered to be well managed (Burke *et al*. 2002).

2.2. Marine and Coastal Resources of Indonesia

Indonesia consists of around 17,500 islands with a coastline of 95,181 km and a coral reef area of around 75 000 km^2 of fringing, atoll and barrier reef, which equates to approximately 12.5 % of the worlds coral reefs. It has a population of around 230 million people and an annual population growth rate of around 1.5% (Resosudarmo 2005), it is the world's largest archipelago and one of the world's centres of highest diversity for coral reef ecosystems (Tun *et al*. 2004). The coral reefs of Eastern Indonesia are the most diverse on earth with 80 genera and more than 450 species of corals. Greatest diversity is around the coastlines of Sulawesi and the Banda Sea where individual sites on reefs may have 140 or more species (Hopley & Suharsono 2000).

The Indonesian coastal zone supports approximately 65% of Indonesia's population, and 75% of cities (with populations exceeding 100,000) as well as 60,000 coastal villages (Soegiarto & Polunin 1981) in (Tomascik *et al*. 1997a, Dahuri 1999). The coral reefs of Indonesia provide annual economic benefits estimated at US$1.6 billion per year (Burke *et al*. 2002). Therefore the reefs of Indonesia are a source of livelihoods and subsistence for hundreds of thousands of people from coastal communities, and provide natural protection from wave erosion protecting coastal homes, agricultural land and tourist beaches. They are a potential source of foreign exchange from divers and other marine tourists, and because of their unique biodiversity they are of great interest to scientists, students, pharmaceutical and other companies. Once again, the quality of reefs in Indonesia is declining rapidly and even remote reefs in unpopulated areas are being impacted (Cesar *et al*. 1997). Over 85% of Indonesian reefs are at risk from human impacts and less than 29% are in good condition, having more than 50% live coral cover (Burke *et al*. 2002).

Maximum sustainable yield of Indonesian fisheries is rapidly being approached and in many areas is already being exceeded with resultant declines in catches. Destructive fishing practices including bomb and poison fishing are used even in marine protected areas. Other destructive practices include the use of destructive or non-discriminatory nets and traps and excessive gleaning and collecting especially on reef flats (Hopley & Suharsono 2000). Fish production in Indonesia increased from 3.5m tonnes (of which 2.6m tonnes were marine) in 1992 to 4.25m tonnes in 2000. This is, in part, due to increasing populations, but it is also the result of increasing domestic consumption (15.9kg per capita per year in 1991 to 19kg in 2000) with fish now contributing more than 60% of the total animal protein consumed (Hopley & Suharsono 2000). Maximum sustainable yield (MSY) for Indonesian fisheries has been estimated at 5.3m

tonnes (6.6m tonnes including EEZ fisheries). The wild fishery alone is estimated at exploiting only 48% of MSY (Dahuri, 1999), but with 85% of Indonesian fishers exploiting the coastal zone the effect is very uneven and coral reef fisheries, even in the more remote areas are under extreme pressure. On coral reefs this pressure comes mainly from the traditional artisanal fishers, still sustaining local coastal communities, but now using more modern gear and equipment. Although most Eastern Indonesian fishers are small boat fishermen, larger numbers are attempting to exploit the same niches, and many use destructive methods to gain some small economic advantage (Fox 1995). Traditionally most local populations utilised their immediate offshore resources. However, certain populations such as the Bajo have specialised in exploiting marine resources and developed a mobility that has allowed them to venture over larger areas. As a result there has occurred over the centuries a migration of specific groups of people, from north and west to south and east, specialised to exploit inshore, especially reefal, resource niches (Fox, 1995). The result is that even in remote areas, reef fisheries have come under increasing pressure (Hopley & Suharsono 2000).

Because many coastal inhabitants are subsistence fishers, and any management regulations imposed are likely to conflict with the needs and interests of these people so dependent on reef resources (Elliott *et al*. 2001). Many traditional societies are accustomed to treating protected areas as open access, so common property resources and regulations are often difficult to enforce, and encroachment by local people is often the most critical management problem (Dixon & Sherman 1991). Sustainable management can increase local income streams and conserve biodiversity but conflicts between local user groups and coral reef managers can only be reduced if local user groups realise the economic and financial value of healthy coral reefs, and the potential losses that will result from continued overexploitation and the use of destructive practices. For example, over a 20-year period, current levels of blast fishing, overfishing, and sedimentation could cost Indonesia more than US$2.6 billion (Cesar 1996)**.**

Away from the urban areas the greatest damage to coral reefs comes from destructive fishing practices and overexploitation of resources. Effective management is essential to maintaining coastal resources, but, is inadequate across much of the region (Burke *et al*. 2002). Successful management at the local level has the greatest potential for meeting global, national and local reef management objectives (Elliott *et al*. 2001). Marine reserves have been developed as a means to preserve coral reefs, mangroves and other specific coastal habitats, but in order for these to succeed, the welfare of local people must also be considered (Haeruman 1988).

To conserve and manage the Indonesian marine environment, a new approach is urgently needed. One of the challenges facing Indonesia is the compromise between conservation in the long term and short term development; although it is being recognised that the two are inseparable for Indonesia to have achieve an affluent future (Tomascik *et al*. 1997b). Rational utilisation of natural resources in a sustainable manner is central the concept of sustainable development within Indonesia (Tomascik *et al*. 1997b).

2.2.1. Indonesian Economic Issues

As Indonesia's coastal zone supports around 65% of the country's total population, the problem of population growth and poverty have given many coastal communities no alternative livelihoods to those which exploit resources from ecologically marginal environments. Eastern Indonesia in particular is less developed than the rest of the country. It has a lower level of human resources, inadequate infrastructure and around 75% of the population depends on agriculture and/or fisheries (Dahuri 1999). Growth in real income is below the national average and investment in most of Eastern Indonesia lags far behind. Conservation projects or management plans must take this into consideration and provide alternative incomes if destructive practices and overexploitation are going to be prevented. Alternative livelihoods often require significant investment and, unfortunately, fishermen are usually seen as a high risk investment and cannot easily obtain credit, but the establishment of alternative livelihood programmes will help alleviate excessive demands on reef resources (McManus 1988).

The fall of President Soeharto and the start of the new *reformasi* era provided the drive to move from and authoritarian to a more democratic society and for a decentralised system of government. This offered Indonesia the opportunity to achieve better natural resource management and sustainability (Resosudarmo 2005). In 1992 the Spatial Use Management Law allowed provincial and local governments to regulate the use of their own coastal and marine areas and in 1999 powers, with financial support, were delegated to provincial and local governments. At the end of 1999 a Ministry of Marine Exploration and Fisheries was introduced. It was hoped that these new initiatives would create the long awaited national, regional and local integration of Indonesia's coastal and marine management, which has been lacking in the past, however there remain additional economic constraints which include a lack of facilities for management, lack of funds, little political or legal support to enforce regulations and lack of trained personnel to apply scientifically based management (Hopley & Suharsono 2000).

(Hopley & Suharsono 2000). This lack of resources, in particular, is often exacerbated by a poor awareness of the problems facing coral reefs and their significance in local economies (Wilkinson 2004).

2.3. The Kaledupa sub-district, Wakatobi Marine National Park

The present study was carried out within the Kaledupa sub-district of Wakatobi Marine National Park (MNP), off the Southeast tip of Southeast Sulawesi, Indonesia. The islands making up the Wakatobi are all coral islands with no ground above 300m. Fresh water comes from wells and caves which abound in the coral island environment. The staple foods are cassava (traditionally) and rice. Sweet potato is eaten occasionally and corn in the wet season. Other local fruits and vegetables abound. Some livestock is farmed but is limited to sporadic keeping of cows, goats, chickens and ducks (Donohue 1999). Throughout Sulawesi marine and coastal ecosystems are of high ecological and economic importance particularly for fisheries and other commercial purposes, hence development of the Island and its constituent provinces and districts requires an understanding of the components, interaction and mechanisms of marine and coastal ecosystems (Whitten *et al*. 1987).

2.3.1. Geography

Wakatobi MNP, formally the Tukang Besi Islands (Tun *et al*. 2004), consists of four main islands, Wangi Wangi, Kaledupa, Tomia and Binongko (the first two letters of each island making up the acronym "Wakatobi"), and numerous smaller islands (figure 2.1.). It is a large 1.39 million hectare marine national park making it Indonesia's second largest national park, and was designated in 1996 (Tomascik *et al*. 1997b). Few tourism facilities exist within the park, and are currently restricted to one hotel on Wangi Wangi, a small dive operation on Tomia, two home stays in the Kaledupa area, and research tourists from the conservation expedition organisation Operation Wallacea. Wildlife on the Islands is scarce, mainly due to overpopulation by humans (Donohue 1999), but the marine and coastal environment is rich with high biological diversity.

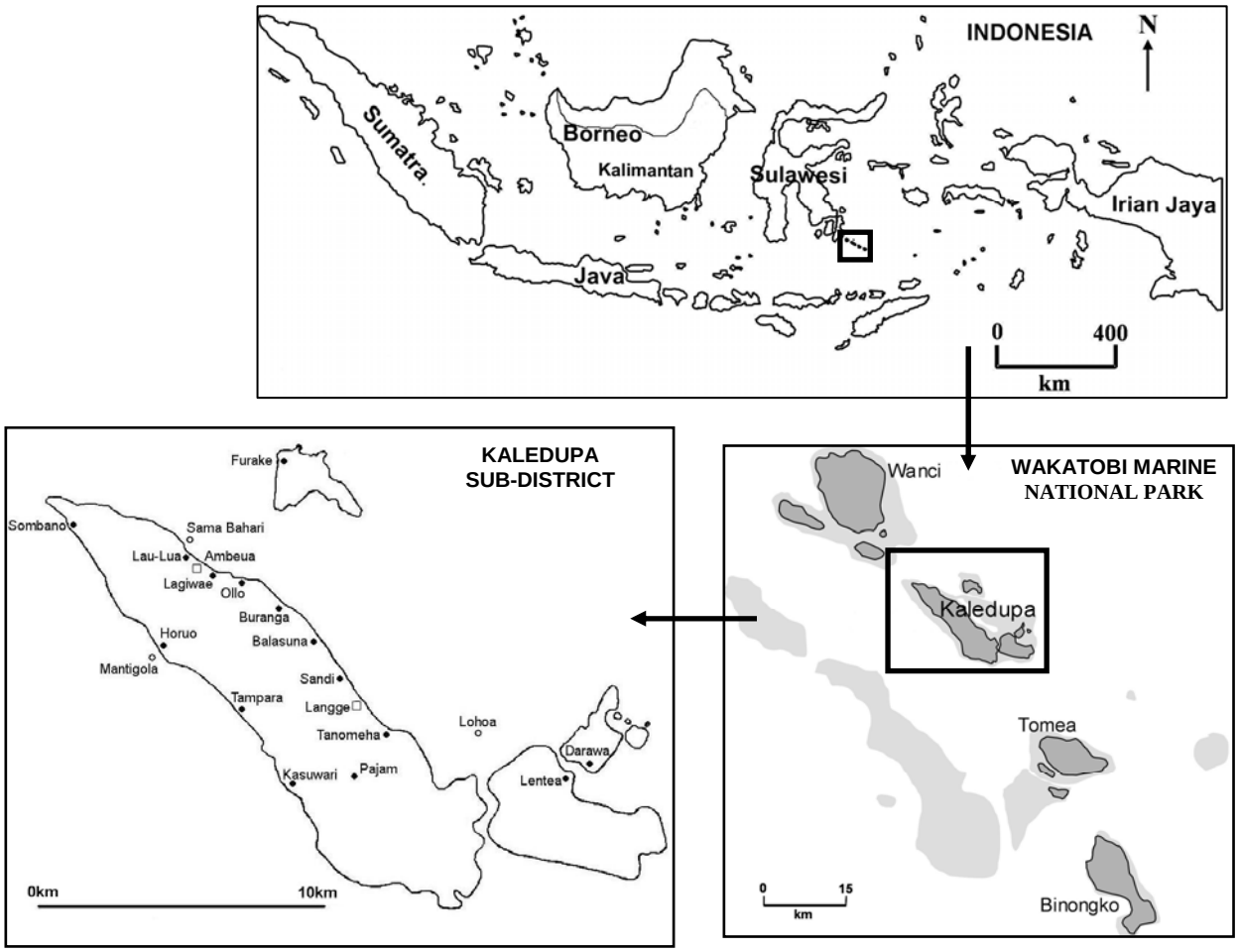

Figure 2.1. Location of the Kaledupa sub-district within Wakatobi Marine National Park, SE Sulawesi, Indonesia.

2.3.2. Natural resource attributes

The Wakatobi is situated within of one of the world's recognised centres of biological diversity. It is known in particular for its coral reef diversity and contains an estimated coral reef area of 600 km^2. The park contains exceptional coral reef, mangrove and seagrass habitats, all with high conservation value (Unsworth *et al*. 2006) and which provide vital resources to local communities.

The reefs in the area have suffered little from the impacts of coral bleaching, probably due to the influence of cool water upwellings from the South which protect the area from widespread bleaching events (Tun *et al*. 2004). A Rapid Ecological assessment (REA) carried out by WWF and TNC in 2003, confirmed the park's status near the centre of coral reef biodiversity. Most reefs are in relatively good health, probably because there is such a large area to provide larvae

and few major disturbances in the last few decades (Pet-Soede & Erdman 2003), but there is growing concern over the rapid deterioration and destruction of the more accessible reefs which suffer strong fishing pressures. The report also outlined widespread, but not severe, coral damage mostly from blast fishing, crown-of-thorns starfish and minimal coral bleaching. It was thought that poison fishing was probably practiced in the area, but evidence was lacking (Tun *et al*. 2004). The use of bombs by fishers in the Wakatobi reportedly began in the 1940's. It is difficult to determine who these fishers are or where they come from as they are often unsafe to approach, and everyone is aware that this is an illegal activity. Often, large fish buying companies from outside Indonesia provide boats and equipment and use Indonesian fishers as cheap labour (hence circumventing Indonesian law which states fishing only for research purposes for non-Indonesian companies in Indonesian waters) (Elliott *et al*. 2001).

Mangroves throughout Sulawesi have been extensively felled for timber or to create brackish aquaculture ponds, hence large expanses are found in few locations (Whitten *et al*. 1987). In the Kaledupa sub-district, mangroves are located predominately on the east and south coasts of Kaledupa but are not considered to be extensive (Pet-Soede & Erdman 2003). However their presence plays an important role in nutrient cycling, coastal protection and in assisting juvenile fish, hence they provide important fisheries support (Operation Wallacea 2003, Unsworth 2007). They have not been cleared for aquaculture, but large areas have been cleared in the last 20 years for timber and fuel and more significantly to make space for the growing population and a growing number of houses (pers comm). A small number of Kaledupan fishermen specialise in the commercial collection of the mangrove crab *Scylla serrata* (Pet-Soede & Erdman 2003).

Seagrass beds throughout the Wakatobi are extensive, some stretching for several kilometres, they are also highly productive and an important source of biomass (Whitten *et al*. 1987). They support a large number of commercial fish species, and provide an important fishing ground for local people for both subsistence and commercial purposes (Salinas de Leon 2006). More importantly it has been shown (Salinas de Leon 2006) that the presence of seagrass, coral reef and mangrove habitats in continuum within the tropical coastal ecosystem of Kaledupa, support significantly higher densities of fish, including important commercial species', than a system missing any of these component habitat types. This creates a very strong argument for the conservation, sustainable utilisation and management of all three habitat types.

2.3.3. Regional organisation

In 2004 the Wakatobi was established as a separate district from its former inclusion within the district of Buton, the Wakatobi district is now the same spatial area as the Wakatobi MNP (figure 2.2.). The further decentralisation of governmental organisation allows the Wakatobi to control and manage its own resources and district control is through the district government leader, the *Bupati*.

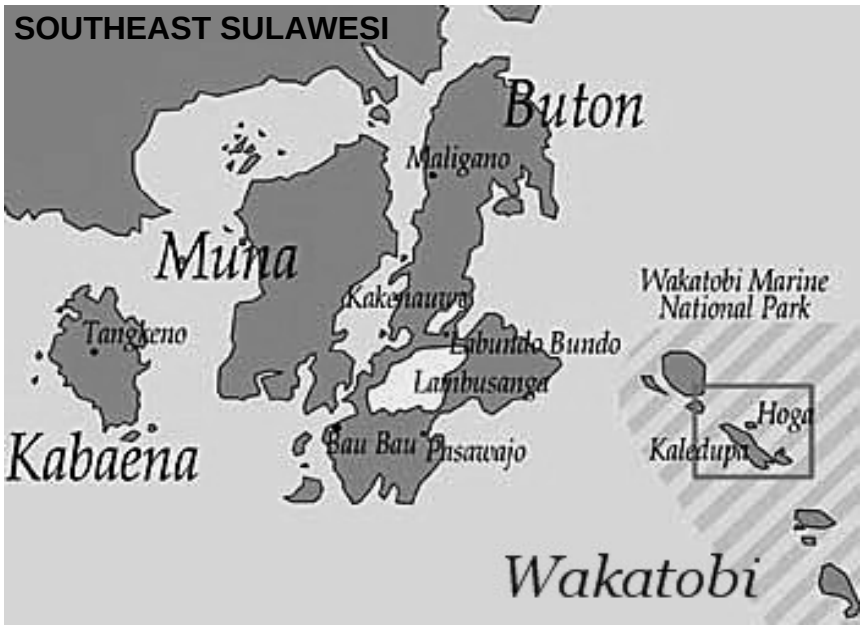

Figure 2.2. Former District of Buton now separate Buton and Wakatobi Districts. Wakatobi District encompassing Wakatobi Marine National Park is highlighted by diagonal stripes.

In 2004 the Wakatobi was further broken down into its constituent sub-districts, *Kecamatan*, centred on the four main islands, under the control of a *Camat* in each sub-district. However, in 2006 the Kaledupa sub-district was split into two *Kecamaten*, *Kaledupa* and *Kaledupa Selatan* (figure 6) each having its own *Camat*. The sub-districts consist of villages, *Desa* controlled by a *Kepala Desa* (village head) and *Kelurahan* controlled by a *Lurah,* some villages are further split into sub-villages, *Kampung* or *Dusun*, controlled by a *Kepala Kampung* (figure 2.3.). Within a *Kelurahan*, the village head (*Lurah*) is employed by the *Camat* for that region. Within a *Desa*, the *Kepala Desa* is elected by the villagers.

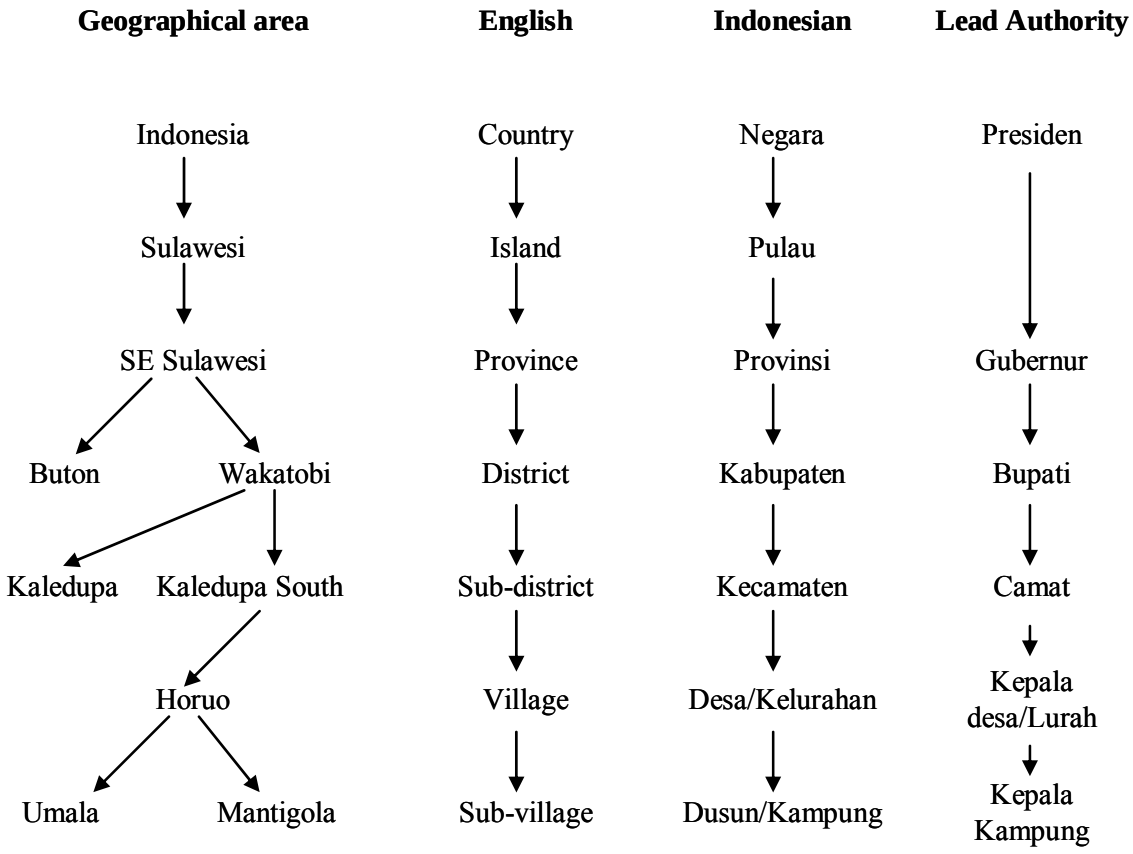

Figure 2.3. Administrative structure of Indonesia from country to village level.

2.3.4. Infrastructure

Kaledupa has concrete or tarmac roads (although many remain in poor condition) connecting most villages and since 2006, access to all villages was available by car although the major source of transport is motorbike. There is a hospital but no doctor and minimal medical provisions. There are a few nurses and midwives, the nearest manned medical facility is in Bau-Bau or Kendari, a days travel away by boat. There are no banks, the closest located on the Wakatobi island of Wanchi. Freshwater is available from numerous public wells. There are three daily markets, the most important of which is in Lagiwae which forms the centre of trade for the sub-district. There are numerous small shops selling basic groceries and a hardware shop in Lagiwae. There is a single power station supplying electricity villages between the hours of 1800 and 0600, houses using electricity from this supply are metered, but often neighbours unofficially connect. Villages without access to the power station run their own generators for power overnight. There are 16 kinder gardens, 17 primary schools, 4 junior schools, and 2 senior high schools (one being a specialist Muslim high school). There are 3 telephones (Wartel), and in some villages there is mobile phone reception.

2.3.5. Demographics

All four of the main Wakatobi islands are inhabited with an estimated population of 100,000 (Hopley & Suharsono 2000). Kaledupa is the second largest island in the Wakatobi chain and the Kaledupa sub-district, consisting of Kaledupa, Hoga and Lentea islands, has a population of around 17,000 spread between 4400 households and 17 villages (figure 2.4.). Despite the relatively small size and population of Sulawesi the number and make-up of the ethnic groups is highly complex and classified locally according to region, religion and farming style. Approximately 80% of the population is Islamic, the remaining 20% are Christian, although large variations exist between regions. Within the Wakatobi area it is estimated that 86-100% of the population is Islamic (Whitten *et al*. 1987), however the people of the Wakatobi Islands can not be characterised in simple socioeconomic or ethnic terms due to the large variation between islands in terms of both socioeconomic habits and ethnic composition (Donohue 1999).

Within the Kaledupa sub-district, there are 2 distinct community types, the Kaledupan Islanders (known locally as *Pulo*) and traditionally nomadic sea people (known locally as *Bajo*) who now live in permanent houses on stilts in the intertidal sand flat and seagrass areas. The Kaledupan islanders (or *Pulo*) occupy 14 villages and 2 sub-villages, and have a population of around 15000. The *Bajo* occupy 1 village (Sama Bahari) and 2 sub-villages (Mantigola and Lohoa), each associated with a *Pulo* land based sister sub-village, although the *Pulo* and *Bajo* sub-villages are very much separate entities. The Bajo have a population of around 2000 in the sub-district (table 2.1.).

The *Pulo* and *Bajo* communities have very different cultural backgrounds, beliefs, values and dependence on natural resources (Sather 1997, Tomascik *et al*. 1997b, May 2005). Both utilise marine resources but the *Bajo* are considered to be more heavily dependent as they were traditionally entirely dependent on the sea for food and livelihoods, setting foot on land only for fresh water or to trade their marine goods.

The *Bajo* still generally fall behind other ethnic groups in terms of their education and economic status and are generally considered poor in the Philippines and Indonesia (Saat 2003), they also generally avoid social contact with *Pulo* except those related to economic exchange (Sather 1997).

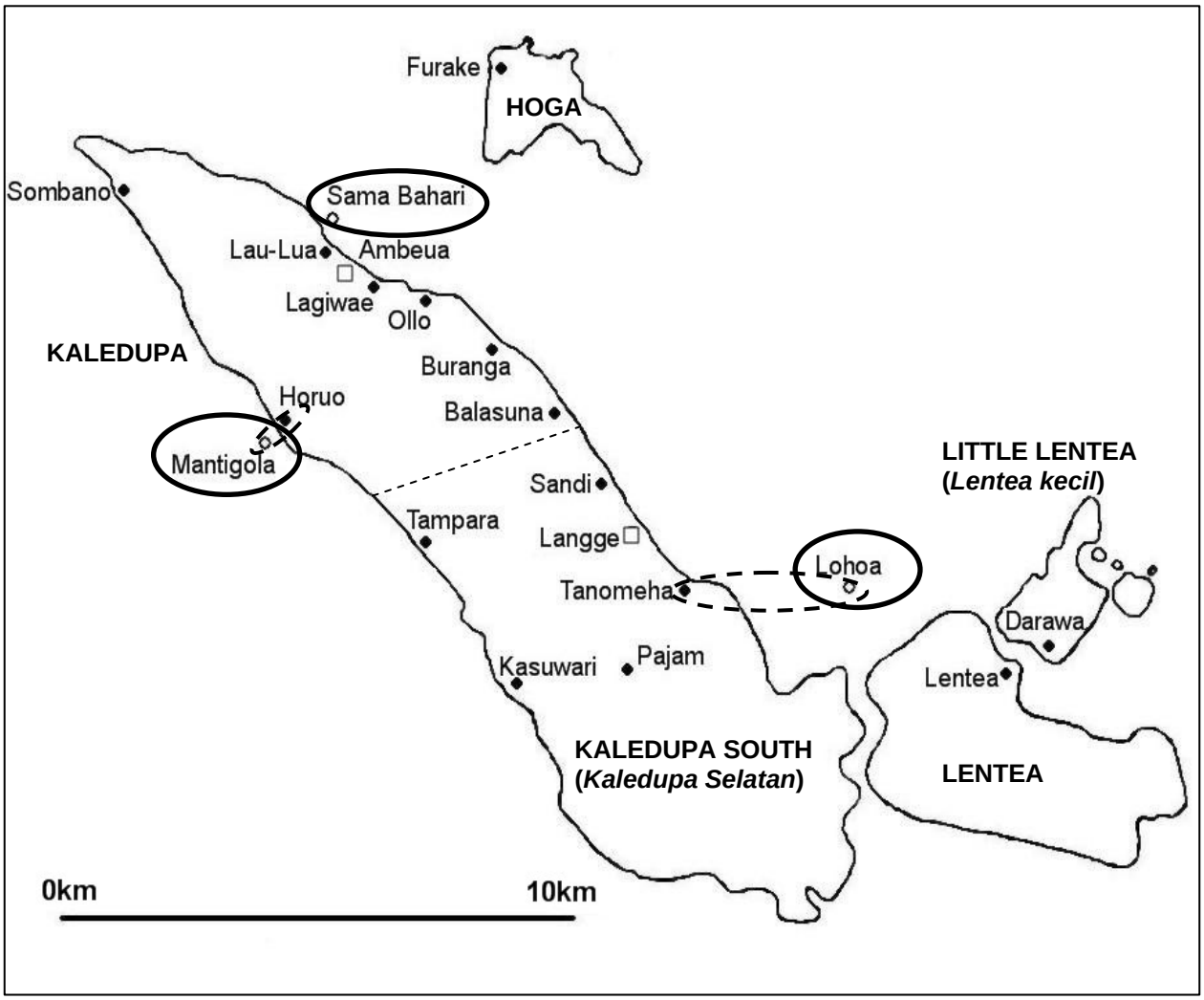

Figure 2.4. The Kaledupa sub-district of Wakatobi Marine National Park, Indonesia. Locations of *Pulo* (Kaledupan Islanders) and *Bajo* (traditional sea gypsies) villages and sub-villages. *Bajo* villages are circled with a solid line and sub-villages linked with a broken line. Square markers indicate the locations of the sub-districts 2 administrative centres in Ambeua (Kaledupa) and Langge (Kaledupa South).

The population of the Kaledupa sub-district is growing by approximately 3% annually (Kecamatan Kaledupa 2006), which is double the average annual Indonesian population growth (Resosudarmo 2005). This means the local demands on natural resources are also increasing, which highlights the need to determine levels of dependence and introduce appropriate management strategies and alternatives where necessary that might be able to conserve the environment whilst economically supporting the growing population.

For many people, coastal areas, especially coral reefs, represent a source of livelihood if other strategies have failed. Displaced people can live in coastal areas and create livelihoods within

minimal expenditure by fishing or gleaning reef areas (Wilkinson 2002) which may result in population increases. In Southeast Asia during the economic crisis of 1998 many people returned to home villages to make a living from the environment when unemployment surged, many resorting to the use of destructive fishing methods (Erdman & Pet 1999, Wilkinson 2002). Hence the marine and coastal environment represents and attractive alternative for displaced peoples from any background which may be an additional reason for rapid population expansions.

Table 2.1. Population structure of the Kaledupa sub-district within the Wakatobi Marine National Park, SE Sulawesi, Indonesia.

	Kaledupan Islanders (*Pulo*)	**Traditionally Nomadic sea people (*Bajo*)**	**Total**
Population	15000	2000	17000
Percentage of total population	88.2	11.8	100
Number of Households	3890	510	4400
Number of Villages	14	1	17
Number of sub-villages	2	2	4
Population increase 2001-2006	15%	11%	15%

2.3.6. Traditional Kaledupan Islanders (Pulo)

In general the people of Sulawesi classify ethnic groups according to region, religion and style of farming, the traditional economy throughout Sulawesi was based largely on agriculture (Whitten *et al*. 1987) and even in small island districts agriculture remains important, but in the case of Kaledupa, marine resource associated activities are most significant to the economy (see chapter 4). For the Kaledupan *Pulo* there is an emphasis on education which remains from a long tradition of parents sending their children away to school and the children returning to Kaledupa as trained teachers. The *Pulo* are not particularly well known for their seafaring abilities or their business expertise, although as in all small island communities, they exploit the resources available to them which include fisheries and other marine products (chapters 4 and 5). Until 1991 there were no shops or markets on Kaledupa (Donohue 1999).

2.3.7. Traditional sea nomads (Bajo)

The early indigenous people inhabiting the Indonesian archipelago had strong associations to the marine environment living as nomadic boat people, or sea nomads (Tomascik *et al*. 1997b). The *Bajo*, also known as the *Bajau Laut*, were the largest and most widely dispersed group of sea nomads in Southeast Asia (Sather 1997). They were traditionally entirely dependent on the marine resources for food, raw materials, livelihoods and their home. A forced shift from their traditional nomadic lifestyles to a more sedentary lifestyle meant that *Bajo* peoples developed semi-permanent settlements in the shallow intertidal or subtidal areas in coastal regions. They remain predominantly reef and inshore fishermen and intertidal gatherers. They are proficient at empty handed foraging and free-diving to collect resources and hold essential knowledge of marine species and spawning grounds (Tomascik *et al*. 1997b, Arunotai 2006). Sopher (1977) stated that "*the collecting of sea products is a continuous operation, and they (Bajo) work hard at it.*" The *Bajo* fish according to the tides, winds, currents and season and consume all marine species apart from sea snakes (Sather 1997).

The *Bajo* are and have been for centuries, part of a market system selling or bartering their marine goods (Sather 1997), often through village middlemen. As specialist marine hunter-gatherers the *Bajo* have been able to supply highly valued items such as sea cucumber, giant clam, top shell and live reef fish using highly specialised techniques such as free-diving and spear fishing to island dwelling communities, in particular they traded dried fish as the major source of protein for insular Southeast Asia (Sather 1997, 2002).

In the past the *Bajo* way of life was effectively harmonious with nature, due mainly to their nomadic existence, but with changing lifestyles and growing populations their association with the sea has become detrimental (Tomascik *et al*. 1997b). The more the *Bajo* are drawn into a market economy, the more they extract natural resources to fulfil their own needs for new consumer products. Additionally, as they have been forced to leave behind their nomadic existence, their fishing grounds have become smaller resulting in high intensity extraction, hence a general perception among officials is that the *Bajo* people are a major contributor to marine resource conservation problems in Wakatobi MNP (Elliott *et al*. 2001). The *Bajo* have resorted to exploitation of marine resources using more efficient methods due to the need for more economically profitable catches, sometimes using both cyanide and bombing techniques. They mine both coral and sand for construction and repair of their villages, the demand for which is increasing with an increasing population (Hopley & Suharsono 2000).

2.4. Local management issues

Many coastal inhabitants are subsistence fishers, and any management regulations imposed are likely to conflict with the needs and interests of these people so dependent on reef resources (Elliott *et al*. 2001). As is the case for many traditional societies local people are accustomed to treating protected areas as open access, so common property resources and regulations are often difficult to enforce (Dixon & Sherman 1991), and encroachment by local people is often the most critical management problem (Furze *et al*. 1996). Sustainable management can increase local income streams and conserve biodiversity but conflicts between local user groups and coral reef managers can only be reduced if local user groups realise the economic and financial value of healthy natural systems, and the potential losses that will result from continued overexploitation and the use of destructive practices. Understanding and management at the local level has the greatest potential for meeting global, national and local reef management objectives (Elliott *et al*. 2001).

For any management plans to be successful, the welfare of local people must be considered (Haeruman 1988). In banning activities such as destructive fishing practices, including overfishing, the economic effects on fishermen and their families needs to be acknowledged and alternative sources of income sought (Hopley & Suharsono 2000). The establishment of alternative livelihood programmes will help alleviate excessive demands on reef resources (McManus 1988). So efforts must be directed towards human activities that utilise coral reefs and associated habitats. The costs of inaction are the losses of the value of coral reefs such as fisheries, food security, biodiversity, coastal protection and tourism (Berg *et al*. 1998). Estimates of some of the costs could provide resource users and decision makers with incentives to drive forward conservation efforts and prevent ecological and economic degradation, however, estimates of the direct financial gains from sustainable utilisation and maintenance of healthy ecosystems may prove far more powerful, the first step here is to make clear to local user groups and managers the current value of these systems.

A key problem for policy makers is the lack of quantitative models and procedures to facilitate a comprehensive economic and ecological analysis, including identification, measurement and prediction of the effects of economic activity on the environment and vice versa. Specifically, the degradation of coral reefs has not been extensively analysed in a framework amenable to economic policy analysis (Ruitenbeek *et al*. 1999), hence there is need for adequate valuation and dissemination of this information to all stakeholders.

Economic assessments have only recently started to examine the extent of the benefits directly and indirectly associated with coral reef use (Bunce *et al*. 1999) and it is thought that case studies may prove useful in developing techniques for studying the ecological economics of coral reefs in particular, and if many such studies are conducted, the compiled information could provide the comprehensive picture necessary for a generally applicable model whilst also potentially generating incentives for new management strategies (Berg *et al*. 1998). The Kaledupa sub-region is an area that could benefit significantly from the development and use of socioeconomic monitoring techniques, due to the high local dependence on marine and coastal resources and the current lack of appropriate management, action is urgently required. There exists a need to assess the natural resource use patterns of local communities and quantify their dependence, and to monitor and mitigate for the impacts of a changing ecosystem on human dependents.

2.5. Aims of the project

It can be difficult presently to link local and regional ecological change with the behaviour and utilisation patterns of human dependants (Haber *et al*. 2006), but there are areas where the link may still be clear, one such example of which is often small island communities.

In order to understand and potentially mitigate for the impacts of global environmental change we need to understand the impact of such changes on systems in which humans play an important role. We need to monitor both ecological and economic changes, the impacts of environmental change on ecosystems and the impacts of ecosystem change on dependent human communities. Integration of ecological, social and economic disciplines and inclusion of the human element in all monitoring and management activities is essential for environmental, ecological and socioeconomic sustainability.

There currently exist accepted methodologies and protocols to measure and monitor ecological change, what is lacking is the measurement and monitoring of economic change that can be associated with ecosystem health and the inclusion of this measurement and monitoring within the development and implementation of management strategies. An understanding of natural resource use patterns and quantification of financial dependence on natural resources in specific regions are required to avoid economically inappropriate management actions that as a result will ultimately fail. Hence the aims of this project were five-fold as follows:-

1) To understand the natural resource use patterns of a small island community and quantify the extent of dependence on these resources.

2) To estimate the direct financial value of marine and coastal based incomes and compare these with other income sources and to identify socially and financially acceptable alternative incomes.

3) To identify livelihood diversity patterns and links to marine and coastal resource use.

4) To identify wealth strata within the sub-district and understand local perceptions of relative wealth.

5) To use economic data obtained from the study to identify key economic criteria that could be used to evaluate the relative economic performance of natural resource management programmes.

Chapter 3. Methods

3.1. Introduction

The human-natural world relationship is by definition a social one. The way nature is viewed and utilised results from societal organisation and from the way members of society see the value of nature (Furze *et al*. 1996). Natural resource management, although clearly concerned with the management of habitats and ecosystems, is fundamentally about the management of people, their aspirations, and their relationship with the ecosystems requiring management (Furze *et al*. 1996, MEA 2005).

Economics is an important discipline as it studies the allocation of scarce resources in society (Pearce *et al*. 1989, Tisdell 2005), and allows us to understand the interactions between resources and society, between trade and market resources, and compare the various values of different resources and actions (Furze *et al*. 1996). Ecosystem and natural resource quality and availability can directly impact the economy in numerous ways such as through the supply of resources, or the dissolution of waste (see section 1.1.2.). Conversely, economic actions can directly impact ecosystems by utilising resources, producing wastes and altering the environment (Furze *et al*. 1996). Any management action implemented for economic reasons will have an impact on the ecosystem and any management action implemented for ecological reasons will have an impact on the economic system, hence a holistic and multidisciplinary approach is required (Furze *et al*. 1996, MEA 2005, UNEP 2006a).

Various protocols for biological and ecological assessment and monitoring of marine ecosystems exist and are routinely carried out in protected areas e.g. (English *et al*. 1997, McEnzie *et al*. 2000, Pet-Soede & Erdman 2003, McMellor & Smith 2005, Mous *et al*. 2005, McMellor & Smith 2006). It is routine social and economic assessment and monitoring that is lacking. The development of effective, statistically robust and cost (and time) efficient assessment methods is required. As part of this process we need to understand local resource use patterns and levels of dependence so that we know where best to concentrate management efforts, where the greatest problems exist, and develop appropriate mitigation measures where necessary to ensure a successful management outcome. Clearly these considerations are site specific but a generally applicable method to gather this data could be compiled using a case study which provides an in-depth, multifaceted investigation, conducted in great detail and relying on the use of various sources of information (Feagin *et al*. 1991b).

A number of social science methods exist that can be used to develop social and economic understanding; all methods involve interaction between researchers and people although the level of interaction can vary greatly (Furze *et al*. 1996, May 1999, Bernard 2000, Bunce *et al*. 2000, Ruane 2005). Various qualitative and quantitative methods (Margoluis & Salafsky 1998, Ruane 2005) are available and some combination of the two can provide detailed descriptive and measurable data suitable for statistical analysis (Roscoe 1975, Bryman 1988, Feagin *et al*. 1991b, Minichiello *et al*. 1995, Bernard 2000, Bryman 2004, Gillham 2005). A multi-method, or triangulation, approach allows for strengthened claims of validity and increased powers of persuasion within associated recommendations as a result of the research (Atkinson & Coffey 2003, Ruane 2005, Brewer & Hunter 2006).

Some social science methods are also of benefit because they can be used where long-term data or spatial data is missing because people can often provide an indication, through their own perceptions, of changing environments, resources and economies over time and space (Pomeroy *et al*. 1996, Pomeroy *et al*. 1997, Biodiversity Conservation Network 1998).

To achieve the aims of the current project various qualitative and quantitative techniques were employed within the overall methodology (Minichiello *et al*. 1995, Furze *et al*. 1996, Margoluis & Salafsky 1998), these techniques included field observations, structured interviews, semi-structured interviews, key informant interviews, wealth ranking, market surveys, and the use of secondary data such as official district statistics. To achieve each project aim, various combinations of techniques and associated data were used, along with various methods of triangulation when dealing with complex or sensitive data, the details of which will be discussed in greater depth in the methods sections of relevant chapters. In general the more numerically based understanding from qualitative analysis (Byers 1994, Minichiello *et al*. 1995, Bunce *et al*. 2000) was required for this work with background support from qualitative analysis.

Research was conducted between 2003 and 2007. Preliminary field observations were made from June to October 2003 from a base at the Operation Wallacea marine research station on Hoga Island. Subsequent research was carried out during field seasons based at the Operation Wallacea field research station in Ambeua, on Kaledupa Island, from 2004 to 2006. A cumulative total of 14 months spent in the field between April and September each year. A summary of methods used and sample sizes is given in table 3.1. Sample sizes are discussed in section 3.4.3.

Table 3.1. Summary of methods and sample sizes used within a socioeconomic study of the Kaledupa sub-district of Wakatobi Marine National Park, Indonesia.

Method	Application	Sample size
Semi-structured interview	Preliminary household survey	318
	Household survey pre-test	30
	Household survey 2005	440
	Household survey 2006	165
	Household survey total	**953**
Semi-structured interview	Key informants	49
Market survey	Stationary and mobile trade	30
Wealth ranking	Preliminary village ranking	10
	Preliminary household ranking	3
	Village ranking	33
	Household ranking	33
	Wealth ranking total	**79**

3.2. Preliminary field observations

Observation can provide qualitative social and economic descriptions of a community obtained by watching the surroundings (Bunce *et al*. 2000). It provides an insight into activities that may be difficult for other people to describe. Two types of observation exist, *directed* and *continuous* observation. *Directed* observation involves focusing on a single specific activity whereas *continuous* observation allows the researcher to gain a broader understanding of general activities in a single place over time (Bunce *et al*. 2000). It allows local people to become involved in the research through interaction with the researcher whilst conducting daily activities, e.g. buying things at the market, without demanding valuable time from local people (Bunce *et al*. 2000) and provides an opportunity for the researcher to integrate somewhat within the community in which they wish to work. It can also provide good information on the material style of life by observing local house (roof, floor and wall) materials, presence of windows and gardens for example (Bunce & Pomeroy 2003).

In 2003 18 weeks were spent carrying out biological fieldwork and monitoring from the Operation Wallacea field base on Hoga Island within the Kaledupa Sub-district (see figure 6 in section 2.5.). This provided an ideal opportunity to carry out continuous type observations to become familiar with local culture and customs and to some extent the Indonesian language

(*Bahasa Indonesia*) and to a more limited extent one of the local dialects, *Bahasa Kaledupa*. During this field season, various Kaledupan villages were visited, including both *Bajo* and *Pulo* villages. Local tours were taken and local produce bought. The largest daily market, most important for fish sale, was also visited on a number of occasions and both sale and landings (direct from small boats to the market sellers) observed. Background data was informally gathered through observations and conversations with local people, which included information on predominant culture and religion, the importance of seafood as a source of protein and other available sources, the relationship between *Bajo* and *Pulo* communities, the structure and number of villages and sub-villages, and the local relative value of Indonesia Rupiah. During this time an essential understanding (Wenger 2003) of the local way of life and insight into appropriate cultural behaviour and required cultural sensitivity on the part of a foreign researcher was also gained.

3.3. Preliminary survey

A preliminary survey was conducted in 2004 which consisted of a structured interview carried out in *Bahasa Kaledupa* with answers later translated to English. Fishermen were the target respondents and all villages were included in the survey. For the purposes of this survey those villages consisting of a *Bajo* and *Pulo* sub-village were treated as two separate villages, as was Furake which is officially part of Ambeua but which is located on Hoga Island and remains geographically separate (see chapter 2; figure 2.4.).

The survey initially aimed to interview all fishermen in every village; however this was not always possible due to extremely high concentrations of fishers in some villages. In some cases fishermen were also unavailable during the survey period. Permission to conduct interviews was sought from the village head of every village prior to commencement, at which point a list of all fishers within the village was provided by the village head.

A total of 318 interviews were conducted with a minimum sample size of 10% of fishermen from each village. Sample size ranged from 10-100% of fishermen depending on respondent availability and feasibility according to the time and resources available. A total of 30% of the estimated number of fishermen from the Kaledupa sub-district were included in the survey.

Key findings from the preliminary survey were as follows:

1) Household income structure could be highly complex with individuals potentially involved in a number of different income generating activities. Mean number of activities per respondent was 2.76 ± 0.08. There was a highly significant difference ($p<0.01$) between *Bajo* and *Pulo* villages, with an average of 1.7 ± 0.09 and 2.99 ± 0.08 respectively.

2) Where marine resource extraction was important, respondents were often involved in various marine resource dependent activities and a number of different techniques were utilised.

3) Seaweed farming is an important local economic activity. 45% of fishers stated seaweed as their most economically important activity, 43% stated fishing, 6% stated farming and 6% other activities.

4) In Bajo villages 70% of fishers stated fishing as their most important economic activity, 28% said seaweed and 2% said other activities. Within the Pulo villages 37% of fishermen stated fishing as their most important economic activity, 49 % stated seaweed, 7% agriculture and 6% stated other activities. This highlights an immediate distinction between these cultures and their access to resources.

5) No Bajo respondents were involved in agricultural activities and most income generating activities were directly associated with marine and costal resource extraction.

6) There is one regular market within the Kaledupa sub-district located in the village of La Ulua and two other irregular and smaller markets in Langge and Buranga. Fishers generally sell in their own villages from their homes or through wandering trade and move to successively distant villages if catch remains. There are middlemen in most villages that buy and sell higher value catches.

Information gathered within the preliminary survey was used to assist in the development of the household survey.

3.4. Household Survey

Two household surveys were conducted during the research field period. The first, conducted in 2005, included a 10 % sample of all households from all villages within the Kaledupa sub-district. This data provided information on income, natural resource use patterns and more general demographics; it was also the basis on which potential economic performance metrics were initially identified. The second household survey was carried out in 2006 and included 11 villages from the sub-district. Villages were selected based on their relative wealth (or economic status), as determined from the first household survey and local wealth ranking (see section 3.7.). The second household survey was used to test the appropriateness of the proposed indicators and their viability, and provided verification of the initial survey.

All villages in the Kaledupa sub-district were included in the first survey as it was considered that the sub-region as a whole could represent a suitable management unit for the purposes of policy development. Additionally this would provide a holistic approach without bias (Feagin *et al*. 1991b). It would also provide detailed data on the sub-region on which justification for subsequent sub-sampling was based.

Key informant interviews were used to gather appropriate village wide information and a household survey to gather specific information on households and individuals. An important point to make here is the distinction between *respondents* and *informants*. *Informants* can describe the wider details of their culture, village or community for example, and *respondents* can describe only their own beliefs, opinions, preferences and ideas (Levy & Hollan 1998). The distinction is important because all people have knowledge about themselves hence everyone can be a *respondent*, however not everyone can be an equally knowledgeable informant so key people must be selected as *informants* (Bernard 2000). For the purposes of the current work, those people with wider community knowledge were selected for key *informant* interviews and for the household survey *respondents* were randomly selected.

Interviews were developed for the purpose of livelihoods and income assessment, investigation of natural resource use patterns and levels of dependence, and identification of possible economic metrics indicative of economic status. Interviews were therefore designed to collect data that would allow logical delineation of economic characteristics that related to annual income as a proxy for wealth.

3.4.1. Sampling approach

A detailed discussion of the chosen study site is given in chapter 2 along with the reasons for this choice. Another reason for the appropriateness of the Kaledupa sub-district as a case study is due to it having distinct, geographically separate villages, and in some cases sub-villages, that can represent statistically appropriate and culturally distinct sub-samples for statistical analysis. Additionally, all villages were accessible, and representative samples could be obtained, as long as local rules and norms were adhered to.

The goal of the sampling was to obtain a sample representative of the whole population so a probability sampling technique was used because this technique provides highest certainty that the sample is indeed representative of the population (Roscoe 1975, Bernard 2000, Bunce *et al*. 2000, McIntyre 2005).

The overall strategy (for the sub-district as a whole) for the 2005 household survey was one of stratified random sampling with each village, or sub-village as appropriate, representing a sampling frame (May 1999, McIntyre 2005). Within each sampling frame simple random sampling was used in the form of *probability proportionate to size* (McIntyre 2005) which allowed each village to be equally represented, a sample size of 10% of households was chosen (see section 3.4.3.). Random sampling is only appropriate when a complete sampling frame is available, i.e. when there is equal opportunity to sample any individual in the sampling population (McIntyre 2005), this access was available within the Kaledupa sub-district. Only a random sample of sufficient size can be used to determine the distribution of specific variables across households in a community (Pollnac & Crawford 2000). A household was defined as a group of people, usually a family unit, living together under one roof and sharing meals.

A list of the names of all villagers, sectioned into households, was available from most village heads. A random numbers table was used to select households for inclusion in the survey from full village lists. The name of the household head (highlighted in the official village lists) was recorded and targeted for interview. A list of replacement households were also collected in this way, for use in cases of refusal or absence. In the case of absence, three attempts were made before a replacement was used. Where village lists were not available (in Lentea) a random strategy of choosing every 10^{th} house in the village was employed, a coin was tossed for further randomisation to decide from which side of the road the house should be selected (McIntyre 2005).

For the second household survey, random stratified sampling was used within each of the chosen sample villages. Villages were stratified according to relative wealth according to primary household occupation/activity. Household lists were divided into three categories: poorest, wealthiest and intermediate, and households from each category were randomly selected for inclusion in the survey.

For all interviews the household head was the primary target respondent, this was usually the oldest male, however, the pre-test highlighted that their spouses were also appropriate with generally equal knowledge as required by the interview. In cases where the spouse was unable to provide adequate detailed information, the household was revisited in the presence of the household head.

3.4.2. Interview structure

It is widely accepted that standardised survey interviews are the most appropriate method to quantify the attributes of a large representative sample within limited timeframes (Bernard 2000, Bryman 2004, McIntyre 2005), hence semi-structured interviews were used in the study.

Interviews comprised largely of closed questions to elicit fixed quantitative answers, with some open-ended questions and limited lickert-scale questions to gauge environmental awareness and attitude. Questions were grouped into the following 9 sections as follows:

1) Identification (of interview)
2) Household characteristics
3) Respondent background
4) Respondent occupation
5) Marine and coastal resource use
6) Children
7) Diet
8) Finance
9) Attitude towards the environment

An additional section was included to record the conditions of the interview including the presence of third parties, perceived understanding of questions, and any other potentially relevant information that was interview specific.

The preliminary household interview structure is given in appendix 1.

Ideally interviews would be carried out in private to avoid the influence of third parties. However, both *Pulo* and *Bajo* cultures are very open so it was often the case that other household members and neighbouring villagers would listen in. If third parties interrupted, it was the answer from the respondent that was elicited and recorded.

3.4.3. Sample size

According to McIntyre (2005) the choice of sample size involves two major analytical factors 1) the heterogeneity of the population (following the rule that the more diverse the population, the larger the sample size should be); and 2) the nature of the study and number of variables involved, the more variables that are of interest, the larger the sample size should be.

Some general rules of thumb can be applied, and are particularly important for the validity of statistical analyses (Roscoe 1975):

1) The use of sample sizes smaller than 10 is not recommended.

2) A sample size of 30 or larger is recommended.

3) Minimum sample sizes apply to sub-samples.

4) In multivariate research (multiple regression for example) the sample size should be at least ten times larger than the number of variables.

Generally, however, the choice of sample size is equally a function of budgetary considerations as it is of statistical ones (Roscoe 1975). Time and financial resources available to the researcher will result in most decisions about sample size reflecting a compromise between analytical and practical issues (Gillham 2005, McIntyre 2005).

Social and economic analyses in the past have neglected studies in which the whole population is sampled, i.e. all villages within a single manageable district. In most cases a small number of villages is chosen for sampling usually encompassing a selected range of conditions, for example

proximity to natural resources or other geographical, social or economic conditions such as population size or development (Ramony *et al*. 2003, Cinner *et al*. 2006). Various sample sizes have been outlined in the social and economic literature ranging from less than 10% of households to around 20% (van Zyl *et al*. 2000, Ramony *et al*. 2003, Cinner *et al*. 2006, Shackleton & Shackleton 2006). In all cases financial and time considerations were important along with the survey purpose, research aims and intended data use.

In general when using a random sampling method, the larger the sample size the greater the level of accuracy and the higher the certainty that the sample is representative of the whole population (Bunce *et al*. 2000), however there is a principle of diminishing returns (McIntyre 2005), which means that after a point any additional sampling points will not yield much improved certainty in excess of that already secured (table 3.2). Hence sample size should be decided according to the *confidence interval* and *level of confidence* required by the researcher (which may again be compromised by available resources) (Bunce *et al*. 2000, Rea & Parker 2005). It is generally satisfactory to present a margin of error (or confidence interval) of ± 3 to ± 5 % for proportional data and a level of confidence of 95 % to 99 % (Rea & Parker 2005). With a population size of 5000, a sample size of 357 would yield a 95 % level of confidence with a 5 % confidence interval. For the same population, a sample size of 586 would yield a 99 % level of confidence with a 5 % confidence interval (Rea & Parker 2005).

Table 3.2. Number of respondents required relative to entire population size for 95 % and 99 % level of confidence and with a 3 % or 5 % confidence interval (Rea & Parker 2005).

Population size	Sample size			
	For 95 % level of confidence		For 99 % level of confidence	
	3 % confidence interval	5 % confidence interval	3 % confidence interval	5 % confidence interval
500	250*	218	250*	250
1,000	200*	278	500*	399
1,500	624	306	750*	460
2,000	696	323	959	498
3,000	788	341	1,142	544
5,000	880	357	1,347	586
10,000	965	370	1,556	622
20,000	1,014	377	1,687	642
50,000	1,045	382	1,777	655
100,000	1,058	383	1,809	659

* Population size for which the assumption of normality does not apply, hence the appropriate sample size is 50 % of the population

Within the present study, the inclusion of the entire sub-district was required for the first household survey, hence due to time constraints, and considering the rules of thumb outlined above, it was decided that for the initial household survey 10% of all households from all villages within the Kaledupa sub-district would be included. This would give an initial sample size of 440 from a total of 4,400 households, which would give a least 95 % confidence with a confidence interval of 5 % (further detail is given in the appropriate results chapters).

The second household survey used random stratified sampling within villages according to relative wealth. 3 households from each of 5 wealth categories (including an intermediate category sub-divided into three) within each village were included. This gave a total sample size of 165 households for detailed interview, with sub-samples of each wealth category equalling 33.

As was the case in the preliminary survey, those villages consisting of separate *Bajo* and *Pulo* sub-village were treated as two separate villages.

3.4.4. Key Informant Interviews

Prior to carrying out interviews in any village it was appropriate to request permission from respective village heads. The village head was also interviewed as a key informant, and in most cases provided a full list of village members grouped as households. A structured interview was used with village heads which comprised of mostly open ended questions related to population size, prevalent economic activities, amenities and health. Full interview structure is given in appendix 2.

This approach of gleaning information and approval from the village head also placed them in a guiding role which facilitated acceptance of the research throughout the village and provided a referral for respondents vouching for the research team (Alder & Alder 2003). This support proved to be highly valuable.

3.4.5. Pre-test

Pre-testing is generally used to help refine the survey instrument (Furze *et al*. 1996, Gillham 2005). The pre-test gives an opportunity to ensure questions are fully understood, concise and not confusing; that questions flow naturally in their order; that they are not culturally or politically insensitive; that they elicit the desired type of response; that responses can be recorded efficiently; and that the interview is not too long (Bunce *et al*. 2000). The pre-test also provides an opportunity for the researcher to ensure that the translator understands all questions and is asking them in the correct manner (see section 3.5.). Three types of pre-test exist: colleague pre-tests (asking informed colleagues to comment); user pre-tests (asking information users for comments); and field pre-tests (with members of the group to be surveyed) (Dillman 1978). The field pre-test, which is a small version of the actual survey, is most advantageous as it has the ability to highlight any problems or issues under real conditions (Furze *et al*. 1996, May 1999), and was therefore the chosen method for the current project.

Based on the ‘rule’s of thumb’ outlined in section 3.4.3., a pre-test sample size of 30 was chosen, with the aim of creating 2 sub-samples with a minimum size of 10 (Roscoe 1975), and ideally 15 men and 15 women. Ambeua village was selected as the pre-test location. As was the case for the full survey, respondents were randomly selected from the full village list. Targets for interview included both the head of the household (usually male) and the spouse of the head of the household. For every second house approached, the female was the target respondent.

Within the pre-test interviews an additional section was included to gain some feedback on the interview from the respondent. Respondents were asked what they thought about the length (time taken), their level of interest in the questions, overall clarity and intelligibility. They were also asked if they had any additional comments on the interview structure or process.

Key points raised from the pre-test were as follows:

1) Female respondents were able to provide, in general, the same depth of information as male respondents. There were cases where male and female respondents could not answer some questions and requested their respective spouses be interviewed instead.

2) Females often control the finances within the household and generally have good knowledge of income from household activities; hence female respondents would not be rejected in the household survey.

3) 4 of the 30 pre-test respondents (13%) considered the interview to be too long. The average time taken for interview was 43.57 ± 1.85 minutes.

4) Requests for financial information were not considered a sensitive issue. People were generally happy to disclose their household earnings.

5) There was some reluctance to discuss diet which appeared to be the most sensitive topic

6) Some questions required revision and clarification, both for correct translation and respondent understanding.

Interview structure was amended after the pre-test to decrease interview time and remove or reword ambiguous questions. (Bunce *et al*. 2000) recommend an interview time of no longer than 45 minutes, so a selection of fixed responses were developed for some questions, based on pre-test answers, and included within the final interview format, to reduce interview time ensure no interviews were longer than 45 minutes (although as the pre-test results highlighted, the average time was in fact less than 45 minutes). The fixed responses also provided coded answers for ease of data entry and analysis.

Final household interview structure is given in appendix 3.

3.5. The use of translators in the field

The present work required the use of a translator to conduct all interviews and surveys. The same translator was not available each year as research was conducted, so three different translators were employed to complete the field research. All were previously trained translators, one from Bau-Bau in the sub-district of Buton (see figure 2.2.) and two originally from the Kaledupa sub-district. Local people were preferred because for adequate transferral of information, the translator must be comfortable in the community in which they are interviewing and be able to make the respondent feel the same way (Whittington 2002).

Additional training was included on-site before carrying out the pre-test and the pre-test itself provided a "practice" run for the translators to become proficient with the interview questions and technique required. There is likely to always be some additional "noise" in people's messages as they are transferred between respondent, translator and researcher, but well prepared translators and a good interview, as simple as the research purpose will allow, with no ambiguities will minimise the chances of any distortions (Whittington 2002).

Before the first interviews were conducted the nature of the investigation, the aims, and any important concepts were explained to the translators. An opportunity was also provided for them to familiarise themselves with the interview and ensure that they understand the objectives of the survey, the questions and the subject matter covered. All interviews were conducted by the researcher and translator together which provided opportunity for additional clarifications to be made at any point and allowed for a strong working relationship to develop and be maintained.

Whittington (2002) suggested a number of rules for good interview practice on the part of the translator, in a simple series of do's and don'ts. These rules were discussed with all translators prior to interview schedule commencement.

1) Do read every question exactly as written in the questionnaire, do not improvise.
2) Do read each question slowly enough so that the respondent can understand.
3) Do wait for the respondent to answer, giving them time to think
4) If the respondent can't answer, repeat the question, the respondent may not have been giving their full attention the first time. If, after the second reading the respondent still can't answer, go to the next question.

5) Do remain neutral about the respondent's answers; do not express surprise, approval, disapproval, judgment, or doubt about a response. Just relay the answer to the researcher.
6) Do not act embarrassed about a respondent's answers to sensitive questions, be very matter of fact.
7) Do not suggest answers (unless the instructions say to read a pre-determined set of answers to the respondent).
8) Do not repeat the respondent's answers, except to the researcher.
9) Do conduct interviews in private if possible (however see section 3.4.2.).
10) Do answer directly any questions the respondent may have about the purpose of the survey.
11) Do listen carefully to the respondent's answer.

An additional rule adhered to was that all information regarding any aspect of the survey, no matter how seemingly small must be relayed to the researcher. An element of trust was required and built with every translator involved in the project prior to interview commencement.

Throughout the household survey, interviews were conducted in the language with which respondents were most comfortable to avoid poor expression on the part of the respondent and distortion of meanings (Bunce *et al*. 2000). Languages used included Colloquial Indonesian *Bahasa Indonesia*, the Kaledupan dialect *Bahasa Kaledupa* and the *Bajo* language. In general, the language of choice within Pulo villages was *Bahasa Indonesia*, only in a small number of cases, usually for the elderly, was *Bahasa Kaledupa* preferred. In 2005 two translators were used, the first was fluent in *Bahasa Indonesia, Bahasa Kaledupa* and English and had some knowledge of the *Bajo* language. The second was fluent in *Bahasa Indonesia* and English, hence when a respondent's preferred (or only) language was *Bahasa Kaledupa* or *Bajo*, a local guide fluent in both *Bahasa Kaledupa* or *Bajo* and *Bahasa Indonesia* was employed.

For work in all villages, a local guide was recommended by the village head to help locate target respondents and act as a referee on behalf of the village head (see section 3.4.4.). In most cases this local guide provided the additional translation to ensure absolute clarity of both questions and answers. In 2006 a translator fluent in *Bahasa Indonesia, Bahasa Kaledupa* and English was employed. Local guides were again used and additional translation was still required in some

instances in *Bajo* villages. Where local guides were used as translators, the same training and principles outlined above were employed.

3.6. Market surveys

Market surveys were conducted to verify fish catches and sale prices, and to provide an additional data source for triangulation of fisheries and fishery-related income data. This method was also used to verify harvest prices and associated incomes from agricultural products. Interviews with middlemen were used as a market analysis too for seaweed.

Market surveys were conducted at random throughout the field research period and included surveys at the static daily market in Ambeua, and of wandering traders in villages where they sold their catch.

Data was collected at the point of sale. Species, length, number in sale, price of sale, time of day and location of sale was recorded for fish species. For invertebrates; species, diameter, carapace size, or other appropriate measurement unit (as some marine worms were sold by the cup), number in sale, price of sale, time of day and location of sale was recorded. All data was recorded onto pre- prepared record sheets (see appendix 4).

3.7. Wealth Ranking

Wealth is often considered a major indicator of the distribution of resources within a community and consequently a major determinant of social and cultural differences (Ghirotti 1992). Income can influence food production and consumption patterns, and the use patterns of natural resources. So estimations of wealth are one of the primary variables that should be investigated in household studies (Ghirotti 1992). Determining wealth however, can be a long and difficult process but a number of methods have been developed to allow more rapid assessments of relative wealth, such as wealth ranking (Grandin 1988, Guijt 1992).

Wealth ranking is now widely used as a mean of community stratification according to local definitions of wealth and using local criterion (Scoones 1995). It is part of an increasing compilation of participatory research techniques applicable in rural development analysis (Munro 1989b, Pretty 1989, Chambers & Conway 1992). Wealth ranking can help understand how richer and poorer households differ from each other, and how local well-being (a

component of economic status) is viewed (Berman & Kofinas 2004). Perhaps most important for the current project, it helps identify different social or economic groups and helps understand the impacts of any potential interventions, particularly natural resource management interventions, on those groups (Guijt 1992, Mearns *et al*. 1992).

Additionally, it is often the case that people are more willing to discuss other people than themselves, particularly when the topic of discussion may be sensitive. The method of wealth ranking allows open discussion with local people about wealth and what makes others appear wealthy. Wealth ranking was therefore also used to gain an understanding of the local concept of wealth, and was used to create a series of benchmarks indicative of wealth.

Wealth ranking was conducted at both the household and village level. To rank villages, random individuals from a number of villages were selected to take part. To rank individual households, the names of all respondents taking part in the household survey for a particular village were included and a person thought to have a good knowledge of the village was asked to rank the individual households. The person chosen for individual wealth ranking had to know more than 80 % of the names to be included within the ranking process. After individuals or villages were ranked, an unstructured interview followed with the aim of eliciting data based on the respondents own views on wealth. Detailed methodology used will be discussed in detail in chapters in which results appear.

It is important to understand that good use of participatory rural appraisal techniques such as wealth ranking is not guaranteed by the methods alone, persistent triangulation and questioning are required to ensure that data generated provide a complete picture of the chosen subject (Pretty *et al*. 1992, Campbell 2001). Therefore wealth ranking data was used in triangulation with data collected from household surveys and other interviews to ensure all groups were considered and that information provided by wealth ranking participants was not contradictory or substantially lacking. Any carefully designed social study integrating techniques in this way will have greater validity (Kirk & Miller 1990).

3.8. Statistical analyses

Statistically viable data was collected throughout. The software programme Microsoft Excel was used to construct suitable data bases for the handling and coding of all data. From Excel, data could be readily copied into appropriate statistical packages for formal analysis. Both Minitab and PRIMER (Clarke & Warwick 1994) were use to perform statistical analyses. Details of the specific analyses used are discussed in appropriate chapter methods. Various statistical analytical methods were employed to identify economic performance metrics; these are also discussed in detail in the chapters in which results are presented.

Chapter 4. Marine and coastal resource dependence

4.1. Introduction

Global economic advances can only be sustained if humanity maintains the health of the world's environment, yet the activities of man are increasingly impacting the environment and causing an alarming loss of biodiversity which is crucial to human well-being and survival (Norse 1993, MEA 2005, UNEP 2006a). There is often a conflict of interests between conservation objectives and human aspirations for improved living conditions in the short term (Randall 1991, UNDP 2005). This conflict of interests exists because of the need to maintain the environment and biological diversity in the long term and meet the daily needs of local communities often dependent on the natural resources available to them.

Solutions must be found that enable communities to continue to utilise natural resources in a sustainable manner and management must be carried out without negatively impacting the local economy. Management strategies must be developed that tackle the challenge of sustaining vital ecosystems whilst economically supporting local communities and growing populations. To achieve these outcomes detailed and in-depth qualitative and quantitative socioeconomic data is required on dependence levels and resource utilisation patterns within highly dependent communities. The detailed and rich data generated within well-crafted case studies can provide a solid empirical basis for further specific concepts and generalisations (Feagin *et al*. 1991a, Furze *et al*. 1996).

Understanding the human aspects of marine and coastal resources is essential for effective coastal management (Pollnac & Crawford 2000, Pomeroy *et al*. 2004a, Plummer & FitzGibbon 2006). Occupations in particular are an important factor of social structure and, perhaps more crucially, they provide an indicator of the relative importance of different components of marine and coastal resources (Pollnac & Crawford 2000). Identification of economically viable and ecologically sustainable alternative (not additional) income streams for dependent communities is also important to natural resource management and alternatives must be made available when incomes begin to, or are expected to, be negatively impacted. Any management strategy, whether government-led or local traditional approach-based, must be implemented on a complete understanding of local livelihoods, otherwise the result could be the development of management strategies incompatible with both resource conservation and the social and economic goals of management (Allison & Ellis 2001).

Within the Wakatobi Marine National Park, Indonesia, several management plans have been introduced but so far there has been limited success. The park remains a "paper park" and resources continue to be degraded (Elliott *et al*. 2001). This chapter uses the example of the Kaledupa sub-district, to outline the complexities that are involved in natural resource use, particularly where livelihoods are concerned, and to point out essential factors to consider when attempting to manage natural resources depended upon by local communities with inter-village cultural differences and variable natural resource use patterns. It highlights the need to understand these specific use patterns, and in particular varying dependence levels, for a successful management outcome.

The human population examined in this study is representative of many small island communities where marine resources are considered to be heavily exploited for income, food, building materials and waste disposal (Elliott *et al*. 2001, Tun *et al*. 2004)**,** and where people from different cultural backgrounds and beliefs are utilising the same resources. So far, limited work has been done to quantify the dependence of any of these communities on natural resources and their resource use patterns and this is the first work to quantify the extent of direct financial dependence of local communities on natural resources and to describe variations in natural resource use patterns between villages within a small geographical area that could be considered a single management unit.

Secondary data is often inadequate in providing information concerning occupations, as most published statistics only include the full time or primary occupation (Pollnac & Crawford 2000), and within the Kaledupa sub-district, central statistical data is particularly limited with major inconsistencies (see section 4.2. table 4.1). The only way to determine the distribution and relative importance of activities and incomes is to carry out detailed surveys (Pollnac & Crawford 2000).

4.2. Chapter aim and objectives

The aim of the current chapter was to understand the natural resource use patterns of communities within the Kaledupa sub-district and quantify the extent of local dependence on these resources. The research had the following three objectives to achieve the aim:

1) To quantify the dependence of local communities on marine resources for food and raw materials

2) To quantify the extent to which Kaledupa sub-district communities depend on natural resources for income

3) To estimate of the direct financial value of marine and coastal resource based incomes as compared to other income sources

4.3. Methods

4.3.1. Household survey

Research was conducted between March and October 2005. A total of 440 semi-quantitative interviews were conducted for the household survey, which consisted of 389 *Pulo* interviews and *51* Bajo interviews reflecting accurate household proportions. Interviews lasted between 30 and 60 minutes. 10% of all households in every village and sub-village throughout the Kaledupa sub-district were included in the survey. Interviews had a strong focus on household income generation and marine and coastal resource use patterns. Basic demographics such as respondent age, marital status and educational attainment were also collected. Household survey structure is given in appendix 3.

Permission and household lists were obtained from the *Kepala Desa* (village head) of every village and from these lists respondents were randomly selected. Three attempts were made to interview each listed respondent, after which a random replacement was used. The head of the household was targeted, however, in their absence, the wife of the head of the household or another household adult were interviewed as an appropriate replacement if able to provide adequate information (see section 3.3.). Appropriate translators were employed for all interviews.

Within the Kaledupa sub-district there are 17 villages, each consisting of various numbers of constituent sub-villages. Where both a *Pulo* and a *Bajo* sub-village made up a Kaledupan village, the villages were treated as separate, both due to cultural differentiation and geographical separation. This was the case for the villages of Horuo and Tanomeha, hence these areas were treated as four independent villages. Hence for the purposes of the present research, the Kaledupa sub-district included 19 villages analysed separately. A summary of all villages, administrative districts, estimated populations, village cultures, number of households and number of households included in the survey is given in table 4.1.

Village population counts were conducted on a monthly basis by the corresponding Kecamatan, however monthly and annual data from 2001-2006 was inconsistent and highly variable, hence estimates herein were based on mean annual data from 2001-2006 (Kecamatan Kaledupa 2006). Household data collected from *Kepala Desa* offices was more reliable and taken to be accurate based on random village household counts and consistency with Kecamatan records.

Table 4.1. Village details, estimated population and number of households in the Kaledupa sub-district of Wakatobi Marine National Park, Indonesia.

Village/sub-village (n=19)	Administrative village (n=17)	Population*	Households	Interviews	Administrative Kecamaten	Culture
Ambeua	Ambeua	1163	324	32	*Kaledupa*	*Pulo*
La Ulua	La Ulua	895	242	24	*Kaledupa*	*Pulo*
Lagiwae	Lagiwae	944	282	28	*Kaledupa*	*Pulo*
Sombano	Sombano	592	127	13	*Kaledupa*	*Pulo*
Ollo	Ollo	1267	324	32	*Kaledupa*	*Pulo*
Buranga	Buranga	1008	316	32	*Kaledupa*	*Pulo*
Balasuna	Balasuna	1216	328	33	*Kaledupa*	*Pulo*
Sama Bahari	Sama Bahari	947	251	25	*Kaledupa*	*Bajo*
Umala**	Horuo	1371***	95	10	*Kaledupa*	*Pulo*
Mantigola**	Horuo		217	22	*Kaledupa*	*Bajo*
Langge	Langge	857	229	23	*Kaledupa Selatan*	*Pulo*
Sandi	Sandi	976	262	26	*Kaledupa Selatan*	*Pulo*
Tanomeha**	Tanomeha	1341***	330	33	*Kaledupa Selatan*	*Pulo*
Lohoa**	Tanomeha		40	4	*Kaledupa Selatan*	*Bajo*
Kasuwari	Kasuwari	1086	288	29	*Kaledupa Selatan*	*Pulo*
Tampara	Tampara	972	238	24	*Kaledupa Selatan*	*Pulo*
Pajam	Pajam	791	176	18	*Kaledupa Selatan*	*Pulo*
Darawa	Darawa	564	185	19	*Kaledupa Selatan*	*Pulo*
Lentea	Lentea	786	130	13	*Kaledupa Selatan*	*Pulo*
Total		**16,776**	**4384**	**440**		

*Mean population estimates calculated from *Kecamatan* and *Kepala Desa* annual data 2001-2006 (Kecamatan Kaledupa 2006).

**Sub-village

***Sub-village data unavailable

4.3.2. Household income generating activities

Multiple sources of income within households and for individuals is a common phenomenon in developing countries (Ellis 2000b, Neefjes 2000, Pollnac & Crawford 2000). Within the Kaledupa sub-district this was made apparent during preliminary observations and through the preliminary survey (chapter 3; section 3.3.) with fishing households having an average of 3.3 income generating activities. As this was the case, information was required on all household activities. Respondents were therefore asked to list every activity they were involved in to make money (or to obtain food), they were also asked to list all other household members and their income generating activities. Where activities listed were the same for the respondent and any other household member, clarification was requested on whether they worked together or separately to generate income from the activity and further income analysis conducted correspondingly.

4.3.3. Income assessment

All household activities were included in the income assessment. Therefore an estimation of the total net Kaledupan income could be made, and the contribution of primary income sources investigated in detail. For each household income generating activity a multi-method approach was implemented which included use of the household survey. The approach consisted of four elements as follows: 1) direct estimates of annual income from respondents for each household activity; 2) direct estimates of weekly/monthly income from respondents for each household activity and number of weeks/months involved per year; 3) direct estimates from respondents of harvest frequency (where applicable), harvest size (in appropriate units) and unit price; 4) market surveys and key informant interviews (with middlemen) conducted to verify typical harvests and unit prices. Income stated in Indonesian Rupiah (Rp) was converted to US$ at a rate of Rp 9103 per US$ 1.

It had to be assumed that respondents were being equally truthful regarding their answers, particularly to income questions, however, by rewording the same questions and repeating, (Minichiello *et al*. 1995, Bernard 2000) and by using the multi-method approach outlined above, it was likely that significant mistruths would be detected. Wealth ranking provided additional verification through triangulation (chapter 6).

For the purposes of the study primary income source was defined as the household activity which yielded highest annual profit and on which the household was most dependant for income or, in the case of no income, food.

4.3.4. Estimation of annual income

Total net annual Kaledupan income (TKi) was estimated using mean total household income (Ti), including income from all primary and supplementary income sources; the mean was multiplied by the total number of households within the sub-district (Tn).

$$TKi = Ti * Tn$$

Kaledupan annual income (from primary household activities) (TKPi) was estimated under the assumption that the 10% sample of households was indeed representative of the whole population. Mean total Kaledupan incomes (MPi) for each primary activity (Pi) were calculated from the household survey data (validated as explained above). Each mean was then multiplied by the number of households stating the activity as their primary income (Hn); this value was then multiplied by 10 to scale up from 10% of the population to the whole population.

$$MPi = Pi * Hn * 10$$

Total Kaledupan annual income from all primary activities was then calculated as the sum of all mean primary household incomes within the sub-district.

$$TKPi = \sum MPi_1 + MPi_2 + MPi_3 \ldots\ldots\ldots\ldots..MPi_n$$

4.3.5. Dietary dependence and use of raw materials

Respondents were asked the number of meals they typically eat in a single day. They were then asked how many of those meals contained fish or other seafood. Repetition questions were also used and respondents were asked how many days in a week they thought they ate fish or other seafood. The same was asked of beef, chicken and eggs. The discussion of diet was largely qualitative and any relevant comments noted.

Respondents were asked what the platform, foundation or perimeter walls of their house was constructed from, pre-test results outlined that coral, land rock, concrete, wood, and a mix of any

of these could be pre-coded. They were also asked if they used sand for construction, and from where they obtained it.

Respondents were also asked what fuel they used to cook, if more than one fuel was named, the frequency of use of each was also requested.

4.3.6. Market surveys

Market surveys were conducted between March and October 2005. Surveys included static market and wandering trade surveys to investigate fish prices at the point of sale. A pre-prepared survey sheet was used to record date, time, species, size (length, weight, width or other appropriate measurement unit), number of individuals, and price paid by the consumer (appendix 4). A total of 20 surveys were carried out at random.

4.3.7. Key informant interviews

Key informants are people who are particularly knowledgeable on the research topic (Gillham 2005). To provide information on typical fishery catches and catch frequencies, seaweed harvests and harvest frequency, and prices, fish and seaweed middlemen were identified as key informants. 10 key informant interviews were conducted. Lists of middlemen were provided by the *Kepala Desa* of each village and respondents randomly selected for interview, the selection was randomised to minimise the chance of collecting potentially preferential data in the eyes of village officials (Gillham 2005). If the same respondent was selected for the household survey and key informant interview, and alternative random replacement was selected to act as a key informant.

4.3.8. Statistical analyses

Income data deviated significantly from a normal distribution which could not be rectified by transformation, therefore ANOSIM was carried out using the computer package PRIMER (Clarke & Warwick 1994)**.** A two way ANOSIM was used to investigate differences between annual incomes generated by *Pulo* and *Bajo* workers, between identified income generating categories, and between villages.

4.4. Results

4.4.1. Dietary dependence

100% of households within the survey were dependent on seafood as their major or, in most cases, only source of protein. This included villages not directly adjacent to the coast and where agriculture was the primary income generating activity. All households ate fish. 80.5 % of households ate fish on a daily basis. 6.4 % of households said they ate fish on at least 2-3 days each week, and 12.5 % said they ate fish on 4-6 days each week. Those people who ate fish ate it for an average of 2.05 ± 0.01 meals per day. The average number of meals per day for Kaledupa was 2.71 ± 0.02. 88.2 % of households stated reef fish as their preferred food (rather than any kind of pelagic fish).

Chicken and beef were eaten but rarely and usually on special occasions. 14.5% of households said they never ate chicken, 75.5% said they ate it 2-3 times each year, 9.3% said they ate chicken once per month and 0.68% said they ate it once per week. 32.7% of households never ate beef, 67.1% said they ate it 2-3 times per year on special occasions, and 0.2% said they ate it once per month.

If fish was unavailable noodles and sometimes eggs were eaten as a replacement. On average households would eat eggs 2.7 ± 0.07 times each month. However, in most cases, without fish, a diet of cassava or boiled rice resulted.

Reef-top gathering (or *gleaning*) for the collection of invertebrates was an important, although sporadic, supplementary activity for recreation and to gather food. 25% of households said they gleaned regularly, with the average number of trips per week being 2.14 ± 0.26 (mean ± SE) for those households stating regular involvement. All households said they would glean occasionally, as a recreational activity. Of the regularly gleaning households 48 % collected invertebrates for household consumption, 14 % sold their catch, and 7 % both ate and sold some of their catch. 31 % of regularly gleaning households said that they carried out the activity for fun, although they would eat whatever they caught. Most of the gleaning activity (82 %) was conducted within the intertidal and shallow sub-tidal seagrass beds, 8 % of households said they gleaned the reef flat and 10 % said they gleaned both the seagrass and reef flat areas.

The major staple food of the sub-district was cassava which was grown locally and eaten as the staple by 60.7% of households. 27.1% of households stated rice as their staple food, and 12.3% a mixture of rice and cassava.

A government funded programme existed in the sub-district to provide some poorer families with free rice, although many families did not have access to this scheme.

4.4.2. Raw materials

Marine sourced building materials were frequently used. Approximately 48 % of households used mined coral as a foundation, platform or perimeter wall for their houses. The coral used was live or dead reef flat coral or coral bombies (relatively small coral colonies that could be picked up in their whole form by hand) taken from the shallow sub-tidal area. 63 % of households used sand for construction purposes. Approximately 42% of those households using coral collected it themselves, 23% bought it from local coral miners and 21% used coral from both sources (collected and bought). Of those households using sand around 35% collected it themselves, 39% bought it from other local sand extractors, and 3% used both these methods of acquisition (table 4.2). 69% of households stated the use of land rock for house construction, all stating that they both collected and bought the rock.

A large percentage of households used mangrove wood to cook on a daily basis, with around a quarter of these households collecting the wood themselves, another quarter buying it from local traders. 50% of households using mangrove wood said they did not know where the wood they used came from as another household member had acquired it.

Table 4.2. Marine and coastal resources used as a source of raw materials, along with household method of acquisition within the Kaledupa sub-district of Wakatobi Marine National Park, Indonesia (n = 440).

Material	% of households	Method of acquisition	% of households
Coral	47.94	Collected	41.51
		Bought	22.64
		Collected and bought	20.75
		Unknown	13.21
Sand	63.07	Collected	34.45
		Bought	38.66
		Collected and bought	2.52
		Unknown	24.37
Mangrove	41.00	Collected	25.00
		Bought	25.00
		Unknown	50.00

Mined coral was used as a building material because it is inexpensive and in the case of collection for personal use, free as it is removed directly from the reef flat when needed. However those households using land rock (fossilised coral taken from the island interior) believed it to be a stronger and better material than reef flat coral and worth the extra cost if bought or effort if mined for personal use. The sand used as a building material, when collected, was taken directly from local beaches, in most cases Hoga Island was the preferred location used for sand extraction.

The major use of mangrove wood was as a fuel to cook, however mangrove wood was also used as a building material to make stilts and frames on which to build houses and to build fish fences, which are a non-selective highly efficient fishing method used in local waters. Mangrove was the selected cooking fuel either through necessity, the households having no alternative due to fuel prices or limited land access, or preferentially due to the distinctive flavour generated by mangrove smoke. Those households that did not use mangrove wood on a daily basis to cook stated that they did use it occasionally as it represents a traditional cooking method, and again for the distinctive flavour generated by the smoke.

4.4.3. Household Primary Income Generation

34 specific primary income generating activities were identified within the study (table 4.3.); these activities could be grouped into 7 categories as follows: 1) marine and coastal resource dependent; 2) tourism; 3) agriculture; 4) work overseas; 5) civil service; 6) trading; and 7) other. The "other" category included various activities that did not fall into any of the preceding categories but for which each had 2% or less household dependence apart from where others provided and in this case, the primary activity undertaken by the provider remained unknown, hence the category allocation was deemed appropriate. It could be argued that tourism is marine and coastal resource dependent as the majority of tourists that visit the region are attracted by the marine environment, particularly the areas coral reefs. However, this is a category requiring separation as it is expected that tourism may grow in the near future with support from the *Bupati* (regional government leader) and should be monitored closely.

Table 4.3. Identified primary income generating activities and their general category groupings from a household survey of the Kaledupa sub-district of Wakatobi Marine National Park, Indonesia (n = 440).

Activity	Number of Households	Percentage of Households	Category
Seaweed cultivation	97	22.05	**Marine and coastal resource dependent**
Seaweed middleman	3	0.68	
Seaweed tying	3	0.68	
Fishing locally (finfish)	44	10.00	
Octopus fishing	3	0.68	
Fish Middleman	7	1.59	
Fishing overseas (finfish)	19	4.32	
Mangrove collection and sale	4	0.91	
Sea transport	8	1.82	
Tourism	11	2.5	**Tourism**
Coconut cultivation	41	9.32	**Agriculture**
Coconut middleman	2	0.45	
Clove*	9	2.05	
Mixed local produce**	35	7.95	
Cassava/local potato	8	1.82	
Work overseas***	22	5.00	**Work overseas**
Teaching	26	5.91	**Civil service**
Local government administrator	10	2.27	
Wandering trade (various)	9	2.05	**Trading**
Shop trade	14	3.18	
Carpentry	6	1.36	**Other**
Pension received	6	1.36	
Wood cutter	3	0.68	
Others provide****	25	5.68	
Sarong weaving	9	2.00	
Other local crafts*****	5	1.14	
Baking	2	0.45	
Land transport	1	0.23	
Not working	1	0.23	
Nurse	1	0.23	
Labourer	3	0.68	
Electric company worker	1	0.23	
Selling ice lollies	1	0.23	
Gardener	1	0.23	
All activities	**440**	**100**	

*Harvested and sold outside of the Wakatobi once annually, all profits returned to Kaledupa.

**Common local produce include perennial crops like banana, tomato, tamarind, cassava, coconut, potato, kankung (green leafy vegetable).

***Earnings brought or sent to Kaledupa.

****Primary income generating activities of providers unknown.

*****Include various weaving crafts for products such as mats, fish traps and roofing panels, and local lantern making.

65% of households stated direct financial dependence on natural resources. 41% of households stated that this dependence for their primary income source was on marine and coastal resources. A further 2% of households stated financial dependence on tourism; primarily marine research and conservation tourism provided by Operation Wallacea, a UK based company operating research and conservation expeditions in the Wakatobi and employing a permanent and seasonal local staff. 22% of households stated dependence on agriculture, with a large proportion of farming households (45%) stating coconut as their primary crop. Other primary crops included cassava and potato (8% of farming households) and clove (10% of farming households). Cloves were harvested in Taliabo (west of the Spice Islands), and farmers travelled to harvest their crop once annually. 8% of households stated civil service as their primary income source, which included teaching and local governmental administration. 5% of households generated their primary income from work overseas with money sent or brought back to Kaledupa by the primary earner. Work overseas included all work outside of the Wakatobi, common examples being tin mining or work within the transport sector in Malaysia. 5% of households depended on trading through local shops or market stalls, mobile trade, or trade from the home. Commonly traded products included food, clothes and fuel; however this category included the trade of all non-marine goods. 17% of households were dependent on other activities, examples of which included nursing, carpentry, labouring and land transport (figure 4.1.).

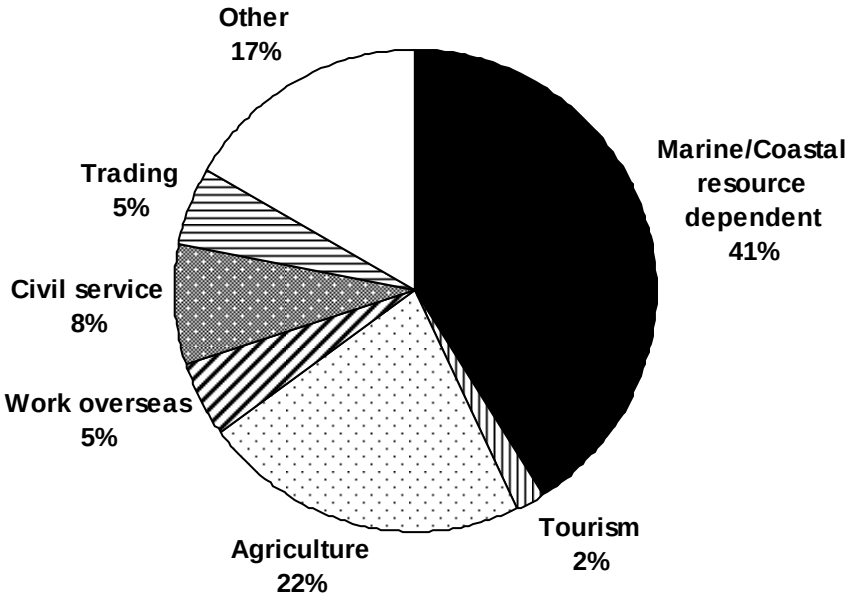

Figure 4.1. Primary household income generating activities within the Kaledupa sub-region of Wakatobi Marine National Park, Indonesia (n=440).

A comparison of Bajo and Pulo primary occupations

There were clear differences in primary income generating activities between *Bajo* and *Pulo* communities (figure 4.2.). 76% of *Bajo* households depend directly on marine resources for their primary income source, this compares to 37% of *Pulo* households (more than 50% higher dependence for the *Bajo*). 6% of *Bajo* households depended on tourism, 2% on work overseas, 2% on civil service, 4% on trade (non-marine products), and 10% on other income generating activities. No Bajo households depended on agriculture for their primary income source. *Pulo* generally had a wider and more equal spread of income generating activities. Agriculture was important with 25% of households dependent. 2% of households depended on tourism; 5% on work overseas; 9% on civil service; 5% on trading and 17% on other activities.

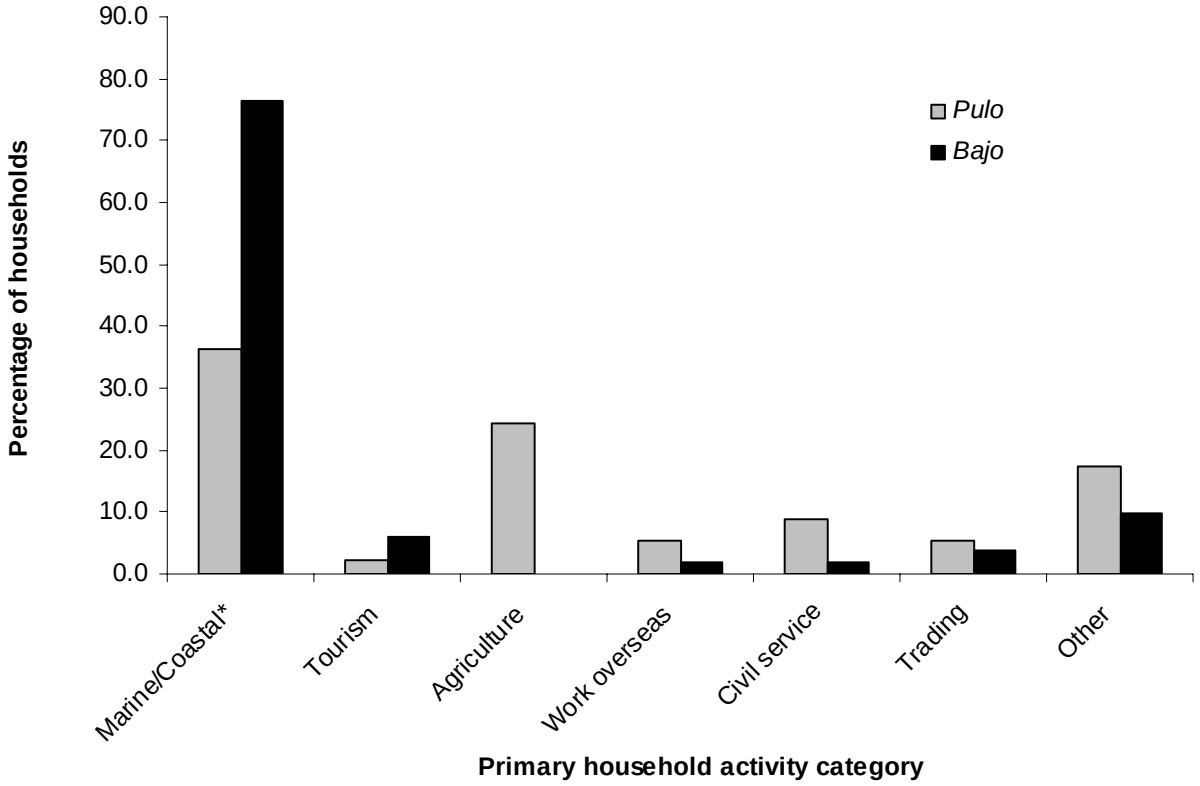

Figure 4.2. Percentage of households involved in each identified primary household income generating activity category. A comparison of *Bajo* (traditionally nomadic sea people) (n=51) and *Pulo* (Kaledupan Island people) (n=389) communities of the Kaledupa sub-region of Wakatobi Marine National Park, Indonesia. *Marine and coastal resource dependent.

Inter-village variation

There is variation between all villages in terms of dependence on marine and coastal resources for primary income. For some *Pulo* villages, dependence on marine and coastal resources is extremely high, and availability of other income generating activities low, whereas in other *Pulo* villages there is relatively low dependence on marine and coastal resources and the full range of potential Kaledupa income generating activities is available (table 4.4.).

Table 4.4. Percentage of households involved in each of 7 available primary income generating categories in each of 19 villages in the Kaledupa sub-district of Wakatobi Marine National Park, Indonesia. **Bajo* villages (traditional sea nomads).

Village	Primary household activity category							No. Categories Present
	Marine/Coastal resource dependent	Tourism	Agriculture	Work overseas	Civil service	Trade	Other	
Ambeua	15.6	9.4	6.3	0.0	37.5	6.3	25.0	6
Lagiwae	7.1	14.3	25.0	3.6	14.3	17.9	17.9	7
La Ulua	25.0	0.0	37.5	4.2	8.3	0.0	25.0	5
Langge	56.5	0.0	13.0	0.0	13.0	0.0	17.4	4
Ollo	34.4	0.0	31.3	6.3	6.3	3.1	18.8	6
Buranga	25.0	0.0	28.1	3.1	6.3	9.4	28.1	6
Sandi	30.8	0.0	34.6	3.8	11.5	3.8	15.4	6
Balasuna	27.3	0.0	39.4	3.0	6.1	3.0	21.2	6
Sombano	69.2	0.0	15.4	7.7	0.0	0.0	7.7	4
Kasuwari	41.4	3.4	20.7	10.3	0.0	3.4	20.7	6
Tampara	16.7	0.0	45.8	12.5	8.3	0.0	16.7	5
Darawa	89.5	0.0	0.0	0.0	0.0	5.3	5.3	2
Lentea	92.3	0.0	0.0	0.0	0.0	0.0	7.7	2
Tanomeha	63.6	0.0	6.1	3.0	6.1	6.1	15.2	6
Umala	20.0	0.0	30.0	20.0	10.0	10.0	10.0	6
Pajam	22.2	0.0	33.3	16.7	0.0	0.0	27.8	4
Sama Bahari*	80.0	12.0	0.0	0.0	0.0	4.0	4.0	4
Mantigola*	72.7	0.0	30.0	4.5	4.5	0.0	18.2	5
Lohoa*	75.0	0.0	0.0	0.0	0.0	25.0	0.0	2

Darawa and Lentea, (*Pulo* villages), had the highest dependence on marine and coastal resources for their primary income source; 90% and 92% of households, respectively, stating dependence on marine and coastal resources for their primary income. The three *Bajo* villages Sama Bahari, Mantigola and Lohoa had 80%, 72% and 75% of households, respectively, dependent on marine

and coastal resources for primary income. Lowest dependence was in Lagiwae with just 7% of households stating dependence.

Highest primary activity diversity was found in Lagiwae with all 7 categories present. Lowest was found in Lohoa (*Bajo*) and Lentea (*Pulo*) with just 2 categories each. Both other *Bajo* villages (Sama Bahari and Mantigola) were each involved in 4 income generating categories.

4.4.4. Marine and Coastal Resource Dependent Activities

Within the 41% of all Kaledupan households dependent on marine resources for their primary income, 4 major categories were identified as follows: 1) Seaweed which includes seaweed cultivation, seaweed middleman activities, and seaweed tying where cultivators pay non-family members to tie seaweed seed to strings; 2) Fishing this is fishing in local waters, i.e. within the Wakatobi, and middleman activities, i.e. sale of fishery products; 3) Fishing overseas which included all fishing activities outside of the Wakatobi; and 4) Mangrove collection which involved the cutting, collection and trade of locally sourced mangrove wood.

Seaweed was the most important marine resource related activity across the Kaledupa sub-district. 57% of marine resource dependent households stated a seaweed related activity as their primary income source (54% Pulo; 3% Bajo). 30% of marine resource dependent households depended on fishing locally, 11% on fishing overseas, and 2% on mangrove cutting and sale. All mangrove traders were *Bajo*.

Within the 76% of *Bajo* households directly dependent on marine resources for their primary income source, approximately 4/5 (88%) stated fishing as that source, hence, although the *Bajo* represent only 11.8% of the Kaledupan population, *Pulo* making up the remaining 88.2% (see chapter 3, table 3.1.), they account for approximately 50% of all fishing households within the sub-district i.e. households that gain their primary income from fishing (figure 4.4.). In Darawa and Lentea, the high dependence on marine and coastal resources for primary income was due primarily to the prevalence of seaweed cultivation as an income generating activity and villagers taking advantage of the close proximity to large areas of sheltered shallow water habitats.

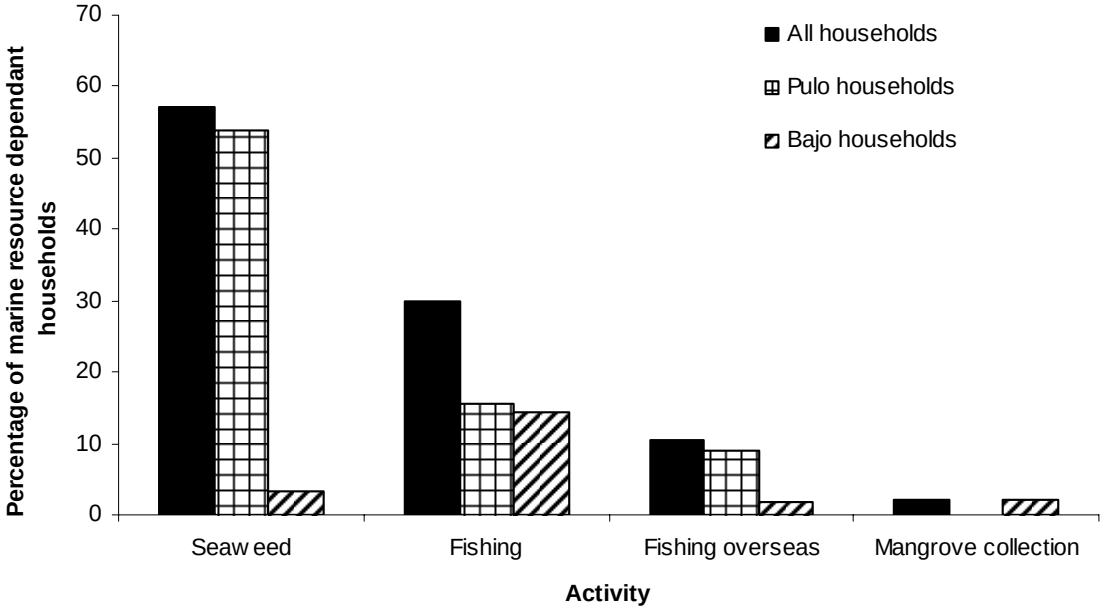

Figure 4.4. Primary income generating activities described within households dependent on marine and coastal resources for their primary income source (41% of Kaledupan households). Marine resource dependent primary income generating activities are shown and the proportion of Pulo (Kaledupan Island dwellers) and Bajo (traditional sea nomads) households involved in each within the Kaledupa sub-region of Wakatobi marine National Park (n=180).

4.4.5. Income value

Income values are given in both Indonesian Rupiah (Rp) for local context and US$ for wider context. For case studies to be meaningful, the results must be understood and applied at the local level, however, for the results to be put into context with the rest of the world, US$ represent a globally recognised unit of currency.

Annual income per person

Civil servants generated the highest mean annual income per person (US$ 1556 ± 80 / Indonesian Rupiah (Rp) 14,252,800 ± 733,847). Tourism came second (US$ 784 ± 148 / Rp 17,181,818 ± 1,357,994), followed by marine and coastal resources (US$ 669 ± 63 / Rp 6,122,494 ± 576,034). Agriculture generated the lowest mean annual income (US$ 371 ± 54 / Rp 3,399,521 ± 493,999) closely preceded by other, trading and work overseas (US$ 459 ± 60 / Rp

4,203,266 ± 546,728, US$ 460 ± 167 / Rp 4,216,889 ± 1,533,204 and US$ 492 ± 86 / Rp 4,502,111 ± 788,725 respectively) (figure 4.5.).

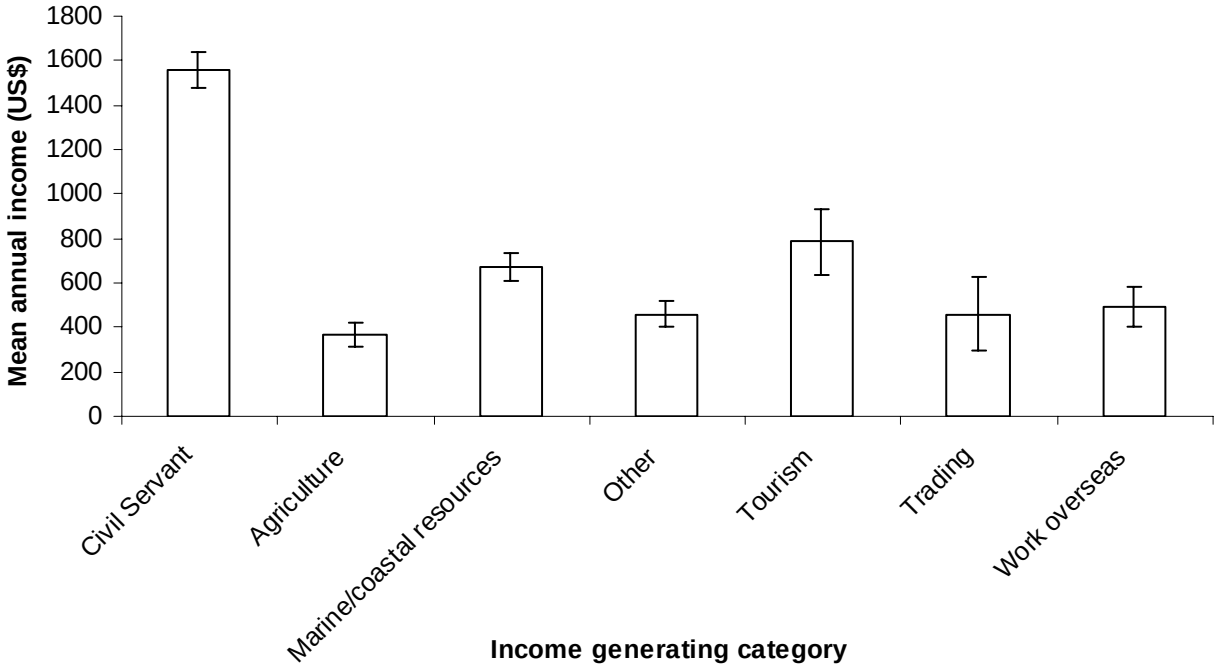

Figure 4.5. Mean (± SE) annual income per person for Kaledupan primary income generating categories. Annual income shown in US dollars (n = 408).

Analysis using a two way ANOSIM showed a highly significant difference in the incomes generated between the 7 income generating categories (global $r = 0.1$; $p < 0.001$). Pairwise tests indicated that civil servants had significantly higher annual incomes than any other category. Marine and coastal resources generated significantly higher incomes than agriculture (global $r = 0.1$; $p < 0.001$) and "other" (global $r = 0.048$; $p < 0.05$); and "other" generated significantly higher income than agriculture (global $r = 0.031$; $p < 0.05$). No significant differences were outlined between any other categories or combinations (table 4.5.).

Table 4.5. ANOSIM pairwise comparison between mean annual incomes generated from each of 7 identified income generating categories within the Kaledupa sub-region of Wakatobi Marine National Park, Indonesia. ** indicates $p = 0.001$. * indicates $p < 0.05$.

Category	Civil service	Agriculture	Marine/coastal resources	Other	Tourism	Trading	Work overseas
Civil service	-	**	**	**	**	**	**
Agriculture		-	*	*			
Marine/coastal resources			-	*			
Other				-			
Tourism					-		
Trading						-	
Work overseas							-

Due to the high dependence on marine and coastal resource dependent activities and agriculture, these categories were broken down into their constituent activities. Seaweed middlemen generated the highest mean individual incomes from marine and coastal resource dependent activities (US$ 1129 ± 509; Rp 10,339,083 ± 4,664,321) followed by fishing overseas (US$ 944 ± 252; Rp 8,645,929 ± 2,311,549). Fishing locally generated a mean individual annual income of US$ 701± 177; Rp 6,420,731 ± 1,622,765, seaweed farming US$ 639 ± 55; Rp 5,849,992 ± 500,072; fish middlemen US$ 470 ± 82; Rp 4,305,905 ± 753,818, and mangrove cutting US$ 158 ± 54; Rp 1,449,999 ± 494,874. Seaweed tying generated the lowest mean annual individual income within the marine and coastal resource dependent category and within the Kaledupa sub-district (US$ 18 ± 7; Rp 168,000 ± 60,399).

Within the agriculture category clove farming generated the highest mean individual annual income (US$ 1051 ± 360; Rp 9,625,000 ± 3,298,742), followed by coconut cultivation (US$ 416 ± 72; Rp 3,806,605 ± 658,795) and mixed agriculture (various local produce) (US$ 184 ± 21; Rp 1,681,809 ± 194,791) (figure 4.6.).

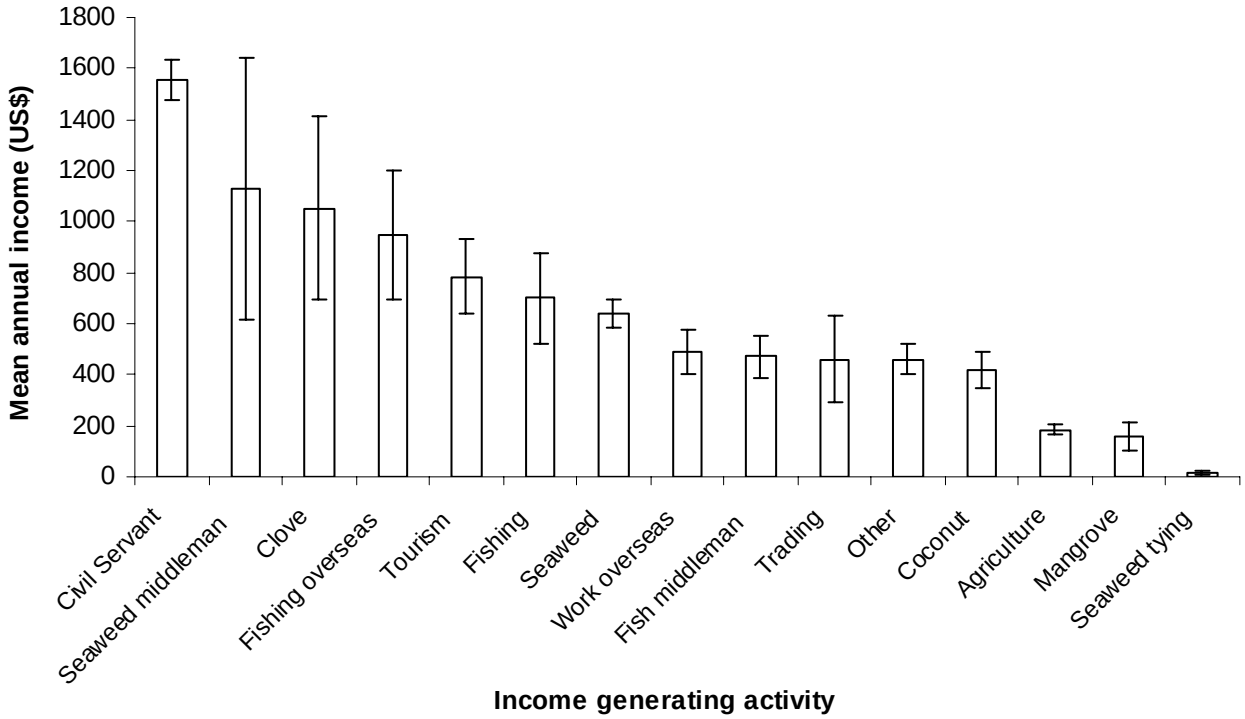

Figure 4.6. Mean (± SE) annual income per person for Kaledupan primary income generating activities. Annual income shown in US dollars (n = 408).

Analysis using ANOSIM highlighted no significant difference in individual annual income between civil servants and seaweed middlemen, significant differences were highlighted again between civil servants and all other activities. Seaweed middleman generated significantly higher incomes than fish middleman, fishing, mangrove, mixed agriculture and work overseas. Fishing generated significantly higher incomes than seaweed cultivation, seaweed tying coconut cultivation and mixed agriculture. Seaweed cultivation generated significantly higher incomes than coconut cultivation, mixed agriculture, trading, mangrove and "other" activities. Seaweed tying generated significantly lower incomes than all other activities.

Coconut cultivation generated significantly higher mean individual annual incomes than mixed agriculture as did clove harvest. Clove harvest generated significantly higher mean annual individual incomes than seaweed cultivation, seaweed tying and work overseas (table 4.6).

Table 4.6. ANOSIM pairwise comparison between mean annual income generated from primary household activities in 19 villages/sub-villages within the Kaledupa sub-region of Wakatobi Marine National Park, Indonesia. ** indicates $p = 0.001$. * indicates $p < 0.05$.

Activity	Civil service	Coconut	Mixed agriculture	Fish middleman	Fishing	Fishing overseas	Other	Seaweed cultivation	Seaweed middleman	Seaweed tying	Clove harvest	Tourism	Trading	Work overseas	Mangrove
Civil service	-	**	**	**	**	**	**	**		**	*	**	**	**	**
Coconut		-	*					*		**					
Mixed agriculture			-		*	**	*	**	*	**	*	*		*	
Fish middleman				-					*	*					*
Fishing					-			**		**					
Fishing overseas						-				**					
Other							-	**		*					
Seaweed cultivation								-		**	*		*		*
Seaweed middleman									-					*	
Seaweed tying										-	*	*	*	**	
Clove harvest											-			*	
Tourism												-	*		**
Trading													-		
Work overseas														-	
Mangrove															-

Net Kaledupan Income and contribution of primary activities

Total annual net Kaledupan income, including income from all primary and supplementary income sources, was estimated as US$ 3,751,864 (Rp 34,357,725,246) (table 4.7.).

Table 4.7. Total annual net Kaledupan income, Kaledupa sub-district, Wakatobi Marine National Park, Indonesia.

Mean annual household income (Ti) (Million Rp ± SE)	**Mean annual household income (Ti) (US$ ± SE)**	**Number of households (Tn)**	**Net annual Kaledupan income (TKi) (Million Rp)**	**Net annual Kaledupan income (TKi) (US$)**
7.8 ± 0.4	853 ± 47	4400	34,357.7	3,751,864

Based on the individual incomes from primary activities, it was estimated that the total annual net Kaledupan income from primary income generating activities was US$ 2.6 million (Rp 24 billion) (table 4.8.), which represents 69% of the estimated total Kaledupan income. Natural resources accounted for approximately 60% of this total.

Table 4.8. Total annual net Kaledupa sub-district income from primary sources by category, Wakatobi Marine National Park, Indonesia.

Primary household activity	Mean annual income (Pi) (Million Rp ± SE)	Mean annual income (Pi) (US$ ± SE)	Within survey households (Hn)	Total annual income for survey households (Million Rp)	Total annual income for survey households (US$)	Total Kaledupan income from primary activity (TKPi) (Million Rp)	Total Kaledupan income from primary activity (TKPi) (US$)
Civil Servant	14.3 ± 0.7	1,556 ± 80	36	513.1	56,031	5,131.0	560,306
Coconut	3.8 ± 0.7	416 ± 72	38	144.6	15,796	1,446.5	157,959
Mixed agriculture	1.7 ± 0.2	184 ± 21	38	63.9	6,979	639.1	69,788
Fish middleman	4.3 ± 0.8	470 ± 82	7	30.1	3,291	301.4	32,914
Fishing	6.4 ± 1.6	701 ± 177	47	301.8	32,954	3,017.7	329,538
Fishing overseas	8.6 ± 2.3	944 ± 252	19	164.3	17,939	1,642.7	179,386
Other	4.2 ± 0.5	459 ± 60	68	285.8	31,212	2,858.2	312,118
Seaweed	5.8 ± 0.5	639 ± 55	93	544.0	59,410	5,440.5	594,102
Seaweed middleman	10.3 ± 4.7	1,129 ± 509	3	3.1	3,387	310.1	33,871
Seaweed tying	0.2 ± 0.06	18 ± 7	3	0.5	55	5.0	550
Clove	9.6 ± 3.3	1,051 ± 60	8	77.0	8,408	770.0	84,084
Tourism	7.2 ± 1.4	784 ± 148	11	79.0	8,627	790.0	86,268
Trading	4.2 ± 1.5	460 ± 167	15	63.3	6,907	632.5	69,073
Work overseas	4.5 ± 0.8	492 ± 86	18	81.0	8,849	810.4	88,493
Mangrove	1.4 ± 0.5	158 ± 54	4	5.8	633	58.0	6,334
Total			**408**			**23,853.3**	**2,604,784**

Direct use of marine resources generated around 48% of the total income from primary activities, equivalent to US$ 1.2 million per year, and approximately double the income generated from civil service (US$ 560,000 per year). Tourism, although one of the highest individual income generating activities (i.e. income earned per person), contributed only US$ 86,300 to the Kaledupan annual economy. Agriculture and other activities each generated and estimated US$ 312,000 per year for the sub-region. Work overseas brought around US$ 88,500 annually to Kaledupa, and trade (of non-marine products) US$ 69,000 annually (figure 4.7.).

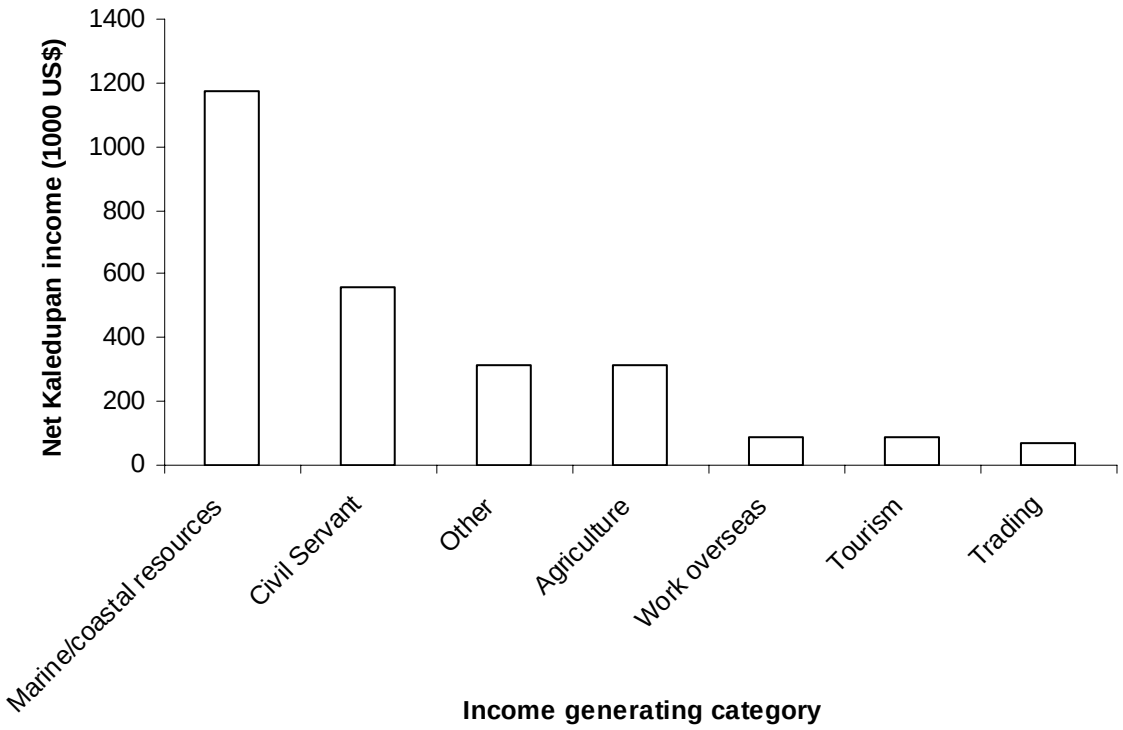

Figure 4.7. Net annual Kaledupan income from 7 identified primary income generating activity categories within the Kaledupa sub-region of Wakatobi Marine National Park, Indonesia (net annual income shown in US dollars, n = 408).

Net primary income from marine and coastal resources

Due to the high dependence on marine and coastal resources for income, this category was again separated into its constituent activities. Seaweed cultivation contributed 23% (US$ 600,000) to the total annual Kaledupan primary income (figure 4.8.), making this activity the most important single economic activity within the sub-region. Fishing was the third highest net income generator, accounting for approximately US$ 330,000 per year. Fish middlemen generated US$ 32,900 annually and fishing outside of the region US$ 179,400 annually. Seaweed middlemen generated US$ 33,900 per year, whilst seaweed tying generated only US$ 550 per year (the lowest contribution to the Kaledupan economy). Mangrove cutting and trade generated an equivalent total of US$ 6334 per year.

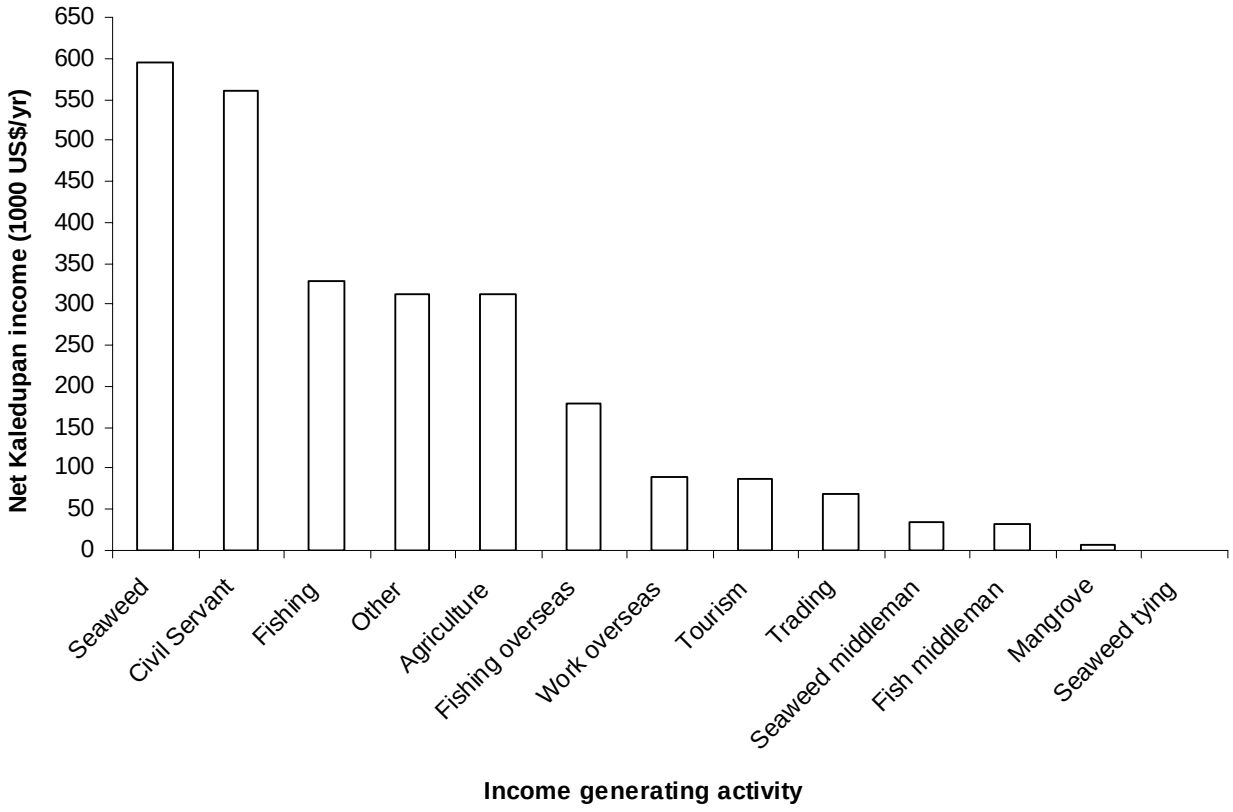

Figure 4.8. Net annual income from all primary income generating activities (including a breakdown of the marine and coastal resource dependent income category) within the Kaledupa sub-region of Wakatobi Marine National Park, Indonesia (net annual income shown in US dollars, n = 408).

Net annual village income from primary sources

Ambeua, a *Pulo* village, had the highest net annual village income (US$ 1088 ± 127; Rp 9,960,825 ± 1,159,303) followed by Sama Bahari (US$ 995 ± 309; Rp 9114133 ± 2827204) a *Bajo* village, although income within Sama Bahari was highly variable. Lohoa had the lowest income (US$ 216.2 ± 69.6; Rp 2,797,662 ± 637,809), but was closely preceded by Pajam (US$ 233.3 ± 64.4; Rp 2,714,761 ± 589,729) (figure 4.9).

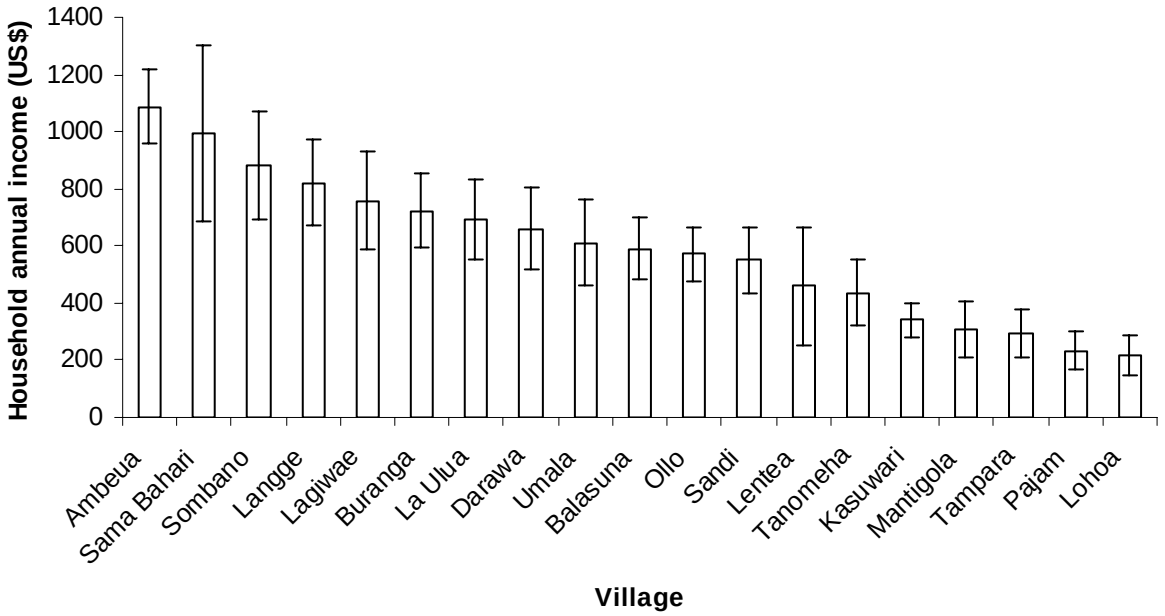

Figure 4.9. Net annual household income generated in all villages within the Kaledupa sub-district of Wakatobi Marine National Park, Indonesia. 10% of all households in each village were included in the analysis (mean ± SE) (n=408).

Analysis using a two way ANOSIM showed a highly significant difference in the incomes generated between villages (global $r = 0.062$; $p = 0.001$). Pairwise tests indicated that Ambeua had a significantly higher annual income than any other village, excluding Sombano. Lagiwae had a significantly higher annual income than Tampara, Tanomeha, Mantigola, Pajam and Kasuwari. La Ulua had a significantly higher annual income than Tampara, Mantigola, Pajam and Kasuwari. Ollo had a significantly higher income than Tampara, Tanomeha and Pajam; Buranga significantly higher than Tampara, Pajam and Kasuwari, Langge significantly higher than Tampara, Mantigola, Pajam and Kasuwari. Tanomeha had a significantly higher income than Kasuwari

Sama Bahari had a significantly higher annual income than Tampara, Pajam, Kasuwari and Mantigola. Umala had a significantly higher annual income than Tampara and Pajam. Sombano had a significantly higher overall annual income than Tampara, Pajam, Kasuwari, Lentea and Mantigola. Kasuwari had a significantly higher annual income than Pajam. Darawa had a significantly higher mean annual income than Tampara, Pajam and Mantigola (table 4.9.).

There were no significant differences between *Pulo* and *Bajo* incomes within any income generating activity or category.

Table 4.9. ANOSIM pairwise comparisons between mean annual incomes generated from primary household activities in 19 villages/sub-villages within the Kaledupa sub-region of Wakatobi Marine National Park, Indonesia. ** indicates $p = 0.001$. * indicates $p < 0.05$.

Village	Ambeua	Lagiwae	La Ulua	Ollo	Buranga	Balasuna	Sandi	Langge	Tampara	Tanomeha	Umala	Mantigola	Sombano	Pajam	Kasuwari	Sama Bahari	Darawa	Lentea	Lohoa
Ambeua	-	*	*	*	*	*	*		**	**		**		**	**	*	*	**	*
Lagiwae		-							*	*		*		*	*				
La Ulua			-						*			*		*	**				
Ollo				-					*	*				*					
Buranga					-				*					*	*				
Balasuna						-													
Sandi							-												
Langge								-	**			*		*	*				
Tampara									-		*		**			*	*		
Tanomeha										-					*				
Umala											-			*					
Mantigola												-	*			*	*		
Sombano													-	**	**			**	
Pajam														-	*	*	*		
Kasuwari															-	*			
Sama Bahari																-			
Darawa																	-		
Lentea																		-	
Lohoa																			-

4.5. Discussion

This work provides the first comprehensive socio-economic study within the Kaledupa sub-region of Wakatobi marine National Park, Indonesia. The present chapter details local marine resource use patterns and highlights the importance of marine resources to the local economy. Dependence on marine resources for food, fuel, building materials and income has been described and this dependence is high, with limited access to non-marine alternatives.

4.5.1. Dependence of local communities on marine resources for food and raw materials

The use of natural resources is an important characteristic of rural coastal peoples (Hanazaki & Begossi 2003), with communities historically tied to marine and terrestrial resources through livelihoods such as artisanal fishing (Begossi 1995). An analysis of diet can identify aspects of local use of natural resources, both marine and terrestrial (Hanazaki & Begossi 2000) and diet habits are directly related to subsistence activities and will reflect changes in these activities (Roosevelt 1987). Within the Kaledupa sub-district there was very high dependence on marine and coastal resources for food, and for raw materials. The whole population is dependent on marine resources for food making this the most important dependency. With diminishing fish stocks and documented catch decline (May 2003, 2005), this has severe implications for future food security in the future.

Food security can be defined as a state where "*all people at all times have both physical and economic access to sufficient food to meet their dietary needs for a productive and healthy life*" (USAID 1992), and clearly this state of security within the Kaledupa sub-district can not be sustained, and may already be to some extent reduced for the large number of households currently dependent on fish for protein with no appropriate alternatives.

Fish or other seafood was omitted from local diet if respondents were unable to catch/collect, afford, or access local markets. Inability to catch or collect was repeatedly due to a lack of fishing success or limiting weather conditions. Local perceptions of seafood availability provide valuable data in terms of food security (Pomeroy *et al*. 2004b). Within the Kaledupa sub-district 90 % of respondents involved in fishing or reef-top gathering stated an opinion of diminishing stocks and the need to travel increasingly further distances and work for longer to acquire adequate catches. For those who were unable to buy or gather seafood, family or neighbours often provided it but this however was also dependent on catch, availability and price.

With limited catches, local households often lack the economic power to purchase equivalent (in terms of nutrition) substitutes. Without seafood, the population of Kaledupa were generally restricted to a diet of rice and noodles, and for the poorest households a diet made up of only cassava resulted. Fish was clearly the preferred choice of food for local people and in particular reef fish. Many people believed that pelagic fish was not nutritious, and that it did not have any of the health benefits they believed came from eating reef fish. This dependence on fish can have short term and long term consequences on the nutritional status and health of the local population (Messer 1989) which may be reflected in their quality of life and sustainability (Becker *et al*. 1997). The current level of fish consumption for local subsistence is considered to be unsustainable (Coblentz 1997, May 2003) so it is vital both to prevent fisheries crashes and decreased human well-being, that alternative sources of protein to reef fish are sourced and used.

Harvesting invertebrates from shallow nearshore and reef-top areas is widespread throughout the tropics (Ashworth *et al*. 2004). It is particularly intensive in Southeast Asia where the widest range of food items are accepted and even sought after (Munro 1989a, Dalzell *et al*. 1996). Gathering of reef-top invertebrates is largely carried out by women (Ashworth *et al*. 2004). The practice is a traditional fishery method carried out by *Bajo* people in particular and they are proficient and regular gatherers (Sopher 1977, Tomascik *et al*. 1997b, Arunotai 2006), however in the Kaledupa sub-district, both *Pulo* and *Bajo* people were involved and the practice represented a recreation and food gathering activity for both cultures. Reef-top gathering, or more accurately seagrass gathering in the Kaledupa case, represented a supplementary food source, although it appeared to be more for recreation than subsistence. No households stated any gleaning products as their major of first choice food source.

Marine sourced building materials were frequently used, although some alternatives did exist. Mined coral, regardless of its illegality, was used as a foundation, platform or perimeter wall for houses. Coral was used as a building material because it is inexpensive when bought and free when removed directly from the reef flat when needed for personal use. There was, however, interest in other, harder, materials such as land rock which many people now believe to be a stronger and better product, although the material was more expensive than coral which limited availability to some groups, particularly the Bajo as they do not have land to mine rock from, additionally as they live on the sea, coral is far more accessible being effectively on their doorstep. All Bajo households used coral as a building material. The practice of coral mining and its subsequent use as a building material is of concern as it is entirely unsustainable and destroys the coral reef (Öhman & Cesar 2000), but for people with no access to other materials the

ecological consequences and the illegality of this practice are irrelevant until alternatives are made available. The apparent preferential use of land rock as a building material however is encouraging and should perhaps be promoted at least to those who can currently afford it.

Sand for use as a building material taken directly from local beaches is also unsustainable but unfortunately depended upon by a large percentage of households. There are currently no local alternatives to sand and no official restrictions exist to control its removal, although some land owners have begun to place signs stating that sand can not be removed from their plots. Alternative materials must be sourced, and clear restrictions put in place and enforced.

Mangrove wood was also used as a building material to make stilts and frames on which to build houses and to build fish fences. The major use of mangrove wood however was for cooking, the *Bajo* in particular depend on mangrove wood to meet their daily cooking needs as they can not afford the specialised equipment required to cook with kerosene or indeed the kerosene itself, particularly in the face of rising fuel prices. Many *Pulo* households have the same problem, and even those that can afford to use kerosene, often prefer the traditional method of cooking with mangrove. *Pulo*, however, have access to land and forest areas, hence terrestrial wood (and coconut husks) can be used for cooking, although the sustainability of this practice is also questionable and all households using land wood stated the increasing distance and time involved in collecting their weekly supply. A number of people stating the use of mangrove wood to cook said that they used kerosene until recently when they had been forced to return to the more traditional method of cooking due to rising fuel prices. Fuel price increased three-fold during the three year duration of the current project and this was largely related to the removal of government subsidies on fuel. Increasing fuel prices in the future could also be a consequence of additional "environmental" taxes implemented in a bid to reduce carbon emissions. However, as mangroves fix and store significant amounts of carbon (Alongi 2002) and they play an important role in carbon sequestration, absorbing an estimated 25.5 x 106 tonnes of carbon a year (Ong 1993), it is essential that they are protected and conserved for this purpose, to prevent the removal of the worlds important carbon sinks (UNEP-WCMC 2006).

4.5.2. Extent to which Kaledupa sub-district communities depend on natural resources for income

Approximately 65% of households in the Kaledupa sub-region were directly dependent on natural resources for income; greatest household dependence on a single category for primary income came from marine and coastal resources. This did not include those households utilising marine resources as a supplementary income or for subsistence consumption, hence this is a minimum percentage estimate and relates entirely to primary household income, i.e. the income generating activity on which the household is most (or entirely) dependent. A further 2% of households stated tourism as their primary income source which, within the Kaledupa sub-district, is primarily marine based research and conservation tourism hence could also be described as marine resource dependent, and of direct non-consumptive value. Tourism was considered as a separate category due to its large economic potential if developed further, which is an aim of the current Wakatobi district *Bupati* (government leader) with plans for improved facilities and access. Access remains a major deterrent to tourists as the trip form the nearest major city, Makassar in Southwest Sulawesi, can take three or four days, however, if marketed properly, this could also be an attraction.

A large number of civil servants worked within the sub-district reflected by 8% of primary incomes being generated by local government administrators or teachers. The high number of teachers is most likely related to the Kaledupan tradition of sending sons (and now daughters) away to be educated and the traditional return of well educated teachers (Donohue, 1999). However, most of the households involved with civil service came from just 4 villages, with 40% of these households concentrated in Ambeua, one of the islands capital villages and administrative centres, so the spread throughout Kaledupa was very uneven. The reason for this could be related to village wealth (see chapter 6) and associated access to formal university education outside of the Kaledupa Sub-district. Ambeua village had the highest mean annual income hence a larger percentage of households may be able to send their children to university to train as teachers or civil servants.

Trade as a source of income appears to have increased dramatically since 1991 when the first market area was built, previously to which no shops or stalls existed (Donohue 1999). In 2005, many small shops were in existence and from 2004-2006 personal observations highlighted the appearance of several more, including printing and photocopying outlets.

Extreme inter-village primary occupational variation existed and specialisation was apparent in some villages. In general dependence on marine resources was much higher in *Bajo* villages than in *Pulo* villages and the *Bajo* were clearly specialised fishers. *Pulo* are not known for their seafaring abilities (Donohue 1999) which may limit travel outside of the region and involvement in fishing activities in local waters or overseas. Overall, there was a greater spread of income generating activities available in *Pulo* villages. However, the highest dependence on marine and coastal resources for income was shown in the two *Pulo* villages Darawa and Lentea. Further analysis indicated that this dependence was largely associated with seaweed cultivation whereas in *Bajo* villages, the dependence was associated with fishing. The geographical isolation of Darawa and Lentea (see chapter 2; figure 2.4.) and their relatively small populations (table 4.1) means they have very limited access to markets and alternative sources of income. These villages have become highly specialised in seaweed cultivation and this activity dominated.

A small percentage of Bajo households were dependent on the collection and sale of mangrove wood for their primary income. All of the individuals involved were widows or the elderly with no available alternative income or method to cook. Although Pulo households do not trade in mangrove wood they do buy it from the *Bajo*, and frequently collect it for personal use.

4.5.3. Estimation of the direct financial value of marine and coastal resource based incomes as compared to other income sources

It is well documented now that coral reefs represent an important economic resource (Cesar 2000a). (Costanza *et al*. 1997a) estimated the world's marine ecosystem services to be worth US$12,319 billion yr^{-1}. With coral reefs alone worth US$6,075 $ha^{-1}yr^{-1}$, equating to US$375 billion yr^{-1} on a global scale. More recently it has been estimated that coral reefs provide annually around US$30 billion in net benefits in goods and services to world economies (Cesar *et al*. 2003). These values are important and significant to central governments and policy makers, but it is the direct financial value of resources on the local scale that is important to those people in a position to most impact these ecosystems.

Natural resource utilisation accounted for approximately 60% of the total net Kaledupan primary income annually. The majority of which was generated directly from the exploitation of marine and coastal resources which created 48% of the total net annual Kaledupan income, equivalent to US$1.2 million per year. This illustrates the significance of the natural environment and specifically the importance of marine resources to this small island community. Seaweed

farming generates the greatest economic contribution to Kaledupa whilst tourism generates some of the highest individual incomes, but due to its current small scale, its annual contribution to the Kaledupan economy remains minimal.

Civil service generated the highest mean individual incomes but proceeded marine and coastal resources for total financial input to the region. Individual incomes from farming were generally low as most of the crops grown on Kaledupa are low value crops such as cassava and banana, however higher value crops such as cashew can be grown but currently the activity is small scale.

Alternative incomes

Development of alternative livelihoods has become a popular policy to improve the socioeconomic status of small-scale fishers and to reduce fishing pressure on overexploited fisheries (Crawford 2002, Cooke 2004, UNEP 2006a).

Seaweed cultivation has been incorporated into many community-based marine and coastal resource management projects in developing countries (Crawford 2002). This study outlined for the first time the enormous importance of seaweed as a source of local income fro the people of the Kaledupa sub-district. Seaweed is an export product. It is grown locally in the shallow sub tidal area on strings then harvested, dried and exported, through various middlemen inside and outside of the Kaledupa sub-district. The Indonesian marine algae industry consists of two major product categories: 1) Agar, extracted from *Gracillaria, Gelidium* and *Gelidiella* species'., and 2) Carrageenan, extracted from *Euchema* and *Chondrus* species'. Both products have a multitude of applications in the food, cosmetics and pharmaceutical industries. The market for Agar is primarily in Asia where it is used as a gelling agent in many processed foods. It is estimated that this market will grow, but only through population growth as new product development tends to favour alternative polymers. The market for carrageenan, on the other hand, continues to grow on a global basis particularly in Europe, Japan and the USA (Fitzpatrick 2005). Seaweed cultivation was introduced to Kaledupa in 1985 (Clifton 2005), the industry initially grew slowly, but from 1993 to 2005 it increased more than 12-fold, with approximately 24% of the cultivators in 2005 having established their farms in 1994-1995 (Clifton 2005). In 2006 there were approximately 1030 cultivators within the Kaledupa sub-region. Seaweed related activities were accepted locally as an alternative to fishing, and in fact most seaweed farmers depended on fishing for their primary income source previously. Activities centred on seaweed farming were

also generally accepted as a good way to make money for anyone interested. There were however a few problems with diminishing growth rates, disease and lack of space.

For the development of alternative incomes such as seaweed cultivation to be a successful management strategy, fishers must be willing to give up fishing in favour of other more financially lucrative activities (Crawford 2002). Because seaweed related activities are socially and financially acceptable to local communities it represents a potential economically and ecologically sustainable alternative income for both *Pulo* and *Bajo* people (Cooke 2004) . The problems with growth, disease and lack of space for cultivation are issues that required further investigation. It is possible that alternative cultivations methods could help. All local cultivators use the same long-line surface method (in the shallow subtidal seagrass areas) to cultivate their seaweed but other methods of cultivation are available, such as vertical lines, and these could be trialled in the area to reduce the need for additional shallow subtidal space and perhaps solve the problem of disease and poor growth rates. However, although seaweed cultivation is socially and financially acceptable (and desirable) further research must be conducted, perhaps in the form of environmental impact assessment, to be sure that is not ecologically or environmentally damaging as it has been implicated in a decreased seagrass biomass in some high intensity cultivation areas (Eklöf *et al*. 2006). Additionally, market structures and prices should be investigated and provisions made to ensure local farmers are receiving maximum economic benefits for their efforts.

Agriculture provides an important contribution to the economy but generates some of the lowest incomes. This is because many of the crops grown on Kaledupa are low value crops such as cassava, potato and banana, and in many villages there is limited or no access to markets. Some high value crops are grown such as cashew but the activity is small scale. However this is an area for further investigation and could be a viable alternative income source if appropriate markets can be identified and accessed.

Tourism also offers an alternative income source and its very nature depends on the maintenance of high environmental quality, particularly the maintenance of healthy coral reefs and associated habitats. Individual incomes from this activity were high, exceeded only by civil servants, but net Kaledupan income from the activity low due to the small scale. Tourism could be developed and would provide another locally acceptable alternative income. However, as in the case of seaweed cultivation and fishing, very strict management regulations and monitoring is required to protect and respect local ecology and culture and minimise any associated negative impacts.

Local trade may be a suitable focus for alternative income sources as a growing industry, particularly in light of growing populations and new aspirations for consumer products.

4.5.4. Implications for management

As utilisation of natural resources is essential to the livelihoods and continued well-being of dependent and indigenous communities, as highlighted in the current example with extremely high dependence on the marine and coastal environment, ways must be found to allow communities to utilise natural resources in an economically and ecologically sustainable manner.

This study uses the example of a small island community in the Indo-Pacific to outline the complexities that should be understood when attempting to manage natural resources depended upon by local communities and highlights the need understand local resource use patterns and dependence levels for the chance of a successful management outcome. When considering the development of a management plan, the impact to local people should be paramount, not only because it is they who will ultimately control the success of the proposed management strategy but also because human communities are an integral part of the ecosystem.

The present research outlined that *Bajo* villages had the highest concentration of fishing dependent households, and that although the *Bajo* represented only 11% of the total Kaledupa sub-region population, they account for approximately 50% of all fishers, concentrated in just three villages. Clearly management efforts to reduce fishing could therefore be targeted at these villages but due to the higher dependence on fishing in these villages and the lack of alternative income sources, steps must be taken to mitigate for the economic effects and to provide alternative culturally acceptable income streams.

Overfishing is currently one of the major anthropogenic impacts in this region (Tomascik *et al*. 1997a) and is having a huge detrimental effect on the environment, particularly on the coral reefs that support target species (Unsworth *et al*. 2007). It is thought by some that even subsistence fishing could be unsustainable (Coblentz 1997) and the fisheries within the Kaledupa sub-district have been documented to be following a pattern which would lead ultimately to a crash in the individual fisheries for many species (May 2003). This is one activity that must be managed but must take into account the financial impact that this will have on local people and alternative sources of income must be found for management success as fishing locally contributes around US$300,000 annually to the Kaledupan economy.

A limited range of income generating activities was indicated which is an area for further investigation when trying to develop local alternative incomes and support local sustainable economic development. Additionally, the variation in available activities between villages outlines the absolute requirement to understand local resource use patterns and available income generating activities on a village to village basis. The specialisation of some villages in terms of income generation may have severe implications for successful management outcomes. This inter-village variation in income generating activities also highlights that there may be activity gaps in some villages that could be filled with other existing local activities or with sustainable alternatives.

Additionally the information on inter-village variation would allow certain villages to be identified as ideal locations to target for specific management initiatives, for example, the *Bajo* villages would be a good place to start when trying to manage local fisheries due to their very high concentration of fishermen as outlined above. *Pulo* villages could be targeted to decrease the demand for fish. As increasing pressure is placed on local fisheries, alternative sources of protein must be sourced.

Farming could represent an alternative protein source and could be the focus of sustainable development initiatives within *Pulo* villages. Some high value crops, such as cashews, are already grown on Kaledupa and the surrounding smaller islands, but involvement in this activity (number of cultivators) is minimal, however it could have potential for growth. Extensive further research would be required into this area, in terms of cultivation potential and products, markets, market structure and market access, and also to assess the willingness of local communities to seek alternative sources of protein which is beyond the scope of the current work. The *Bajo* generally do not own any land and do not have the skills or inclination necessary to farm.

In the case of mangrove exploitation and the high preference for the use of mangrove wood because of the distinctive flavour generated by the smoke, management strategies must be introduced that allow the sustainable utilisation of mangrove and perhaps involve mangrove replantation schemes.

4.5. Conclusions

This study was the first to quantify the direct dependence of people of the Kaledupa sub-district on marine and coastal resources. It has provided insights into what has to be considered during attempts to create and implement successful community-based local management plans for natural resources.

There was extremely high dependence on marine and coastal resources for food, livelihoods and raw materials. So it is vital that management initiatives are introduced that are acceptable both economically, to support local human populations, and ecologically. The dependence and value of marine and coastal resources as discussed in this chapter simply relate to the direct use and direct financial value of these resources, it is important to remember that other indirect and non-use values exist such as storm protection and biological life support and have not been considered. These attributes increase the overall value of the natural environment substantially (Costanza *et al*. 1997b), so values presented herein estimate effectively a minimum value and are not a price tag as such. For local dependent households it is income and personal and family well-being that are significant hence direct financial values are most meaningful, particularly in the long term if links can be provided between economic and environmental status which may push forward conservation efforts.

This chapter also outlines that people are prepared to accept alternative sources of income and raw materials where available; however, these alternatives must be socially, culturally and financially appropriate. It is encouraging to see the preferential use of land rock as a building material, rather than mined coral, even if the reasons are related to specific rock attributes and not to the prevention of further environmental degradation.

Chapter 5. Livelihood diversification

5.1. Introduction

The international community has set the goal of eradicating extreme poverty and hunger, the first objectives being 1) to reduce by half the proportion of people living on less than one US dollar a day and 2) to reduce by half the proportion of people who suffer from hunger (UN 2007). Historically human populations were entirely dependent on natural resources to sustain their daily lives but with current expanding markets and globalisation trends, dependence has decreased even in remote regions (IUCN, 2002). However, an estimated 53 % of the global human population still depend directly on natural resources to sustain their daily lives (IUCN 2002). Clearly these resources must be maintained and used sustainably to go on supporting this large percentage of the human population.

It is well documented that most of the world poorest people live in rural areas and depend on natural resources for food and income (Randall 1987, IUCN 2002, MEA 2005). A large part of this dependence is on marine and coastal resources (UNEP 2006a). More than one billion people in Asia depend on fish for protein and globally around 200 million people fish for their primary income source (IUCN 2002, UNEP 2006a). This dependence can create conflict between users and biodiversity conservation objectives (Randall 1987), but it can also give local people the chance to engage in conservation through sustainable use (IUCN 2002). The challenge is to find a balance that meets the needs of human populations whilst maintaining ecosystems, because human and ecosystem well-being are so closely interlinked we need to plan and manage ecosystem protection and human development simultaneously (Prescott-Allen 2001) and one may not be achievable without the other (MEA 2005).

The status of many coastal communities worldwide is fragile, due mainly to high dependence on now severely depleted and overfished natural resource bases and highly degraded coastal ecosystems (Pomeroy *et al*. 2006, UNEP-WCMC 2006, UNEP 2006b). Additionally, the dynamic nature of coasts along with often fragmented development and sometimes hostile conditions, can result in limited infrastructure and human support services (Whittingham *et al*. 2002). These conditions are most likely to affect the poorest people within communities who are usually most dependent on natural resources and who typically have the most limited access to available support systems (Pomeroy *et al*. 2006). However, a major benefit of living in such

areas is that the marine natural environment can provide a rich and accessible resource for poor communities (Whittingham *et al*. 2002, Njifonjou *et al*. 2006, UNEP 2006a).

Natural resources are particularly important to households in developing countries where the opportunities of a range of income generating activities may be highly limited. More than 66% of the world's population live in developing countries which is estimated to rise to around 77% by 2025 (Drakakis-Smith 2000). In areas where dependence is still high and populations are rapidly increasing, the pressure placed on natural systems in most cases is unsustainable (Coblentz 1997). In Southeast Asia the coastal population includes some of the world's poorest people whose livelihoods have become increasingly vulnerable. Indonesia in particular has one of the world's largest areas of coral reef and highest human dependency on fisheries and aquaculture for livelihoods (Whittingham *et al*. 2002).

The present and future wellbeing of dependent communities depends on their ability to continue to access natural resources from their immediate environments (Pyhälä *et al*. 2006), this means that activities must be carried out in a sustainable manner, perhaps with the introduction of various alternative sources of income and food to help reduce the pressure. It is at the local level that connections between ecosystems health, human health and well-being, and individual livelihoods are most clear and most critical (King & Hood 1999).

5.1.1. Livelihoods and natural resources

A largely quoted definition of livelihoods is provided by (Chambers & Conway 1992), wherein a livelihood '*comprises the capabilities, assets - including both material and social resources - and activities required for a means of living*' (Scoones 1998, Ellis 2000b, SFLP 2006). A livelihood is therefore more than income alone, it encompasses income, social institutions, gender relations, and property rights required to sustain a given standard of living (Ellis 1998, 2000b, SFLP 2006). However, as livelihoods and income are inextricably related, the composition and level of individual or household income at any given time is the most direct and measurable outcome of the livelihood process (Ellis 2000b).

Worldwide livelihoods are being placed under increasing pressure largely due to environmental degradation (MEA 2005). For example in the marine realm 14 out of the 17 world fisheries are in decline (IUCN 2002) and a large percentage of the world coral reefs have already been lost (Wilkinson 2004) resulting in a major decline of the worlds biodiversity, the maintenance of

which is crucial for continued survival of all species (Sala & Knowlton 2006). More than one billion people today live in and around biodiversity "hotspots", many encompassing coral reef areas (Myers *et al*. 2000, IUCN 2002, Price 2002), these people are especially dependent on natural resources and biodiversity for livelihoods (Randall 1987, IUCN 2002, UNEP 2006a) and resource depletion is threatening both the income and the nutritional status (or food security) of low income households in developing countries (Bergeron *et al*. 1998, Allison & Ellis 2001, Sadovy 2005).

Current patterns of natural resource exploitation are largely considered to be unsustainable and there is concern that competition over dwindling resources could trigger future conflict (IUCN 2002). Some of the major factors threatening livelihoods, in addition to the loss of biodiversity, are poor management, a lack of alternatives, and increasing competition for common resources due to population increases (Scoones 1998). Natural background environmental fluctuations and change may also have an impact, potentially reducing the availability or accessibility of natural resources.

5.1.2. Sustainable livelihoods

The concept of 'sustainable livelihoods' has become increasingly important in the development and environmental management debate (Scoones 1998). A livelihood becomes sustainable when it can cope with and recover from stresses and shocks and maintain or enhance its capacities and assets both now and in the future, while not undermining the natural resource base (Chambers & Conway 1992, SFLP 2006). If sustainable livelihoods can be achieved, they could provide a means for sustainable living and well-being and perhaps improved economic status, both for current and future generations whilst providing essential environmental maintenance and protection (IUCN 2002).

Sustainable development can be defined as "*development that meets the needs of the present generation without compromising the ability of future generations to meet their own needs*" (Brundtland 1987). Development is concerned with meeting human needs and aspirations (and improving well-being) by providing adequate food and shelter, reducing poverty, improving health and improving education (Kammerbauer *et al*. 2001). All definitions of sustainable development recognise that maintenance of the environment and ecosystem functions are important factors directly contributing to human welfare (Garcia *et al*. 1999). Sustainable livelihoods are therefore an integral part of sustainable development. Sustainable development

can be limited by the supply of natural resources and their renewal rate, the availability of technology to utilise resources efficiently, and the effectiveness of social systems in distributing benefits (FAO 1999).

Sustainable livelihoods can be achieved through access to a range of livelihood resources (natural, economic, human and social capitals) which may be combined in pursuit of different livelihood strategies, a common one of which is livelihood diversification (Scoones 1998), in its simplest form this can be termed occupational multiplicity (Pollnac & Crawford 2000).

Livelihoods can be based on a subsistence or wealth generation goal and on a diversified or specialised strategy (Smith *et al*. 2005). Diversification or specialisation may also be described as generalisation or specialisation as defined in basic ecological theories such as optimal foraging (Begon *et al*. 1996). It is thought that diversification may be a strategy for sustainable livelihoods in cases of diminishing resources and degraded ecosystems as households search for alternative means of food and income (Amanor 1994, Pomeroy *et al*. 2006).

A sustainable livelihood, by its nature, implies avoiding depleting stocks of natural resources which will result in a permanent decline in the rate at which the natural resource base yields useful products and services (Scoones 1998).

5.1.3. Livelihood diversification

Livelihood diversification can be defined as "*the process by which rural families construct a diverse portfolio of activities and social support capabilities in order to survive and to improve their standards of living*" (Ellis 1998). Recognition of this diversity requires an extended concept of rural households to include all spatially dispersed contributions to household welfare in addition to the resident social unit, this therefore includes all income and food input into the household from any source (Ellis 2000b, Ashley *et al*. 2003).

Livelihood diversity is an important attribute of rural livelihoods, particularly in coastal areas where marine and coastal resource related activities, especially fishing, are dominant (Allison & Ellis 2001). Fishing is a high risk occupation and diversification may be a strategy to reduce the risk of lost income at times of diminished catch (Allison & Ellis 2001). For most artisanal fisheries, the assets tied up in fishing are low, therefore mobility between occupations can be high (Allison & Ellis 2001).

Diversification can be a transient phenomenon i.e. when households change their primary income generating activity they may spend some time carrying out both the new and old activity to reduce financial risk in the short term until the new activity proves reliable and financially viable (Saith 1992). It can also be associated with success at achieving livelihood security and sustainability under improving economic conditions, or failure under deteriorating economic conditions (Collier 1988, Preston 1989). There is a current trend towards livelihood diversification which has been widely documented e.g. (Ellis 1999, Béné *et al*. 2000, Twyman 2000, ODI 2003, Shepherd & Terry 2004).

Determinants of diversification can include any or all of the following: seasonality (Chambers *et al*. 1981, Agarwal 1990); risk reduction strategies (Bryceson 1996); changing labour markets; credit market failures (i.e. no available funds to carry out timely purchases of capital equipment); asset strategies (to increase income in the future) and; coping behaviour or adaptation (to crises) (Ellis 2000a, Ashley *et al*. 2003). Where livelihood activities rely on different markets, livelihood diversity provides flexibility and allows interchange between expanding and declining markets which spreads financial risk (Ellis, 1999).

Overall, livelihood diversification characterises rural household survival strategies, it is a serious long term issue that can reflect the vulnerability of livelihoods and the state of the natural resources on which people depend (Ellis 2000a). It is often the case that the poorest fractions of a community will depend heavily on a given combination of natural resources for food and income, the more wealthy parts of the community, due to different socioeconomic and institutional constraints and opportunities, usually develop quite different combinations, but both resulting in a diversified range of livelihood activities (Béné *et al*. 2000).

Ashley *et al*. (2003) suggests the following pattern of diversification relative to wealth from lowest to highest livelihood diversity on a scale of 1-5 as follows:

1. Poorest: constrained to a single activity perhaps due to limited labour with no capable household members.
2. Insecure poor: diversify to create work days.
3. Secure poor: diversify to mitigate risk.
4. Rich: diversify to increase wealth.
5. Richest: specialise in various commercial activities.

5.1.4. Specialisation

Livelihoods can also be based on specialised strategies (Smith *et al*. 2005). Specialisation allows actors to become proficient in a given activity, for example fishing, from which they may be able to create acceptable incomes. Many indigenous communities remain specialists, still focusing on traditional livelihoods (Sather 1997, Tomascik *et al*. 1997b, Saat 2003, Shepherd & Terry 2004).

Within any given area diversification and specialisation may occur at the same time, but at different levels (Ashley *et al*. 2003). For example, the regional economy may diversify, but individuals may become more specialised. Additionally, within the same regions, different villages may diversify or become more specialised depending on the resource base available to them and the success or perceived sustainability of current livelihood strategies (Ashley *et al*. 2003).

5.1.5. Livelihoods and natural resource management

It is well accepted that social, cultural, economic and political factors impact the success of environmental management more than biological or physical factors (Fiske 1992, Kelleher & Recchia 1998, McClanahan 1999, Mascia 2003). So socioeconomic considerations such as food security, livelihood opportunities, compatibility with local culture and local environmental awareness and knowledge significantly increase the chances of successful management outcomes (Pomeroy *et al*. 2004a). Any form of management if developed on an incomplete understanding of livelihoods can result in the development of management strategies that are inappropriate for conservation and for local economies (Allison & Ellis 2001, Allison & Horemans 2006).

Adopting a livelihood based approach to management, often referred to as the sustainable livelihoods approach or SLA (Chambers 1987, Chambers & Conway 1992, Allison & Horemans 2006, Njifonjou *et al*. 2006), requires an understanding of the livelihood strategies of households and communities, the means by which households adapt to reduce risk, and the incentives that drive resource use (Pomeroy *et al*. 2006).

Livelihood analysis should include all household income generating activities, primary and supplementary and the activities of all household members. Income generating activities are most relevant in the analysis of livelihoods (Seppala 1996, Ellis 2000b).

5.1.6. Marine and coastal resource management

Marine and coastal resource management efforts in the past have focused on improving fishery efficiency and stock conservation through regulations imposed on just the fishing sector, ignoring the wider coastal economy (Allison & Ellis 2001). This has generally been the case for all marine resource associated management i.e. a focus on those people utilising resources for primary income generation without taking into consideration the complex livelihood strategies of all local people and their food and subsistence needs (Béné *et al*. 2000). A wider livelihoods approach (Scoones 1998) is required to understand all the components that make demands on the resources available to households (Ellis 1998), and to understand the ways in which households may already have adapted to decreases in the resource base. The intricate nature of activities conducted by communities and households means that potential management interventions must be considered through an integrated approach in which the different sectors of the economy are viewed together (Béné *et al*. 2000). A fundamental factor should be to realise what dependent communities already have and to strengthen their own inventive coping solutions (Moser 1998). The development of diversified livelihoods may reduce the need for top-down initiatives that have previously characterised artisanal fisheries management (Allison & Ellis 2001).

Small-scale fisheries are often characterised as the occupation of last resort and fishermen as the poorest of the poor (Smith 1981, Christy Jr 1986, Pauly & Chua 1988), therefore another important factor is that many fishing communities do have characteristically low incomes, but they are not necessarily poor because their income is generated through fishing, they may often already be poor people with limited or no land who can subsist through fishing (Dunn 1989).

The sustainable livelihoods approach (Chambers 1987, Chambers & Conway 1992) focuses attention on the strategies that people use to access resources, mediated by governing institutions and social capital, for pro-poor development and poverty reduction strategies with a focus on income generation (Ashley & Carney 1999, IUCN 2002, Allison & Horemans 2006, Glavovic & Boonzaier 2006, Njifonjou *et al*. 2006). By its nature, this approach has strong implications and potential use in environmental management and conservation due to the inextricable links between humans and ecosystems.

5.1.7. Livelihood diversity within the Kaledupa sub-district

The present work was designed to investigate a system based on multiple activities, with marine and coastal resource dependent activities considered as an element of the whole system. The dynamics of activities within households involved in occupational multiplicity was important as was the heterogeneous nature of local communities (within and between cultural groups). Even relatively small rural communities are heterogeneous, made up of different socioeconomic strata that may be characterised by discrete livelihood strategies such as diversification or specialisation (Vosti & Reardon 1997, Ashley & Carney 1999, Ellis 1999).

Secondary data is inadequate in providing information concerning livelihoods, as most published statistics only include the full time or primary occupation, and most coastal communities, particularly in rural areas are characterised by high livelihood diversity (Fiske 1992, Pollnac & Crawford 2000). Local communities are usually accustomed to a lifestyle including a number of income generating activities with sometimes a single steady-wage activity (Fiske 1992).

Within the Kaledupa sub-district livelihood diversity is apparent at the village level (chapter 4). Marine resources represent the single most important resource currently utilised by Kaledupan communities for livelihoods (food and income). However, detailed analysis of this diversification at the household level and specific inter and intra-village patterns is so far lacking, as are any links between livelihood diversity and economic status (or income).

If described in relation to total annual household income, livelihood patterns could identify whether livelihood diversification or specialisation in the sub-district is associated with improved or deteriorating economic conditions. Additionally, the impact of livelihood diversification on natural resource use trends is yet to be explored.

5.2. Chapter aim and objectives

The aim of the present chapter was to identify livelihood diversity patterns and possible links between livelihood diversity and income, and livelihood diversity and marine and coastal resource use. Specific objectives were as follows:

1) To quantify the percentage distribution of livelihood activities as primary or supplementary sources of income or food.

2) To investigate livelihood diversity patterns between *Bajo* and *Pulo* communities.

3) To investigate livelihood diversity patterns between villages and identify livelihood strategies.

4) To identify any relationships between livelihood diversity and marine and coastal resource dependence.

5) To investigate any relationships between livelihood diversity and total annual household income.

6) To investigate the relationship between livelihood diversity and source of primary income generation.

5.3. Methods

The household survey was used to collect all data used in the current chapter (see sections 3.4. and 4.3.1.).

5.3.1. Identification of livelihood activities

Respondents were asked to list all activities contributing to household income and food, and were subsequently asked to rank each activity in terms of relative importance for household income and food, the primary income generating activity being ranked first (appendix 5). Percent distribution rankings were then calculated for each activity.

Respondents were asked specifically to include all activities that they are usually involved in within a year. If activities were seasonal, further details on periods of involvement were also requested from the respondent. This helped to generate information on diversity patterns and more accurately estimate incomes from seasonal activities.

5.3.2. Household income analysis

It had to be assumed that respondents were equally truthful regarding their answers (particularly to income questions), however, modified application of the *internal consistency* method (de Vaus 2002) helped to verify information at the point of interview. This method allowed a multi-item measure at a single point in time, allowing consistency of answers to be examined later, and major inconsistencies to be further investigated at the time of the interview. When answers were consistent, the data was considered to be reliable. In the case of household income, each household activity was investigated separately using the multi-method approach outlined in chapter 3 (including the use of key informant interviews and market surveys for verification); in addition respondents were asked to estimate their weekly, monthly and annual total household income.

It has been shown (May 2003, 2005) that reliable fisheries catch data can be provided through interviews with fishermen, hence in addition to income estimation, catch and harvest information was also requested from respondents for the purposes of income verification (chapter 3).

Income stated in Indonesian Rupiah (Rp) was converted to US$ at a rate of Rp 9103 per US$ 1.

Any households that chose to withhold income information were excluded from the investigation into the relationship between income and livelihood diversity.

5.3.3. Statistical analyses

A Mann-Whitney U test was used to investigate the significance of differences in the number of livelihood activities and percentage of income from primary activities between *Bajo* and *Pulo* communities. The test was chosen as the most powerful non-parametric test available for analysis of non-normal data.

ANOSIM, using the PRIMER computer package (Clarke & Warwick 1994) was used to investigate differences in livelihood diversity between villages and between primary income generating activity categories.

Due to non-normality within the data set a Spearman rank-order correlation was used to test the relationship between livelihood diversity and marine resource dependence; livelihood diversity and natural resource dependence; and livelihood diversity and percentage of income from primary activity.

Variation in livelihood diversity between villages and primary activity categories was investigated by calculating the coefficient of variation (Zar 1974, Dytham 2005).

5.4. Results

5.4.1. Percentage distribution of livelihood activities

The average number of livelihood activities per household throughout the Kaledupa sub-district was 3.8 ± 0.1 (mean ± SE).

43.4 % of households had a second activity (in addition to their primary activity), 22.7 % had a third, 3.9 % a fourth and 1.1 % a fifth activity (table 5.1.).

66.6 % of households utilised marine and coastal resources as either a primary or supplementary livelihood activity. A further 3.4 % of households stated tourism as a livelihood activity, which could also be considered marine resource dependent. Within the Marine and coastal resource use category 28.4 % of households fished and around a quarter were involved in seaweed cultivation. 4.3 % of households stated fishing overseas as a livelihood activity, all other marine activities being carried out by 2.5 % or fewer households for each activity. Fishing overseas represented only a source of primary income, as did fish middleman and mangrove trade. All other marine resource related activities were used as a primary or supplementary activity.

Approximately half of all households stated agriculture as a livelihood activity. Clove harvest and cassava or local potato cultivation represented only primary livelihood activities (no households stated these as any rank of supplementary livelihood).

4.8 % of households stated work overseas as a livelihood activity, 8 % civil service, 8 % trade, and 25 % stated some other activity. Work overseas and civil service again were only stated as primary livelihood activities (table 5.1.).

Table 5.1. Percent distribution of ranking of productive household activities within the Kaledupa sub-district of Wakatobi Marine National Park, Indonesia (n = 440). * Primary household activity.

Category	Activity	1st*	2nd	3rd	4th	5th	Total	Category Total
Marine and coastal resource use	Seaweed cultivation	21.8	3.0	0.5	0.0	0.0	25.2	**66.6**
	Seaweed tying	0.7	0.5	0.0	0.0	0.0	1.1	
	Seaweed middleman	0.7	1.4	0.5	0.0	0.0	2.5	
	Fishing	10.9	10.0	5.9	1.4	0.2	28.4	
	Fishing overseas	4.3	0.0	0.0	0.0	0.0	4.3	
	Fish middleman	1.6	0.0	0.0	0.0	0.0	1.6	
	Mangrove	0.9	0.0	0.0	0.0	0.0	0.9	
	Coral mining	0.0	0.0	0.2	0.0	0.0	0.2	
	Sea transport	1.8	0.2	0.2	0.0	0.0	2.3	
Tourism	Tourism	2.3	1.1	0.0	0.0	0.0	3.4	**3.4**
Agriculture	Mixed agriculture	8.4	11.4	11.4	2.0	0.2	33.4	**55.5**
	Coconut	10.0	7.3	0.7	0.0	0.5	18.4	
	Clove	1.8	0.0	0.0	0.0	0.0	1.8	
	Cassava/potato	1.8	0.0	0.0	0.0	0.0	1.8	
Work overseas	Work overseas	4.8	0.0	0.0	0.0	0.0	4.8	**4.8**
Civil service	Civil service	8.0	0.0	0.0	0.0	0.0	8.0	**8.0**
Trade	Trade	4.3	3.2	0.5	0.0	0.0	8.0	**8.0**
Other	Sarong weaving	2.0	0.0	0.5	0.0	0.0	2.5	**25.0**
	Others provide	5.7	0.0	0.0	0.0	0.0	5.7	
	Other	8.2	5.5	2.5	0.5	0.2	16.8	
	Total	**100.0**	**43.4**	**22.7**	**3.9**	**1.1**		

5.4.2. Livelihood diversity: a comparison of Bajo and Pulo communities

There was a highly significant difference in the mean number of livelihood activities between *Bajo* and *Pulo* communities (2.7 ± 0.2 and 3.9 ± 1.1 respectively) (mean ± SE) ($W = 7944.5$; $p < 0.001$).

Within *Bajo* villages the number of activities per household ranged from 0 to 4 activities. 49 % of households had a second activity, 14.3 % had a third and 4.1 % had a fourth activity. No *Bajo* households had a fifth activity (table 5.2.).

All households utilised marine and coastal resources as a primary livelihood activity and around half of all households also utilised marine and coastal resources as a supplementary livelihood activity. A further 4.1 % stated tourism as a household activity. No households stated agriculture as a household livelihood activity of any rank. 2 % stated work overseas, 2 % civil service, 6.1 % trade, and 12.2 % stated some other activity as a supplementary livelihood.

Within the Marine and coastal resource use category 89.8 % of households fished and 26.5 % were involved in seaweed cultivation.

Table 5.2. Percent distribution of ranking of productive household activities within *Bajo* villages of the Kaledupa sub-district, Wakatobi Marine National Park, Indonesia (n = 51). * Primary household activity.

Category	Activity	1st*	2nd	3rd	4th	5th	Total	Category Total
Marine and coastal resource use	Seaweed cultivation	10.2	16.3	0.0	0.0	0.0	26.5	**140.8**
	Seaweed tying	0.0	0.0	0.0	0.0	0.0	0.0	
	Seaweed middleman	2.0	0.0	0.0	0.0	0.0	2.0	
	Fishing	46.9	26.5	14.3	2.0	0.0	89.8	
	Fishing overseas	6.1	0.0	0.0	0.0	0.0	6.1	
	Fish middleman	6.1	0.0	0.0	0.0	0.0	6.1	
	Mangrove	6.1	0.0	0.0	0.0	0.0	6.1	
	Coral mining	0.0	0.0	0.0	0.0	0.0	0.0	
	Sea transport	4.1	0.0	0.0	0.0	0.0	4.1	
Tourism	Tourism	2.0	2.0	0.0	0.0	0.0	4.1	**4.1**
Agriculture	Mixed agriculture	0.0	0.0	0.0	0.0	0.0	0.0	**0**
	Coconut	0.0	0.0	0.0	0.0	0.0	0.0	
	Clove	0.0	0.0	0.0	0.0	0.0	0.0	
	Cassava/potato	0.0	0.0	0.0	0.0	0.0	0.0	
Work overseas	Work overseas	2.0	0.0	0.0	0.0	0.0	2.0	**2**
Civil service	Civil service	2.0	0.0	0.0	0.0	0.0	2.0	**2**
Trade	Trade	4.1	2.0	0.0	0.0	0.0	6.1	**6.1**
Other	Sarong weaving	0.0	0.0	0.0	0.0	0.0	0.0	**12.2**
	Others provide	6.1	0.0	0.0	0.0	0.0	6.1	
	Other	2.0	2.0	0.0	2.0	0.0	6.1	
	Total	**100.0**	**49.0**	**14.3**	**4.1**	**0.0**		

Pulo households had a range of activities from 0 to 5. 44.9 % of households had a second activity, 25.6 % had a third, 3.8 % had a fourth activity, and 1.3 % of households had a fifth activity (table 5.3.).

62.6 % of households utilised marine and coastal resources as a primary or supplementary livelihood activity, a further 3.4 % stated tourism as a household activity. 62.6 % of households stated agriculture as a household livelihood activity. 4.8 % stated work overseas, 8 % civil service, 8 % trade, and 26.7 % stated some other activity.

Within the Marine and coastal resource use category 22.6 % of households fished and 27.2 % were involved in seaweed cultivation.

Table 5.3. Percent distribution of ranking of productive household activities within *Pulo* villages of the Kaledupa sub-district, Wakatobi Marine National Park, Indonesia (n = 389). *Primary household activity.

Category	Activity	1st*	2nd	3rd	4th	5th	Total	Category Total
Marine and coastal resource use	Seaweed cultivation	23.3	3.3	0.5	0.0	0.0	27.2	62.6
	Seaweed tying	0.8	0.5	0.0	0.0	0.0	1.3	
	Seaweed middleman	0.5	1.5	0.5	0.0	0.0	2.6	
	Fishing	6.4	7.9	6.7	1.3	0.3	22.6	
	Fishing overseas	4.1	0.0	0.0	0.0	0.0	4.1	
	Fish middleman	1.0	0.0	0.0	0.0	0.0	1.0	
	Mangrove	0.3	0.0	0.0	0.0	0.0	0.3	
	Coral mining	0.0	0.0	0.3	0.0	0.0	0.3	
	Sea transport	2.1	1.3	0.0	0.0	0.0	3.3	
Tourism	Tourism	1.8	0.0	0.3	0.0	0.0	2.1	3.4
Agriculture	Mixed agriculture	9.5	12.8	12.8	2.3	0.3	37.7	62.6
	Coconut	11.3	8.2	0.8	0.0	0.5	20.8	
	Clove	2.1	0.0	0.0	0.0	0.0	2.1	
	Cassava/potato	2.1	0.0	0.0	0.0	0.0	2.1	
Work overseas	Work overseas	5.1	0.0	0.0	0.0	0.0	5.1	4.8
Civil service	Civil service	8.7	0.0	0.0	0.0	0.0	8.7	8
Trade	Trade	4.1	3.3	0.5	0.0	0.0	7.9	8
Other	Sarong weaving	2.3	0.0	0.5	0.0	0.0	2.8	26.7
	Others provide	5.6	0.0	0.0	0.0	0.0	5.6	
	Other	9.0	5.9	2.8	0.3	0.3	18.2	
	Total	**100.0**	**44.9**	**25.6**	**3.8**	**1.3**		

5.4.3. Livelihood diversity: a comparison of villages

There were inter-village differences in number of livelihood activities (figure 5.1.). Ambeua, Tampara and Sandi had the highest number of livelihood activities (4.6 ± 0.4), closely followed by Lentea (4.6 ± 0.8). Sama Bahari, Mantigola and Lohoa, the three *Bajo* villages, and Tanomeha (*Pulo*) had the lowest number of activities (2.7 ± 0.3, 2.7 ± 0.4, and 2.8 ± 0.3, 2.8 ± 0.3 respectively) (mean ± SE).

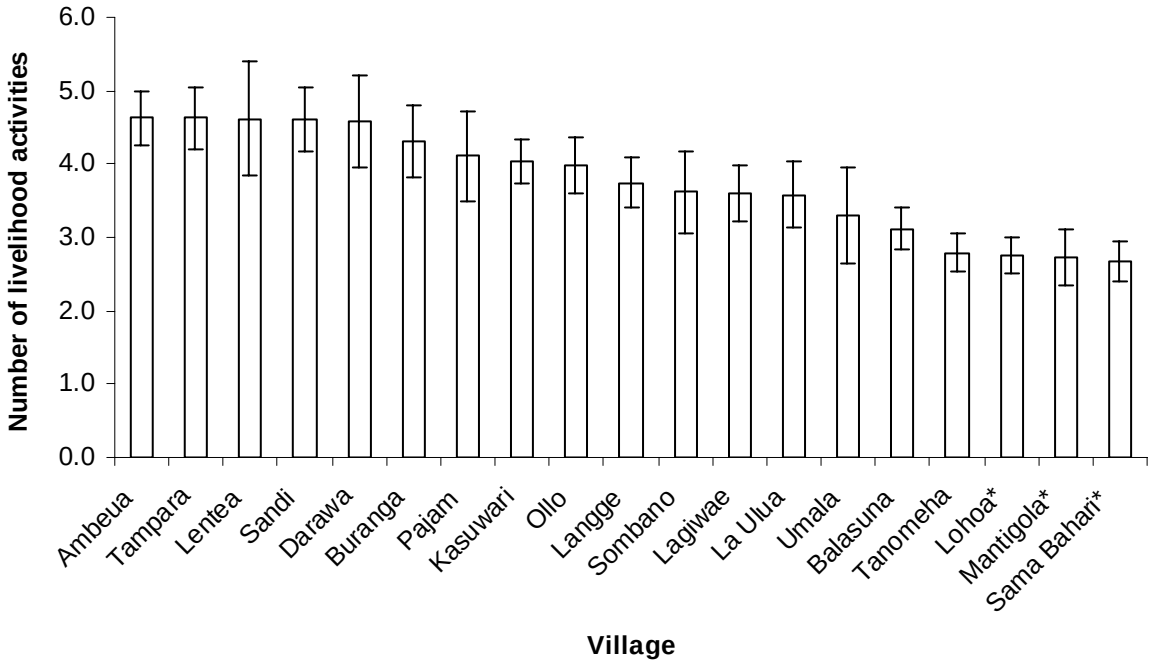

Figure 5.1. Mean (± SE) number of livelihood activities in all villages within the Kaledupa sub-district of Wakatobi Marine National Park, Indonesia (mean ± SE) (n = 440). **Bajo* village.

Analysis using a one way ANOSIM showed the difference between villages to be significant (*global r = 0.018; p < 0.05*). Pairwise tests indicated highly significant differences between Ambeua and Sama Bahari, Sama Bahari and Sandi, and Sama Bahari and Tampara. Significant differences were also highlighted between other villages (table 5.4.).

Table 5.4. ANOSIM pairwise comparisons between mean number of household livelihood activities in the 19 villages/sub-villages within the Kaledupa sub-region of Wakatobi Marine National Park, Indonesia. ** indicates $p < 0.001$. * indicates $p < 0.05$.

Village	Ambeua	Lagiwae	La Ulua	Ollo	Buranga	Balasuna	Sandi	Langge	Tampara	Tanomeha	Umala	Mantigola	Sombano	Pajam	Kasuwari	Sama Bahari	Darawa	Lentea	Lohoa
Ambeua	-					*				*		*				**			
Lagiwae		-																	
La Ulua			-																
Ollo				-															
Buranga					-	*				*									
Balasuna						-			*										
Sandi							-			*		*				**			
Langge								-				*				*			
Tampara									-	*		*				*			
Tanomeha										-					*				
Umala											-								
Mantigola												-			*				
Sombano													-						
Pajam														-					
Kasuwari															-	*			
Sama Bahari																-	*	*	
Darawa																	-		
Lentea																		-	
Lohoa																			-

Variation (as measured by the coefficient of variation, CoV; (see (Zar 1974)) in household livelihood diversity between villages was lowest for Pajam then Umala (CoV of 22.3 % and 28.8% respectively) and highest for Lentea followed by Tampara and Mantigola (CoV of 85.0%, 64.5 % and 64.5 % respectively) suggesting that within Pajam the number of livelihood activities was more evenly distributed (figure 5.2.).

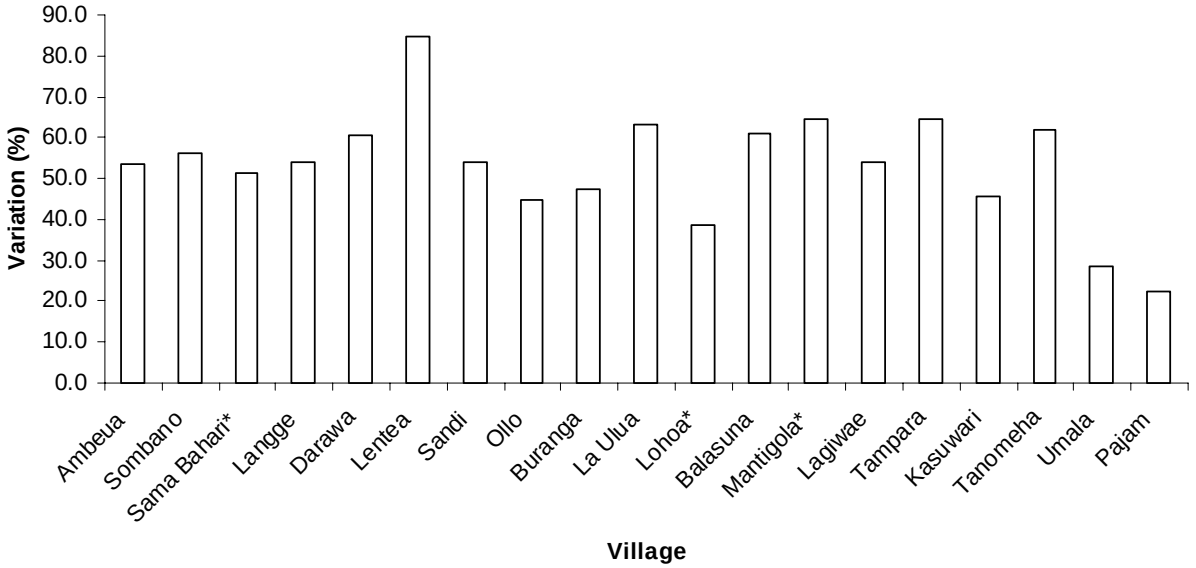

Figure 5.2. Variation as measured by the coefficient of variation in household livelihood diversity between villages within the Kaledupa sub-district of Wakatobi marine National Park, Indonesia (n = 437).

5.4.4. Relationship between livelihood diversity and marine and coastal resource use

There was a significant negative correlation between household livelihood diversity and number of marine and coastal resource related activities at the household level ($r_s = 0.167; p < 0.001$), however the association was weak. As livelihood diversity increased, marine and coastal resource dependence (represented as number of marine and coastal resource related activities) decreased. This correlation is also significant when replacing number of marine and coastal resource dependent activities with total number of natural resource related activities (including all agricultural categories) (r_s *0.385; p < 0.001*).

The same association was also reflected at the village level between livelihood diversity and number of marine and coastal resource related activities, again with *Bajo* villages Sama Bahari, Mantigola and Lohoa having the lowest village livelihood diversity but relatively high marine and coastal resource use diversity (1.5 ± 0.2, 1.2 ± 0.2 and 1.3 ± 0.5 respectively) (mean ± SE), and Darawa and Lentea appearing as outliers from the general trend with relatively high numbers of marine and coastal resource related activities (1.6 ± 0.2 and 1.3 ± 0.2 respectively) (mean ± SE) and relatively high livelihood diversity. Ambeua had the highest livelihood diversity (4.6 ± 0.4) and lowest marine and coastal resource activity diversity (0.4 ± 0.2) (mean ± SE) (figure 5.3.).

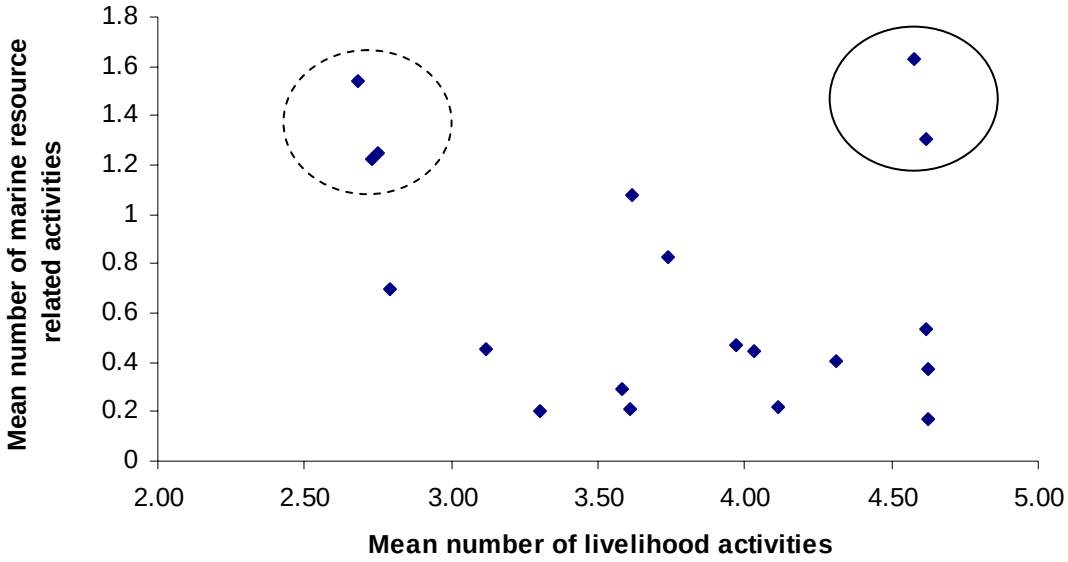

Figure 5.3. Relationship between livelihood diversity and marine and coastal resource use diversity in villages of the Kaledupa sub-district, Wakatobi Marine National Park, Indonesia (n = 440). *Bajo* villages circled by a dashed line; Darawa and Lentea circled by a solid line.

5.4.5. Livelihood diversity and income

There was a highly significant positive correlation between total annual household income and livelihood diversity ($r_s = 0.25; p < 0.001$), although the association was week implying other important factors.

At the village level there was no significant correlation between mean annual household income and mean livelihood diversity. However, Ambeua had the highest mean annual income (1729.0 ± 212.0) and high mean livelihood diversity (4.6 ± 0.4) and two of the *Bajo* villages (Lohoa and Mantigola) had some of the lowest mean livelihood diversity values (2.8 ± 0.3 and 2.7 ± 0.4 respectively) and some of the lowest household incomes (640.0 ± 3970. and 416.0 ± 103.0 respectively). The *Bajo* village Sama Bahari had relatively high mean household income (1268.0 ± 317.0) but low livelihood diversity (2.7 ± 0.3) (mean ± SE).

On average, throughout Kaledupa the greatest percentage of household income was generated from the primary household activity (67.4 ± 1.6 %). This was 70.4 ± 20.2 % for *Bajo* villages and 68.7 ± 3.9 % for *Pulo* villages (mean ± SE). This difference was not significant. Individual village details are given in table 5.5.

Table 5.5. Percentage of household income from primary activities and livelihood diversity in villages within the Kaledupa sub-district of Wakatobi Marine National Park, Indonesia.

Village	n	Livelihood diversity (mean ± SE)	Income from primary activity (%)
Mantigola	22	2.7 ± 0.4	99.82
La Ulua	24	3.6 ± 0.5	88.53
Lentea	13	4.6 ± 0.8	86.33
Tanomeha	33	2.8 ± 0.3	80.73
Sombano	13	3.6 ± 0.5	79.65
Sama Bahari	25	2.7 ± 0.3	79.62
Darawa	19	4.6 ± 0.6	76.92
Ollo	32	4.0 ± 0.4	71.63
Balasuna	33	3.1 ± 0.3	69.44
Langge	23	3.7 ± 0.3	68.71
Ambeua	32	4.6 ± 0.4	63.23
Buranga	32	4.3 ± 0.5	58.33
Pajam	18	4.1 ± 0.6	55.14
Kasuwari	29	4.0 ± 0.3	54.36
Umala	10	3.3 ± 0.7	54.28
Lagiwae	28	3.6 ± 0.4	49.22
Sandi	26	4.6 ± 0.4	45.63
Tampara	24	4.6 ± 0.4	35.01
Lohoa	4	2.8 ± 0.3	31.74

Overall there was a significant negative correlation between livelihood diversity and percentage of income from the primary activity ($r_s = -0.385; p < 0.001$).

5.4.6. Primary income generating activity category and livelihood diversity

Households stating an agricultural activity as their primary income source had the highest livelihood diversity, 4.5 ± 0.2. The second highest livelihood diversity was found within the tourism category (4.0 ± 0.6). Households stating a marine and coastal resource related primary income generating activity had a mean livelihood diversity of 4.0 ± 0.2. Those stating trade as a primary income source had the lowest mean livelihood diversity (2.79 ± 0.44) (mean ± SE) (figure 5.4).

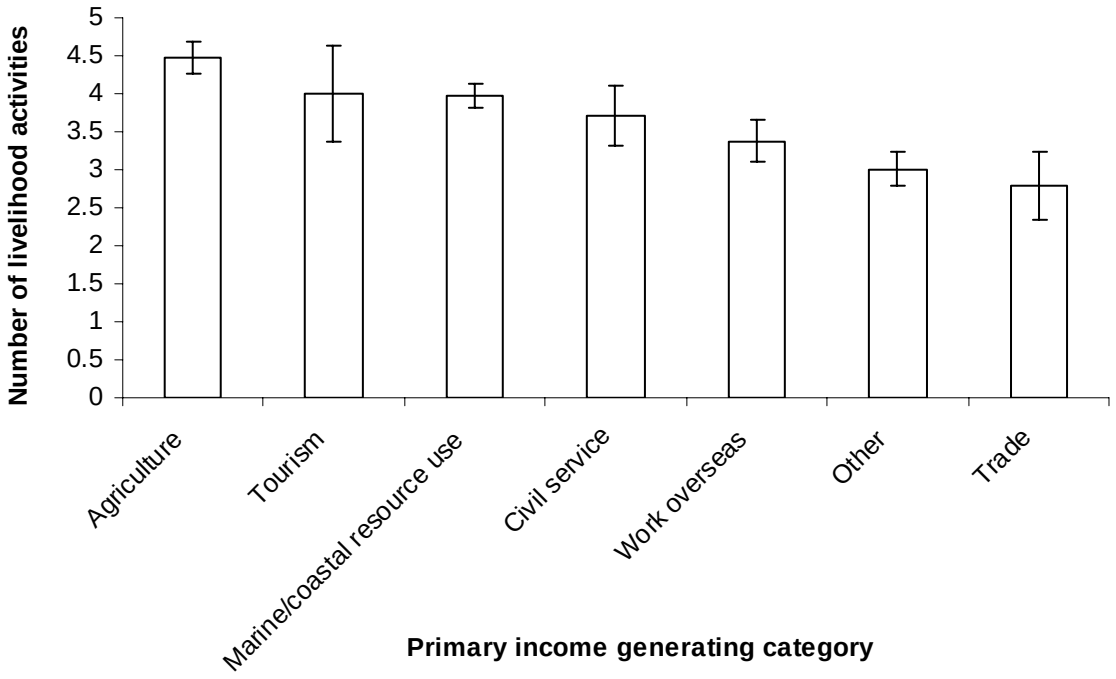

Figure 5.4. Livelihood diversity between seven identified primary income generating activities within the Kaledupa sub-district of Wakatobi Marine National Park, Indonesia (mean ± SE) (n = 440).

Analysis using ANOSIM showed a highly significant difference in the number of livelihood activities between primary income categories (*global r = 0.065; p < 0.001*). Pairwise tests outlined where significant differences were found between categories (table 5.6.).

Table 5.6. ANOSIM pairwise comparisons between mean number of household livelihood activities in 7 primary income generating categories within the Kaledupa sub-district of Wakatobi Marine National Park, Indonesia. ** indicates $p < 0.001$. * indicates $p < 0.05$.

Primary income generating category	Marine and coastal resource use	Agriculture	Civil service	Trade	Tourism	Work overseas	Other
Marine and coastal resource use	-	*		*			**
Agriculture		-	*	**			**
Civil service			-				
Trade				-		*	
Tourism					-		
Work overseas						-	
Other							-

An additional significant difference between individual activities, outlined using ANOSIM, highlighted seaweed cultivators as having significantly higher livelihood diversity than civil servants (4.1 ± 0.2 and 3.7 ± 0.4 respectively) (mean ± SE) (*global $r = 0.082$; $p < 0.05$*). No other significant differences between activities were identified.

5.5. Discussion

Where detailed economic analysis is required, ideally the income values of all activities that contribute to household livelihoods should be included (Pollnac & Crawford 2000). However, as most households in developing countries do not keep income records and income can be highly variable, it can be difficult and extremely time consuming to provide accurate figures (Ferguson *et al*. 2002). The relative importance of household livelihood activities can be used as a minimally acceptable level of measurement (Pollnac & Crawford 2000) which means an assessment of livelihood diversity is essential. The present chapter not only outlines the complex patterns of livelihood diversity throughout the Kaledupa sub-district, but also investigates livelihood diversity in relation to household income and the percentage of household income generated from the primary household activity.

Chapter 4 showed primary income generating activity diversity at the village level; in this chapter the focus was on all income and food generating activities i.e. livelihood activities at the household and village level and between cultures. Livelihood diversity has been described in relation to marine and coastal resource use, household income, and household primary income generating activity to outline existing patterns and links, which are highly complex and variable.

5.5.1. Percentage distribution of livelihood activities

A large percentage of households stated the involvement in more than one livelihood activity, and around a fifth of households stated involvement in three or more activities. Within the Kaledupan community as a whole, it is clear that the occurrence of livelihood diversity (or occupational multiplicity) is high.

Detailed analysis of all livelihood activities showed that almost 70 % of households utilised marine and coastal resources as a primary or supplementary activity. The highest use was fishing, with almost one third of households fishing for livelihoods, followed closely by seaweed cultivation, an activity in which one quarter of households were involved.

The importance of agriculture, beyond its use as a primary activity was also outlined, with around one third of households stating mixed agriculture as livelihood activity of some ranking. Those households involved with clove cultivation or cassava and local potato, used these activities only as a primary income source. In the case of clove this is most likely due to the high incomes generated from this activity (chapter 3). However, in the case of cassava and local

potato cultivation, incomes were some of the lowest; hence it may represent a "last resort" activity for *Pulo* individuals with no available alternative.

Work overseas and civil service were also only utilised as a primary activity, again most likely due to the relatively high incomes generated from these sources.

5.5.2. Bajo and Pulo livelihood diversity

In general, *Pulo* individuals had higher livelihood diversity than *Bajo* individuals. The most likely reason for this is that *Pulo*, living on the land, have greater access to a more varied selection of resources, including agriculture. As all major markets are within *Pulo* villages, they also have greater access to these markets and access to larger populations' means that some public services are in greater demand.

Within *Bajo* communities, almost half of all households had two or more livelihood activities, but less than one tenth stated a third activity or more. No households had a fifth activity, which also reflects the more limited livelihood diversity of the *Bajo*. For Pulo households, fewer were involved in a supplementary activity, perhaps due to the higher incidence of the highest income generating primary activities within Pulo villages, although around a quarter of households had a third activity or more. Involvement in fishing was much reduced in *Pulo* communities with around a fifth of households involved, although around a third of households were involved in seaweed cultivation keeping dependence on marine and coastal resource high.

All *Bajo* households were involved in marine and coastal related activities of some kind and many were involved in multiple such activities. Almost 90 % of *Bajo* households stated fishing as a source of livelihood, which reinforces the fact that these people are enormously dependent on this single activity. Around one quarter of households were involved with seaweed cultivation.

Involvement in agricultural activities within *Pulo* communities was equivalent to marine and coastal resource involvement. This indicates extremely high dependence on natural resources for *Pulo* households which is a typical trend in developing rural communities (Ellis 1999).

5.5.3. A comparison of village level livelihood diversity

In addition to differences in livelihood diversity between *Pulo* and *Bajo* villages, there were also inter-village differences between villages within the *Pulo* community. Ambeua, the capital village of Kaledupa (north), had the highest livelihood diversity with activities spread throughout most income generating categories.

Lentea also had high livelihood diversity, although most activities fell within the marine and coastal resource use category. Lentea is geographically separate from all other villages, being located on the southern most island of the Kaledupa district (its closes neighbour Darawa on the next Island) (see figure 2.4.). This means that available resources are limited. The land is largely unsuitable for agriculture, although some crops are grown, so marine resources provide the most important natural resource base therefore it is likely that households have developed livelihood strategies to cope with this, based on the resources available. This diversity will allow provide some risk reduction, but the community remains vulnerable. Qualitative data showed that they access the seaweed market through a middleman who is also the village head; fish is sold within the village and in Darawa, so access to markets is limited.

This difference in livelihood strategies may indicate that Ambeua is one of the wealthiest villages, diversifying to increase income, whereas Lentea may be one of the poorer villages, diversifying to mitigate risk (Ashley *et al*. 2003).

Tampara also had high livelihood diversity (equivalent to that of Ambeua), but was mainly dependent on agriculture perhaps diversifying within the agricultural sector again to mitigate risk (Ashley *et al*. 2003).

The reasons for differences in livelihood strategies between villages could be due to available resources and resource quality, differing local policies, knowledge transfer, differing village management strategies or social pressures. The *Kepala Desas* play a key role in some villages for example in Darawa, the *Kepala Desa* is highly supportive of seaweed cultivation as he is also a seaweed middleman. Additionally there are village rules in some villages and local cooperatives that work together to police the use of their seaweed or fishing grounds.

Comparisons in intra-village variation can provide a useful tool when investigating factors such as livelihood diversity. For example, Lentea had the highest variation indicating that livelihood strategies in terms of diversification were not evenly spread. Lentea had the lowest primary

activity diversity but the variation may indicate that this was not the case for all households and that strategies within the village may be variable. Pajam on the other hand had low variation indicating that for this village the apparent strategy of livelihood diversification was a more evenly spread phenomenon.

5.5.4. Livelihood diversity and marine and coastal resource use

As would perhaps be expected there was a general trend of a decrease in the number of marine and coastal activities, and in the number of natural resource related activities with increasing overall livelihood diversity. The correlation, explained only around 16 % of the variability within the data set meaning that involvement in marine and coastal resource activities is an important factor but other more important factors influence livelihood diversity. However, the relationship implies that as households and villages diversify they do not generate additional activities and incomes from the same limited resources; increased livelihood diversity therefore indicates that other skills or resources are utilised. This is perhaps a livelihood security response to make use or at least have available income from alternative markets, as a top up income or as a potential replacement activity if the primary activity should fail to generate sufficient income (Ellis 1998). Therefore an increase in livelihood diversity may represent a decreased dependence on natural resources (and not simply additional use of natural resources) in the longer term. However, it is important to keep in mind that the greatest percentage of household income comes from the primary activity currently (see section 5.5.5.).

Darawa and Lentea did not conform to this trend, having relatively high livelihood diversity and extremely high dependence on marine and coastal resources. This could be associated to the geographical isolation of these villages, perhaps a need to diversify away from fishing due to ecological degradation (Allison & Ellis 2001), and limited availability of other resources or markets, i.e. non-marine resources, hence their only opportunities lie within the marine and coastal resource dependent category.

Livelihood diversity can reduce financial risk but only if selected household activities do not rely on the same resources or markets (ODI 2003). For Lentea village, livelihood diversity is high but this diversity remains within the marine and coastal resource use category, hence maintaining financial vulnerability and vulnerability to environmental change. Additionally, the low annual income generated from Lentea may also be related to this still high dependence on natural resources, with limited access to outside markets and influences.

Ellis (1999) provides some evidence for the positive relationship between household income and a departure from the use of natural resources. In the case of Ambeua, relative to other Kaledupan villages, this does appear to be the case. However, this is not the same for all villages, for example, Sama Bahari has low livelihood diversity, high marine and coastal resource dependence and relatively high mean annual household income. It may be the case that for this *Bajo* village, dependent specifically on fishing, villagers may be specialised and skilful enough to maintain income through fishing alone. This does, however, make the village highly vulnerable, particularly to diminishing stocks and degraded ecosystems.

It is important to note that for those villages with high dependence on fishing and low livelihood diversity such as the *Bajo* villages, the reason could be that these villages diversify only at times of extreme stress or to cope with abnormally adverse conditions, and if these conditions are not annual events, the diversity may not have been shown within the present study. Fishing capital outlay for artisanal fishers is generally low, hence mobility between occupations can be high (Allison & Ellis 2001), therefore it may be the case that people who fish for their primary income diversify only at times of extreme stress or struggle, and return to fishing when conditions improve. This may not be an annual phenomenon and diversity may increase on a larger temporal scale, confirming livelihood diversity in some cases to be a more transient phenomenon (Saith 1992).

Additionally, subsistence fishing can be a key cultural element with practical value to ensure household viability. For some communities it is a way to maintain independence and a role in direct production, therefore it is highly valued and the right to fish highly practiced and guarded (Fiske 1992), resulting in limited participation in other activities out of choice.

As most primary livelihood activities in developing regions are centred around natural resources, and in the Kaledupa sub-district, marine and coastal resources in particular, a shift away from these activities may alter the relationship between local people and the environment (Pilgrim *et al*. 2007, Pilgrim *et al*. in press). This shift will inevitably alter the impact on natural resources by decreasing the pressure from local community extraction or increasing the pressure due to a shift from subsistence to commercial exploitation (Twyman 2000). A move away from natural resource use however, may be detrimental in terms of conservation due to environmental disconnection and associated disregard, especially where local support and institutions are required (Pretty & Ward 2001, Pretty & Smith 2004, Pilgrim *et al*. 2007).

Another important point is the importance of fishing as a source of protein (see chapter 4). A number of authors have stressed the links between human population size and pressure on fish stocks (Jennings & Polunin 1996, Coblentz 1997, Labrosse *et al*. 2000, McManus *et al*. 2000), however the effects of human population size acts simultaneously with marine resource dependence, the cultural importance of fishing and access to a market economy (World Bank 2000). It has been suggested (Zann & Vuki 2000) that the role of fisheries in generating income increases with the development of cash-based economies and market access, with higher incomes allowing increasingly more people to buy fish instead of bartering or catching it themselves (Clua *et al*. 2005). Whether catching or buying fish, the result is the same and excessive consumption will continue unless other acceptable sources of protein can be found and the market for fish reduced in conjunction with the introduction of appropriate alternative incomes.

International markets have developed though demand for specific high value products such as live reef fish or aquarium species (Sadovy *et al*. 2003) but these remain limited in areas like Kaledupa with a relatively poor distribution network mainly due to relative geographical isolation.

5.5.5. Livelihood diversity and income

There was a significant correlation between total annual household income and livelihood diversity but this relationship explained only around 25 % of the variability within the data set meaning that livelihood diversity is important but alone is not the major factor influencing household income.

Ambeua is a clear example where this is not the case, having the highest mean annual income, but also one of the highest livelihood diversities which perhaps highlights the village as having achieved successful livelihood security and sustainability under improved economic conditions (Collier 1988, Preston 1989, Béné *et al*. 2000). This provides further evidence to strengthen the assumption that some wealthier villages diversify as a means to increase wealth, whereas others, such as Lentea, with the highest livelihood diversity but relatively low mean annual income, may diversify to mitigate risk, putting it into the secure poor category (Allison & Ellis 2001).

Tampara, having the lowest mean annual income, and relatively high livelihood diversity, does not fall into an identified category (Allison & Ellis 2001), but livelihood diversity here may be a

survival strategy due to failing livelihood security and sustainability under deteriorating economic conditions (Collier 1988, Preston 1989). This may also be the case for Lentea, having the highest livelihood diversity but one of the lowest incomes and high dependence on natural resources particularly marine natural resources. These communities may be diversifying to increase work days to meet the needs of their households (Allison & Ellis 2001).

There was a significant negative relationship between livelihood diversity and percentage of income from primary sources indicating that with multiple activities the primary activity becomes less important, however, for all villages, apart from Lagiwae, Sandi, Tampara and Lohoa, primary activities still generated by far the greatest percentage of household income.

5.5.6. The influence of primary income generating activities

Households stating an agricultural activity as their primary source of income had the highest mean livelihood diversity. These households were also some of the poorest in the sub-district, again indicating livelihood diversity as a survival strategy under poor economic conditions (Collier 1988, Preston 1989).

Those households stating tourism as the primary income generating activity had the second highest mean livelihood diversity, however in this case is most likely that diversification is in response to seasonality (Ellis 1999) tourism in the region being highly seasonal and generally restricted to June, July and August, when Operation Wallacea, the main tourist supplier to the sub-district has its field season.

In regions where environmental conditions are variable and natural resource yields unpredictable, natural resource dependent work is often seasonal and one way to cope with seasonality is to diversify livelihood activities to ensure continuous income streams, a common strategy of which is migration of workers to areas with available casual labour (Ellis, 1999). The number of households involved in work overseas (stated both as a primary and supplementary activity within the study area) may also be reflecting this trend. The overseas work may generate high incomes but could also be seasonal, hence individuals return to work at home when the season ends, or it could be the case that even though seasonally available work at home may not generate the highest household income, those activities may be the preference of individuals when they area available (the preference being the activity itself or the option to work at home).

Trade as a primary activity resulted in the lowest mean livelihood diversity, which implies that trade provides adequate income to meet the daily needs of households, and that it is perhaps a full-time occupation involving most household members. It may be an activity that requires all of the available working time of those involved to make it financially viable. Qualitative observational data strongly backs up this claim, particularly when trade is from a shop, market stall, or from the household (which in many instances becomes a small "shop floor").

Household livelihoods are shaped by many factors and local and distant institutions (for example local customs and norms), social, human, and natural capitol may all be important (Ellis 2000b, Pretty & Smith 2004). Additionally, some households may specialise for example in Sama Bahari, which may make them more vulnerable, whereas others may diversify for example in Lentea, but also remain economically vulnerable.

Human capital is often shown as a key to successful livelihood diversification (Ellis 1999), hence the delivery and quality of education and skills acquisition may result in variations in these cases. Sama Bahari, having low diversity, reflects the limited education currently available to the *Bajo* in this area, which would support this notion.

This work has outlined a single clear trend does not exist to explain livelihood diversity, although there are factors explaining some of the diversity patterns. Therefore generalised assumptions can not be made about all villages within the Kaledupa sub-region for any success in environmental management, detailed information is required at the village level and that information is provided herein.

It is not possible to say with any certainty what combination of livelihood resources result in the ability to follow what combination of livelihood strategies (Scoones 1998), but it is possible to understand local trends at the village level.

Ellis (1998) concluded that the removal of constraints to livelihood diversity, and the expansion of opportunities for diversification are desirable policy objectives because they give households greater potential for improved livelihood security and generally raise living standards. This is also the case when considering high dependence on natural resources, and the only way to reduce pressure on vital ecosystems is also to provide people with alternative livelihoods. These livelihoods, however, would need to be secure and as diversity is often the key to security, it should be promoted. Additionally, the development of efficient and well-regulated markets and the access of poor people to land, resources and markets must be improved, and economic

growth is the prime means of creating income and employment opportunities (White Paper 1997).

5.6.Conclusions

The present chapter describes in detail some of the highly complex livelihood strategies and patterns of diversity within the Kaledupa sub-district as a detailed case study. This work highlights additional complexities and patterns that must be understood and included in the creation of successful management strategies. It is important to understand what communities already have in terms of existing livelihood strategies and use existing resources and structures to help strengthen internal coping strategies (Moser 1998).

The effects of livelihood diversification on environmental resource management and the reasons behind this diversification are often varied and highly context-specific (Ellis 1999, Reyes-Garcia *et al*. 2007), which has been outlined herein.

The Kaledupa sub-district represents a relatively small geographical area that could be considered as a single manageable unit, however, within this area, livelihood diversity variability exists between cultures, villages within the same culture, primary activity groups, marine resource dependent groups and wealth groups (in terms of income). The reasons for differences in livelihood strategies between households and villages could be due to various factors such as available resources and resource quality, differing local policies, knowledge transfer, differing village management strategies or social pressures. The *Kepala Desas* play a key role in some villages providing support for certain activities.

Understanding these complexities is essential for a successful management outcome maintaining livelihoods and ecosystems in the future. Useful tools include the direct assessment of household livelihood diversity and variability at the village level as investigated though internal variance in diversity.

Chapter 6. Wealth ranking and Local Wealth Criteria

6.1. Introduction

The importance and value of natural resources in the lives of rural communities has been receiving growing international attention (Campbell & Luckert 2002, Shackleton & Shackleton 2006). This is particularly in light of the acknowledgement that sustainable economic development and ecosystem conservation are not separable (Scherr *et al*. 2002, MEA 2005).

Within any community there will be socioeconomic differentiation arising from a variety of factors such as employment, education, age and access to resources (Cavendish 2002, Shackleton & Shackleton 2006). This differentiation is important when considering policy and management interventions for sustainable livelihoods and sustainable utilisation of resources, not only because different socioeconomic groups may use natural resources differently (Cavendish 2002), but also because their dependence will vary as will the impacts of management actions upon them, which has strong implications for management success. The poorest fractions of a community will depend heavily on a given combination of natural resources for food and income, the more wealthy parts of the community, due to different socioeconomic and institutional constraints and opportunities, usually develop quite different combinations, and livelihood strategies must be distinguished within each stratum (Béné *et al*. 2000).

Wealth strata must also be clearly identified both to facilitate an understanding of resource use patterns and to determine indicators of relative local wealth. The Chambers English dictionary describes wealth as '*valuable possessions of any kind…; riches…; an abundance…*' and wealthy as '*rich*' or '*prosperous*'. With increased wealth usually comes improved well-being and household security which is an understandable human aspiration (Randall 1991). An increase in wealth can also result in decreased dependence on natural resources which can result in a decrease in pressure from local community extraction (Twyman 2000). However, increased wealth could also be a factor of increased commercial exploitation of the resources available to local people (Twyman 2000, Pilgrim *et al*. in press).

In any case, as ecosystems begin to suffer so too will the human community, the first affected being those fractions of the community who are most dependent on natural resources for livelihoods (UNDP 2005). Food security will be reduced for all households particularly in areas where dependence on natural resources for food remains high (FAO 2005). With deteriorating

ecosystems comes depleted resources and ultimately the wealth and well-being of the whole community will be impacted. If resources are maintained and used sustainably, they represent a source of improved livelihoods and food security into the future (UNDP 2005, Glavovic & Boonzaier 2006).

It is vital that at the local level, resource degradation is shown to be directly associated with reduced economic status (wealth). It is also important to make clear to local people that management actions will not be economically detrimental in the short or long term. Economic status must be maintained as a key objective of management and as such economic status (or wealth) must be measured and monitored to ensure this is the case and that economically inappropriate decisions are not made. Local perceptions of wealth are important considerations as it is these perceptions that will drive local actions.

It is important that the economic status and any economic changes within all wealth categories of a community can be measured on a relative scale and that monitoring is capable of highlighting changes in any local wealth category.

6.1.1. Wealth ranking

Participatory rural appraisal (PRA) or Rapid rural appraisal (RRA) were designed to give local people, particularly the underrepresented poor, the opportunity to express and analyse their lives and local conditions and the ability convey their situation to outsiders (Pretty *et al*. 1995). The methods consist of group or individual informant rating methods such as wealth ranking and have become increasingly popular among development workers who use the techniques to understand local wealth criteria and to identify and target groups for specific activities (Pretty *et al*. 1995, Scoones 1995, Bergeron *et al*. 1998, Campbell 2001). The methods can also be useful to allow stratification of communities according to wealth, and to evaluate the success of various livelihood strategies (Adams *et al*. 1997, Béné *et al*. 2000).

Most of the existing literature outlines examples of socioeconomic data collection either using contemporary sample surveys e.g. (Agarwal 1990, de Camargo & Petrere 2001, Mascia 2003, Barros & Victoria 2005, Bogale *et al*. 2006, Ness *et al*. 2007) or PRA techniques e.g. (Mearns *et al*. 1992, Pretty *et al*. 1992, Sarch 1992, Sheil & Liswanti 2006, Hargreaves *et al*. 2007) with some research comparing the two method types e.g. (Scoones 1995, Adams *et al*. 1997, Temu & Due 2000, Campbell 2001). Some argue that ranking exercises alone are valid (Temu & Due

2000), with others outlining vital inaccuracies and misleading information without some form of triangulation (Pretty *et al*. 1992). It is generally accepted that a combination of PRA techniques and typical sample surveys, such as household surveys can provide a comprehensive picture of wealth within a region (Adams *et al*. 1997, Béné *et al*. 2000, Campbell 2001, Campbell & Luckert 2002, Shackleton & Shackleton 2006, Tschakert *et al*. 2007).

It has been well demonstrated that wealth ranking can provide an adequate means of stratifying households by socioeconomic status e.g. (Scoones 1995, Adams *et al*. 1997). However examples do exist where factors underlying wealth are too complex and detailed to be captured by standard and simplistic methods (Johda 1988, Bergeron *et al*. 1998) but the use of triangulation and appropriate multivariate statistical analyses can be used to understand these complexities (Pretty *et al*. 1992, Scoones 1995, Bergeron *et al*. 1998, Campbell 2001).

(Scoones 1995) demonstrated that when properly conducted, wealth ranking can provide a cost-effective research tool for examining issues of wealth in rural contexts. However, to be effective the wealth ranking method must follow a number of key recommendations (Grandin 1988, Guijt 1992, Campbell 2001) and be verified through some form of triangulation (Kirk & Miller 1990, Pretty *et al*. 1992, Campbell 2001). Recommendations for successful wealth ranking as follows:

1) Examination of the nature of the households being ranked must be included.
2) Ranking criteria should be derived within the study (i.e. criteria from other studies in other regions is not appropriate).
3) A representative number of key informants should be included in the ranking process.
4) Ranking should be undertaken by individuals not groups.
5) A minimum of three participants should be included in the ranking process to reduce bias.

6.2. Chapter aim and objectives

The aim of the present chapter was to identify wealth groups within the Kaledupa sub-district and understand local perceptions of wealth. The objectives of the chapter were therefore as follows:

1) To identify wealth groups at the village level in terms of the poorest, wealthiest and intermediate villages.

2) To further stratify single villages in terms of wealth and identify the wealthiest, poorest and intermediate fractions of each village community.

3) To identify factors that local people perceive to be indicators of wealth i.e. the main household characteristics indicative of wealth on a local scale.

6.3. Methods

In the present work, wealth ranking was used both as a form of verification, or triangulation, with household surveys, key informant interviews and market surveys for income data, and to facilitate the collection of information on local perceptions of wealth and indicators of wealth locally within and between villages. Local perceptions of wealth were important to help develop economic indicators meaningful to local people and to outline any changes in wealth or perceived wealth at the local level due to management actions or ecological change.

6.3.1. Wealth ranking by card sorting

Wealth ranking was used to provide clear distinctions between different socioeconomic strata, or wealth groups, and further strengthen and clarify the distinctions made between Kaledupan villages and activities as outlined in the intensive one-off interviews. Wealth ranking, a participatory rural appraisal method, was also used in combination with informal local group discussions to identify local perceptions of wealth. This method facilitates an understanding of relative wealth within a specific area and how richer and poorer groups or individuals differ from each other, it also allows definition of local well-being and wealth criteria (Guijt 1992).

The wealth ranking method was also used to differentiate wealth groups within single villages. Whilst typical surveys usually stratify sample populations according to criteria decided by the researcher, wealth ranking provides a mechanism to implement criteria offered by local people (Scoones 1995). With verification this provides a means for the researcher to identify appropriate wealth indicators that are meaningful to local people.

The present work used wealth ranking to stratify the Kaledupa sub-district by village according to relative wealth. Within these wealth strata smaller sub-samples of villages were selected to be further stratified according to the perceived wealth of individual households by wealth ranking participants. In both cases the method comprised in its basic form a brief discussion of wealth and what it means, the ranking exercise and then a discussion of the choices made by the participant, their reasoning, and a reflection on the major indicators of wealth at the village or household level that lead the participant to make their decisions. The method was adapted from that described by (Grandin 1988) and subsequently(Guijt 1992). A number of other authors have also documented use of the method e.g. (Pretty 1989, Banlina & Tung 1992, Sarch 1992).

Identification of wealth groups at the village level

In 2005 the first series of village ranking was conducted using all villages from the Kaledupa sub-district that were included in the initial household survey. 19 villages, or sub-villages where a *Bajo* and *Pulo* sub-village constituted a village, were included. Mean annual village income and wealth ranking data were used to stratify Kaledupa into three wealth groups *wealthiest*, *poorest* and *intermediate*.

Based on village ranking and household survey data collected in 2005, villages were selected for inclusion in the 2006 household survey. Villages were selected to include both *Bajo* and *Pulo* cultures and to represent the three wealth categories.

In 2006 village ranking was repeated including 11 villages selected for inclusion in the 2006 household survey. Village ranking was conducted prior to commencement of the household survey to confirm the relative wealth status of the villages.

Respondents selected to take part in the ranking of villages were considered to be knowledgeable about the sub-district. Respondents could name all villages and sub-villages within the sub-district and had personal knowledge of each of the villages. Respondents included the *Camat* of Kaledupa (head government official in 2005 before Kaledupa was split into Kaledupa and Kaledupa Selatan). A total of 10 respondents were included in the first village ranking survey. Subsequent surveys used 3 participants from each of 11 villages resulting in a total of 33 participants. The method was conducted with the researcher, translator and participant present in private to avoid third party influence and biased ranking because of the presence of someone from one of the other villages to be ranked.

It is recommended (Guijt 1992) that participants from different socioeconomic groups are used, however, in the case of village ranking, participants had to have some knowledge of all villages so participant recommendations were taken from the *Camat* and a number of *Kepala Desa's* (village heads).

Cards were prepared with the names of the 19 villages/sub-villages prior to the ranking. The ranking process started with a discussion about wealth particularly that it was about *relative* overall wealth and well-being and the purpose of the exercise. The general differences between rich and poor were also discussed as was the unit being ranked i.e. the household. It was explained that the participant would be given 19 cards with the name of each of 19 Kaledupan

villages (or sub-villages as appropriate) and that they would be asked to put the cards into group or rows each with a different level of wealth (or well-being). After the discussion participants were given the stack of 19 cards and asked to put them into groups according to relative wealth. Respondents were allowed to create as many groups as they felt were required and were allowed to change the groups or card placements at any time.

A record was taken of the number of groups chosen by the participant and the villages placed in each group. The participant was asked to shuffle the cards and repeat the process two more times to validate their responses. If any changes were made to groups or village placements during the process, they were discussed immediately after the third ranking and reasons, if relevant, were recorded.

To elicit local wealth criteria, following the ranking, participants were asked what the characteristics of each group were and what made each group different to the next. They were asked what the wealthiest village had or didn't have that made them wealthy and the same for each to the poorest.

Stratification of villages according to wealth

In 2005 a preliminary household wealth ranking exercise in Lagiwae was conducted to trial the method. The trial was used to assess the feasibility of the wealth ranking method by cards in the Kaledupa setting, it outlined that the method was viable, local understanding of wealth was compatible with western views (as in the Chambers English dictionary), and local relative wealth criteria were simple to elicit. Lagiwae was chosen as the preliminary ranking village due to the presence of all income generating activity categories (although Ambeua had a greater mean livelihood diversity, it was lacking the work overseas income generating category).

3 participants from Lagiwae were included in the preliminary household wealth ranking of that village. They included a local shop owner, a member of a local non-government organisation, and a cook working for the tourist organisation Operation Wallacea. Participants were selected to have a good knowledge of fellow villagers and households.

In 2006 the household wealth ranking method was used in each village included in the 2006 household survey, this resulted in 11 villages being included. Due to the high number of households within each of the Kaledupan villages, using all households was deemed inappropriate as the method is best carried out with up to 100 households (Guijt 1992).

Therefore, households included in the exercise were those households included in the 2006 household survey. Using households from the household survey also provided a means of triangulation to verify the information given, particularly in relation to income and allowed a mechanism to effectively test the accuracy of the wealth ranking method. Households were randomly selected for interview from lists generated with the help of the *Kepala Desa* (village head) in each village and using primary household activity as a proxy for wealth. A stratified random sampling technique was used (for detail see chapter 7) which included three strata based on perceived local wealth, the strata were *wealthy*, *poor* and *intermediate*.

In the 2006 household ranking method three participants were selected in each of the villages included in the household survey of that year. In every village the *Kepala Desa* (village head) was included in the ranking exercise and was asked to recommend two other participants who knew their village well.

Cards were used as in the village ranking method, but bearing the name of the household head. Again the procedure was a brief discussion followed by the ranking and post-ranking discussion to elicit the participants' reasons for groupings and household placements.

If names on the cards were unknown to the participant those cards were discarded. Where more than 3 names were unknown an additional participants were sought. Wealth ranking was conducted in private to avoid third party influence and the presence of household survey respondents or other household members. The process was repeated three times with each participant and choices recorded as in the village ranking method. Following the ranking an open discussion was conducted to elicit reasons behind groupings and household placements.

Calculation of wealth scores and grouping

For each participant a wealth score for each village or household was calculated by dividing the group number in which the respective village/household card was placed by the total number of groups made (see table 6.1.).

Table 6.1. Example wealth ranking table

Participant name:		
Groups	Cards	Score
1	1, 2, 3	0.33
2	4, 5, 6	0.66
3	7, 8, 9, 10	1.00
Participant name:		
Groups	Cards	Score
1	1, 2, 3	0.25
2	4, 5, 6	0.50
3	7, 8	0.75
4	9, 10	1.00

A mean wealth score for each card (village or household) was then calculated from the scores generated by each participant. Cards were then listed in order from richest to poorest and sub-divided into groups according to their individual scores. Groups were divided into the mean number of groups used by participants and divisions made between cards having the largest gaps between their mean individual scores (table 6.2.).

Table 6.2. Example sub-division of households/villages into wealth groups

Card number	Mean score	Wealth group
1	0.29	1 (wealthiest)
2	0.29	
3	0.29	
4	0.58	2
5	0.58	
6	0.58	
7	0.88	3
8	0.88	
9	1	4 (poorest)
10	1	

Due to the nature of the ranking method, the lowest wealth scores were calculated for the wealthiest households or villages and highest wealth scores for the poorest households or villages. The wealth score scale was 0-1 although a score of zero would not be possible.

6.3.2. Statistical analyses

A one-way ANOSIM, using the PRIMER computer package (Clarke & Warwick 1994) was used to test for significant differences in wealth scores between primary income generating activities.

Due to non-normality within the data set a Spearman rank-order correlation was used to test the relationship between mean household income and wealth score by village.

6.4. Results

6.4.1. Village wealth ranking (all villages)

10 participants were included in the ranking of all Kaledupan villages. Mean number of wealth groups chosen was 4.6 ± 0.2 hence villages were distributed between 5 wealth categories based on their mean wealth score. Ambeua, Buranga, Langge and Lagiwae were ranked as the wealthiest villages; Sombano, Umala, Sama Bahari and Lohoa were ranked the poorest, with all other villages in the intermediate category (table 6.3.).

Table 6.3. Division of Kaledupan villages, Wakatobi Marine national Park, Indonesia, according to relative wealth scored using the wealth ranking by cards method (Grandin 1988) (n = 10).

Village	Mean wealth score	Wealth/well-being group	Wealth category
Ambeua	0.21	1	Wealthiest
Buranga	0.21	1	
Langge	0.21	1	
Lagiwae	0.26	1	
Ollo	0.33	2	Upper intermediate
Balasuna	0.33	2	
Darawa	0.36	2	
La Ulua	0.41	3	Middle intermediate
Kasuwari	0.41	3	
Lentea	0.42	3	
Tanomeha	0.47	4	Lower intermediate
Sandi	0.51	4	
Tampara	0.52	4	
Mantigola*	0.55	4	
Pajam	0.59	4	
Sombano	0.66	5	Poorest
Umala	0.68	5	
Sama Bahari*	0.74	5	
Lohoa*	0.94	5	

* *Bajo* villages

Criteria used by local people to rank villages included access to and quality of natural resources, village amenities, dominant income generating activity, income of villagers, quality of life of villagers, and three additional criteria grouped as 'other' which were village age, quality of houses, and number of children. Details, in the format of participant comments or statements, are given in table 6.4.

Table 6.4. Local wealth criteria used by local participants in a wealth ranking exercise to place Kaledupan villages into relative wealth groups, Kaledupa sub-district, Wakatobi Marine National Park, Indonesia. Criteria are local participant comments or observations translated directly (n = 10).

Relative Wealth group	Criteria for inclusion in selected relative wealth group					
	Natural resources	**Village amenities**	**Dominant Occupation**	**Income/ finance**	**Quality of life**	**Other criteria**
1	Best land: fertile so good agriculture	-	Civil servants Work overseas	Good incomes	Best life Children go to university People educated	Oldest villages of Kaledupa Good houses
2	Good sea and land resources	-	Few civil servants Fish or farm outside the island	Similar to group 1 but income generally less Give less money to Independence Day fund*	Life quality improving	-
3	Poor quality land Sandi and Pajam depend on land natural resources Lentea depends on marine natural resources	Less public services Fewer buildings Fewer roads	Mostly fishers	Single income source	-	-
4	Natural resources poor Disconnected from big villages Fewer public services	Not enough water/wells No basic facilities Limited clean water	-	-	Hard life	Many children (Sama Bahari in particular)

* Independence Day fund is an annual collection of donations from each village by their respective *Kecamaten*.

Blanks indicate no criteria mentioned for that specific category and group combination.

Villages for use in the subsequent household survey and additional wealth ranking exercise were selected based on both their wealth/well-being groups from the wealth ranking exercise and mean total annual village income (chapters 4 and 5), with consideration of the criteria outlined in table 6.4.

Some inconsistencies existed between the income and wealth category rankings; most notably Sombano and Sama Bahari had some of the highest mean annual incomes but were ranked by local people in the poorest group. Additionally Umala was ranked in the poorest wealth group but had an intermediate mean annual income. Ambeua was the wealthiest as considered on the wealth ranking scale and had the highest annual income (table 6.5.).

Table 6.5. Wealth scales with Kaledupan villages positioned according to their relative wealth ranking scores and their estimated total mean annual income. Wealth ranking categories shown and separated with a dashed line.

Estimated annual income	Relative income	Wealth ranking position	Wealth/well-being group	Relative wealth
Ambeua	Highest	Ambeua	1	Wealthiest
Sombano		Buranga		
Sama Bahari*		Langge		
Langge		Lagiwae		
Lagiwae	Upper intermediate	Ollo	2	Upper intermediate
Buranga		Balasuna		
La Ulua		Darawa		
Darawa	Middle intermediate	La Ulua	3	Middle intermediate
Umala		Kasuwari		
Balasuna		Lentea		
Ollo	Lower intermediate	Tanomeha	4	Lower intermediate
Sandi		Sandi		
Lentea		Tampara		
Tanomeha		Mantigola*		
Kasuwari		Pajam		
Mantigola*	Lowest	Sombano	5	Poorest
Tampara		Umala		
Pajam		Sama Bahari*		
Lohoa*		Lohoa*		

* *Bajo* village

6.4.2. Village wealth ranking (sub-sample)

33 participants were included in the ranking of the sub-sample of Kaledupan villages. 11 villages were included, three from each wealth category (wealthiest, intermediate and poorest) and two *Bajo* villages. The mean number of wealth groups chosen for these villages was 3.33 ± 0.21 with a range from 3-4 wealth groups. Hence the sub-sample of villages was split into 3 wealth categories (table 6.6.).

Table 6.6. Division of a sub-sample of Kaledupan villages, according to relative wealth. Scored using the wealth ranking by cards method (Grandin 1988), Kaledupa sub-district, Wakatobi Marine National Park, Indonesia (n = 33).

Village	Mean wealth score	Wealth/well-being group	Wealth category
Ambeua	0.40	1	
Buranga	0.47	1	
La Ulua	0.50	1	Wealthiest
Langge	0.54	1	
Mantigola*	0.56	1	
Darawa	0.67	2	
Sampela*	0.72	2	Intermediate
Kasuwari	0.75	2	
Umala	0.90	3	
Sombano	0.95	3	Poorest
Pajam	0.95	3	

* *Bajo* village

There was a significant negative correlation between mean village wealth score and mean total annual household income ($r_s = -0.705; p < 0.001$) (figure 6.1.).

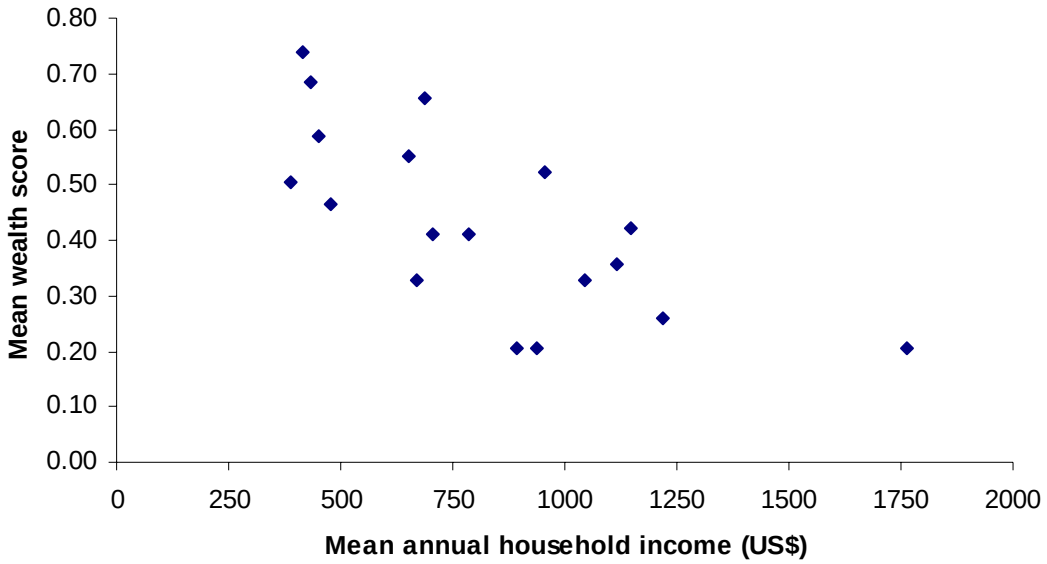

Figure 6.1. Changes in mean wealth score (using the wealth ranking by cards method) (Grandin 1988)) with mean total annual household income for Kaledupan villages, Wakatobi Marine National Park, Indonesia (n = 33). A wealth score closer to 1 indicates a poorer village.

Participants described in detail the criteria they used to rank the 11 Kaledupan villages and discussed specific differences between wealth groups and individual villages. Details, in the format of participant comments or statements, are given in table 6.7.

Table 6.7. Local wealth criteria, as stated by wealth ranking participants, used to place a sub-sample of Kaledupan villages into relative wealth groups within the Kaledupa sub-district of Wakatobi Marine National Park, Indonesia. Villages included *Pulo* villages Ambeua, Buranga, Langge, Darawa, Kasuwari, La Ulua, Pajam, Sombano and Umala; and *Bajo* villages Mantigola and Sama Bahari. Criteria are given in the directly translated format of participant comments or statements (n = 33).

Relative Wealth group	Criteria for inclusion in selected relative wealth group					
	Natural resources	**Village amenities**	**Dominant Occupation**	**Income/finance**	**Quality of life**	**Other criteria**
1	Easy access to freshwater Good land (fertile) to farm	Electricity source Close to market and *Bajo* villages for trade Better roads, reach throughout the village	Civil servants Deep sea and live reef fish fishers (Sama Bahari and Mantigola) Seaweed farming Multiple activities	Guaranteed monthly income Multiple incomes Highest incomes	Well educated Local businesses Money management Healthy people as access to freshwater and hospital Good life	High quality houses Toilets Good village sanitation Simple possessions Houses in Mantigola and Sama Bahari meet daily needs, condition is not important to them Many people
2	Rich resources Extensive farming land	Market	Fishing: centres that others rely on for fish Civil servants Farmers Multiple economic activities, but no space to develop further	Poor income Some supplementary income from farming Obvious gap between rich and poor Variable incomes Multiple incomes Income all year around	Simple lifestyle Poor education, particularly in natural resource use	Simple houses No sanitation No toilets Some people know how to manage money Some people don't know how to save money Some people can use kerosene to cook

Table 6.7. continued.

Relative Wealth group	Criteria for inclusion in selected relative wealth group					
	Natural resources	**Village amenities**	**Dominant Occupation**	**Income/finance**	**Quality of life**	**Other criteria**
3	No freshwater within village boundaries Few marine resources Poor land, lots of rock, limits agriculture	No mains electricity; can't run high demand electrical equipment (e.g. fridge) Far from market so not easy to trade	Work overseas Occasional high income from clove harvesting Limited to livelihoods from the sea Farmers Seasonal income, after season just farm	No savings Work just to meet daily needs Income dependent on season Marine dependent	Poor lifestyle Poor education	Darawa and Sombano are isolated Simple houses in poor condition No toilets Poor sanitation Cook with wood Fewer people live there
4	No freshwater Soil infertile	No wells No access to markets No schools or markets	Farmers /fishers selling within the village	Low income Depend more on farming for food more than income	Insecure	Simple houses Limited possessions Sombano and Pajam isolated, poor roads and limited interaction with other villages High proportion of widows Limited communication Limited land ownership

6.4.3. Household wealth ranking

Preliminary ranking

Preliminary survey data using Lagiwae village outlined a significant negative correlation between household wealth score and total annual household income ($r_s = -0.619; p < 0.001$). Mean number of wealth groups used by participants was 5.7 ± 0.9 resulting in 6 wealth categories for that village. Seaweed farmers and fishermen were in the poorest group for this village, with civil servants dominating the wealthiest 2 groups. There were 2 major gaps in wealth ranking scores between groups 3 and 4 and groups 5 and 6. Groups 4-6 were dominated by natural resource dependent activities (fishing and farming) with no civil servants.

A number of wealth ranking criteria were outlined by participants outlining simple distinctions between wealth groups. Criteria were based on material possessions (having or not having), house quality, quality of life, income source and finance (table 6.8.).

Table 6.8. Local criteria used to place households into relative wealth groups within Lagiwae village, Kaledupa sub-district, Wakatobi Marine national Park, Indonesia. Criteria are given in the directly translated format of participant comments or statements (n = 3).

Wealth group	Criteria for inclusion			
	Materialistic	**Occupation/Income/finance**	**Quality of life**	**Other criteria**
1	Motorbike TV Painted house Wooden house Furniture	Civil servants Good carpenter (best in village) Good income Have savings Certain (dependable) income Multiple incomes	Don't worry about daily life Can send children to university	
2	Old motorbike	Civil servants Carpenter Retired (pension)	Good life but not as good as group 1	Feeding more children
3		Adequate income Good farmers/carpenters Some civil servants (lower level) No additional incomes		
4	House in poor repair	Farmers Farmers with additional incomes No certain income	Old people Can't work	Widows
5	No TV No motorbike	Low income Farmers with no additional income		Too many children Widows
6	No TV No motorbike Simple house	No certain income	Simple life	Lot of Children Poor but earns more than group 7, only 2 children
7	Nothing in house	No income	Cant buy rice/feed family every day	Lots of children

Wealth ranking within selected villages

Wealth ranking within the 11 villages used for the household survey in 2006 gave an overall mean number of wealth groups of 3.76 ± 0.15 with a range from 3 to 5 groups. Table 6.9. a-k shows the detailed distribution of wealth groups within villages and the expected wealth category of respondents.

Table 6.9. a-k. Wealth scores (from wealth ranking by cards method adapted from (Grandin 1988), wealth groups and expected wealth categories (based on Key informant interviews) of household survey respondents in 11 villages within the Kaledupa sub-district of Wakatobi marine National Park, Indonesia. Mean number of wealth groups as categorised by each of 3 participants for each village are shown (mean ± SE) after the village name (a-i *Pulo* villages; j-k *Bajo* villages).

a) Ambeua (4.7 ± 0.33)

Primary household activity	Mean wealth score	Relative wealth group	Expected wealth category
Civil servant	0.22	1	Wealthy
Civil servant	0.22		Wealthy
Civil servant	0.22		Wealthy
Fishing	0.43	2	Intermediate
Seaweed	0.50		Intermediate
Farming	0.57	3	Intermediate
Seaweed	0.58		Intermediate
Work overseas*	0.65		Intermediate
Farming	0.70	4	Intermediate
Fishing	0.78		Intermediate
Farming	0.85		Poor
Fishing	0.85		Intermediate
Fishing	0.85		Poor
Seaweed	0.90	5	Intermediate
Farming	1.00		Poor

b) Buranga (3.67 ± 0.33)

Primary household activity	Mean wealth score	Relative wealth group	Expected wealth category
Other/trade	0.28	1	Wealthy
Trade/transport	0.28		Wealthy
Trade	0.28		Wealthy
Seaweed	0.56	2	Intermediate
Seaweed	0.56		Intermediate
Seaweed	0.56		Intermediate
Farming	0.64		Intermediate
Farming	0.72	3	Intermediate
Work overseas*	0.72		Intermediate
Seaweed	0.75		Intermediate
Farming	0.81		Poor
Seaweed	0.83		Intermediate
Seaweed	0.92	4	Intermediate
None	1.00		Poor
Seaweed tying	1.00		Poor

* Initially stated primary income from agriculture

c) Langge (4.0 ± 0.58)

Primary household activity	Mean wealth score	Relative wealth group	Expected wealth category
Civil servant	0.19	1	Wealthy
Fishing/Seaweed	0.26		Intermediate
Work overseas	0.26		Wealthy
Civil servant	0.26		Wealthy
Fishing/Seaweed	0.52	2	Intermediate
Farming	0.52		Intermediate
Fishing/Seaweed	0.59		Intermediate
Seaweed	0.59		Intermediate
Seaweed	0.59		Intermediate
Farming	0.67	3	Intermediate
Farming	0.74		Intermediate
Seaweed	0.76		Intermediate
Farming	1.00	4	Poor
Other	1.00		Poor
Seaweed tying/Farming	1.00		Poor

d) Darawa (3.0 ± 0.00)

Primary household activity	Mean wealth score	Relative wealth group	Expected wealth category
Seaweed middleman	0.33	1	Wealthy
Seaweed middleman	0.44		Wealthy
Seaweed	0.44	2	Intermediate
Seaweed	0.44		Wealthy
Seaweed	0.67		Intermediate
Seaweed	0.67		Intermediate
Seaweed	0.67		Intermediate
Fishing/seaweed	0.67		Intermediate
Seaweed	0.78		Intermediate
Seaweed	0.78		Intermediate
Farming	0.78		Intermediate
Seaweed	0.78		Intermediate
None	1.00	3	Poor
Seaweed/fishing /farming	1.00		Poor
None	1.00		Poor

e) Kasuwari (4.67 ± 0.33)

Primary household activity	Mean wealth score	Relative wealth group	Expected wealth category
Teaching	0.22	1	Wealthy
Teaching	0.22		Wealthy
Teaching	0.30	2	Wealthy
Seaweed	0.37		Intermediate
Seaweed	0.45	3	Intermediate
Fishing	0.50		Intermediate
Seaweed	0.57		Intermediate
Fishing	0.65	4	Intermediate
Farming	0.72		Intermediate
Fishing	0.72		Intermediate
Fishing	0.78		Intermediate
Farming	0.80		Intermediate
Farming	0.85		Poor
Farming	1.00	5	Poor
Farming	1.00		Poor

f) La Ulua (4.33 ± 0.33)

Primary household activity	Mean wealth score	Relative wealth group	Expected wealth category
Trade	0.23	1	Wealthy
Trade	0.30		Wealthy
Trade	0.38		Wealthy
Seaweed	0.45		Intermediate
Fishing	0.55	2	Intermediate
Farming	0.62		Intermediate
Fishing	0.62		Intermediate
Fishing	0.70	3	Intermediate
Seaweed	0.70		Intermediate
Farming	0.77		Intermediate
Seaweed	0.77		Intermediate
Farming	0.78		Intermediate
Farming	1.00	4	Poor
None	1.00		Poor
Farming	1.00		Poor

g) Pajam (4.33 ± 0.33)

Primary household activity	Mean wealth score	Relative wealth group	Expected wealth category
Civil servant	0.23	1	Wealthy
Fish middleman	0.23		Wealthy
Farming	0.32		Intermediate
Civil servant	0.38	2	Wealthy
Fishing	0.47		Intermediate
Fishing/Farming	0.47		Intermediate
Fishing	0.53		Intermediate
Farming	0.55		Intermediate
Fishing	0.78	3	Intermediate
Trading	0.78		Intermediate
Fishing	0.85		Intermediate
Other	0.92	4	Intermediate
Farming	1.00		Poor
Farming	1.00		Poor
Farming	1.00		Poor

h) Sombano (4.33 ± 0.33)

Primary household activity	Mean wealth score	Relative wealth group	Expected wealth category
Seaweed middleman	0.23	1	Wealthy
Civil Servant	0.30		Wealthy
Seaweed middleman	0.37		Wealthy
Seaweed	0.53	2	Intermediate
Fishing/Seaweed	0.60		Intermediate
Seaweed	0.68		Intermediate
Fishing	0.68		Intermediate
Seaweed	0.78	3	Intermediate
Fishing	0.78		Intermediate
Farming	0.83		Intermediate
Farming	0.92	4	Poor
Farming	0.92		Poor
Farming	0.92		Intermediate
None	1.00		Poor
Farming	1.00		Intermediate

i) Umala (2.67 ± 0.33)

Primary household activity	Mean wealth score	Relative wealth group	Expected wealth category
Trading	0.50	1	Wealthy
Seaweed middleman	0.50		Wealthy
Farming	0.50		Intermediate
Teaching	0.67	2	Wealthy
Fishing	0.67		Intermediate
Fishing	0.78		Intermediate
Fishing	0.78		Intermediate
Fishing	0.78		Intermediate
Farming	0.78		Intermediate
Farming	0.78		Intermediate
Seaweed	0.89	3	Intermediate
Seaweed	0.89		Intermediate
None	1.00		Poor
Farming	1.00		Poor
Farming	1.00		Poor

j) Mantigola (3.33 ± 0.33)

Primary household activity	Mean wealth score	Relative wealth group	Expected wealth category
Teaching	0.30	1	Wealthy
Fishing	0.30		Wealthy
Seaweed	0.53	2	Wealthy
Fishing	0.61		Intermediate
Fishing	0.61		Intermediate
Seaweed	0.61		Intermediate
Farming	0.70		Intermediate
Fishing	0.70		Intermediate
Trade	0.70		Intermediate
Fishing/seaweed	0.71		Intermediate
Seaweed	0.83		Intermediate
Seaweed	0.89		Poor
Seaweed	1.00	3	Poor
Seaweed	1.00		Poor
Seaweed	1.00		Intermediate

k) Sama Bahari (2.75 ± 0.29)

Primary household activity	Mean wealth score	Relative wealth group	Expected wealth category
Fish middleman	0.37	1	Wealthy
Fishing	0.37		Intermediate
Fish middleman	0.37		Wealthy
Seaweed	0.54	2	Intermediate
Fish middleman	0.54		Intermediate
Mangrove	0.63		Wealthy
Seaweed	0.71		Intermediate
Fishing	0.71		Intermediate
Fishing/seaweed	0.84		Intermediate
Fishing	0.84		Intermediate
Seaweed	0.88		Intermediate
Baking	1.00	3	Intermediate
Fishing	1.00		Poor
Mangrove	1.00		Poor
Fishing	1.00		Poor

Distribution of wealth classes as generated by the wealth ranking exercise generally reflected the expected wealth category. Overall 84.24 % of expected wealth category placements were correct. Within the categories 84.85 % of expected wealthy household placements were correct; this was 86.87 % for expected intermediate households and 75.76 % for expected poor households.

There was a significant negative correlation between household wealth score and total annual household income ($r_s = -0.620; p < 0.001$) (figure 6.2.).

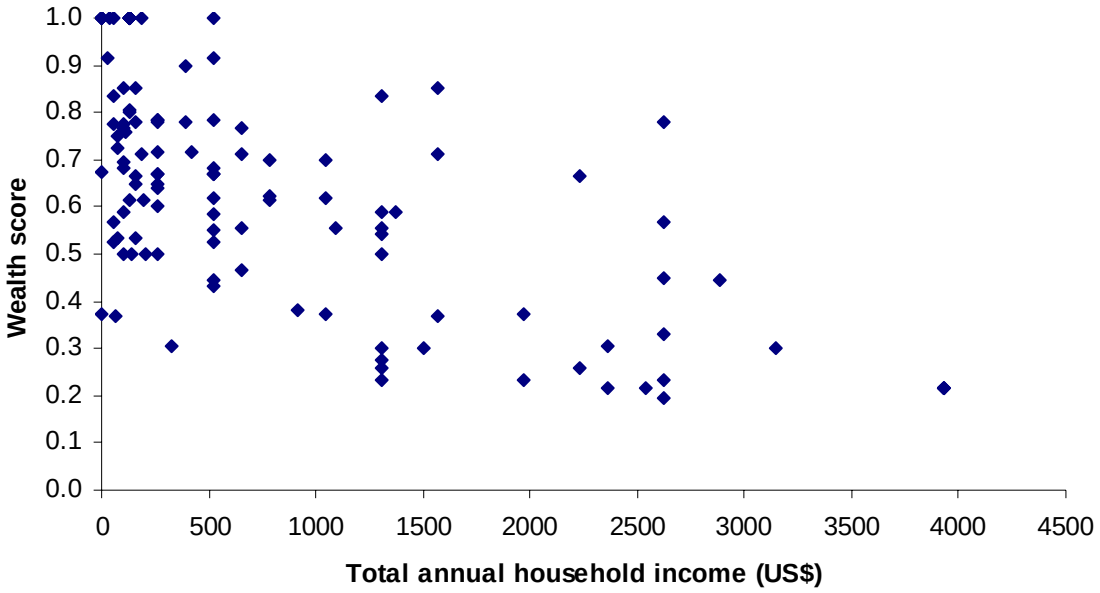

Figure 6.2. Changes in wealth score (using the wealth ranking by cards method (Grandin 1988)) with total annual household income within 11 villages in the Kaledupa sub-district of Wakatobi Marine National Park, Indonesia (n = 119). A wealth score closer to 1 indicates a poorer household.

Distribution of households according to primary activity

100 % of seaweed middlemen within the survey were placed within the wealthiest group (wealth group 1). 76.9 % of civil servants were also in the wealthiest group as were 75 % of fish middlemen and 75 % of traders. 93.5 % of fishers were placed in groups 2-4 with 56.1 % in group 2 (an intermediate group using any number of groups). 95.2 % of seaweed cultivators were in groups 2-4, with 58.5 % in group 2. Of those households stating a combination of seaweed farming and fishing as their primary household activity, 75 % were placed in group 2.

All seaweed tying households were placed in group 4 but because no seaweed tying households were present in villages that were given more than 4 wealth groups this was the poorest group for that activity.

Detailed percentage distribution of all primary household activities between all wealth groups as chosen by participants is shown in table 6.10.

Table 6.10. Percentage distribution of primary household activities within five relative wealth groups reflecting diminishing wealth from group 1 – 5, as selected by participants included in a wealth ranking by cards exercise in the Kaledupa sub-district of Wakatobi Marine National Park, Indonesia (n = 440).

	Wealth group				
Activity	**1**	**2**	**3**	**4**	**5**
Fishing	6.5	51.6	22.6	19.4	0.0
Fish middleman	75.0	25.0	0.0	0.0	0.0
Fishing/seaweed	12.5	75.0	12.5	0.0	0.0
Seaweed	2.4	58.5	34.1	2.4	2.4
Seaweed middleman	100.0	0.0	0.0	0.0	0.0
Seaweed tying	0.0	0.0	0.0	100.0	0.0
Mangrove	0.0	50.0	50.0	0.0	0.0
Farming	5.3	21.1	26.3	39.5	7.9
Civil servant	76.9	23.1	0.0	0.0	0.0
Work overseas	33.3	0.0	66.7	0.0	0.0
Trade	75.0	12.5	12.5	0.0	0.0
None	0.0	0.0	50.0	50.0	0.0
Other	25.0	0.0	25.0	50.0	0.0

A one-way ANOVA highlighted significant differences in wealth scores between primary household activity categories (*global r = 0.303; p = 0.001*). Mean wealth scores for each activity are shown in figure 6.3.

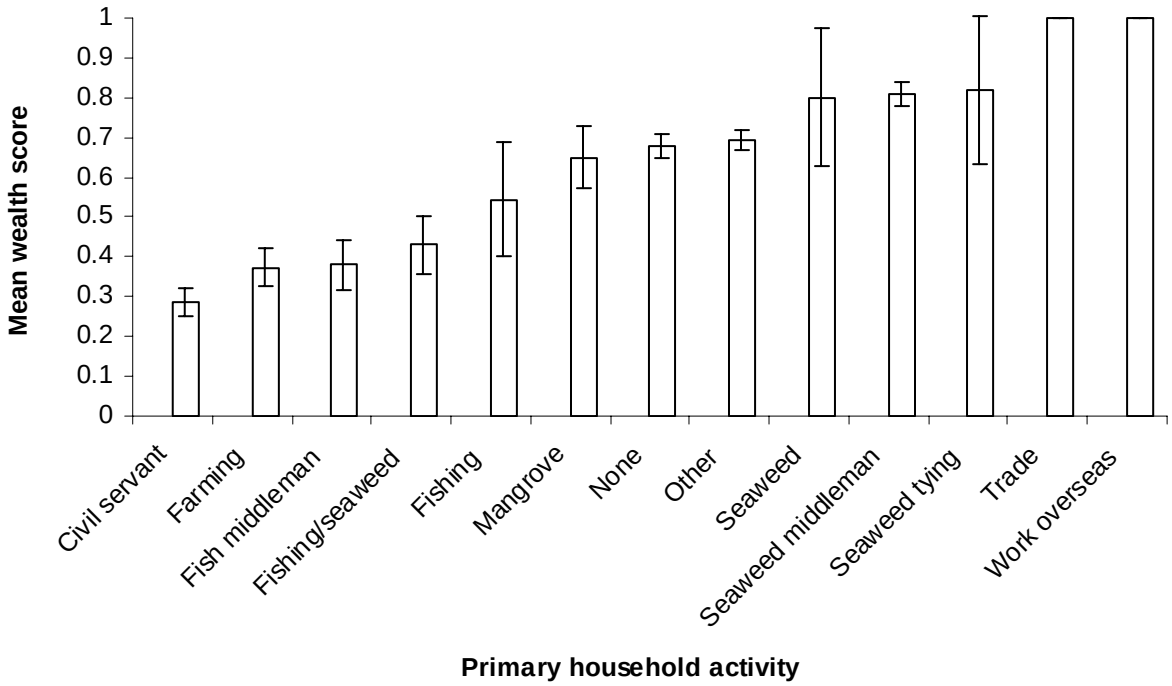

Figure 6.3. Wealth scores obtained from a wealth ranking by cards activity carried out in 11 villages in the Kaledupa sub-district of Wakatobi Marine national Park, Indonesia. Wealth scores shown for primary household activity (mean ± SE) (n = 440).

Pairwise tests indicated significant differences in wealth scores between fish middleman and fishing, seaweed farming, agriculture, and those with no activity. There were also significant differences between various combinations of other activities (table 6.11.).

There were significant differences in wealth scores between civil servants and all other activities except trade and fish middleman, civil servants having consistently the higher mean wealth score.

Table 6.11. ANOSIM pairwise comparisons between mean wealth score and primary household activity in 11 villages/sub-villages within the Kaledupa sub-region of Wakatobi Marine National Park, Indonesia. ** indicates $p = 0.001$. * indicates $p < 0.05$.

Primary household activity	Fishing	Fish middleman	Seaweed farming	Seaweed middleman	Seaweed tying	Fishing/seaweed	Mangrove	Agriculture	Trade	Civil servant	Work overseas	None	Other
Fishing	-	*		*				*	*	**		*	*
Fish middleman		-	**					**				*	
Seaweed farming			-	**				*	**	**		*	*
Seaweed middleman				-	*	*		**		*		*	
Seaweed tying					-				*	*			
Fishing/seaweed						-		*		**		*	
Mangrove							-			*			
Agriculture								-	**	**	*		
Trade									-			*	
Civil servant										-	*	**	*
Work overseas											-	*	
None												-	
Other													-

6.4.4. Local wealth criteria

The preliminary wealth ranking activity outlined some simple wealth criteria which were expanded upon in the 2006 wealth ranking exercise. More detailed information was gathered and wealth criteria (or local wealth indicators as perceived by local people) were grouped into 4 main categories: house condition; possessions; occupation; income/finance; quality of life; and other criteria (table 6.12.).

Table 6.12. Local wealth criteria used to place households into relative wealth groups within 11 villages in the Kaledupa sub-district of Wakatobi Marine National Park, Indonesia. Criteria are given in the directly translated format of participant comments or statements (n = 33).

Relative Wealth group	Criteria for inclusion in selected relative wealth group					
	House condition	**Possessions**	**Occupation**	**Income/finance**	**Quality of life**	**Other criteria**
1	Good houses Biggest houses House in good condition Zinc roofs Tiled floor Concrete houses Wooden walls/floor No bamboo Houses look nice Clean and well kept	Electronic equipment Fridge Chairs/sofas Cupboards Satellite dish Motorbike CD player/radio Motorboat Compressor Car	Civil servants Businessmen Middlemen Shop owners Money lender Multiple successful activities Two or more primary earners Rent home-stays/houses	Highest income Regular income Have savings	More food than daily needs Have electricity Children at high school Children at university Few people live in house	Cook with electricity Many assets Passenger boats Electricity Own multiple houses
2	Good houses Big houses Simple houses Wood and bamboo Palm roof Zinc roof Floor wood but 2nd class Houses not as good as 1 Concrete house	No high value items No motorbike May have TV May have motorbike No electrical equipment Electrical equipment May have fridge No engines Canoe	Fishers and farmers Fish fence fishermen Seaweed farmers Single successful activity Multiple activities	Income enough Income less than group 1 Income not stable Good income	Civil servant with lifestyle as fishers and farmers Enough food to meet daily needs Some can send children to university	No electricity Some electricity

Table 6.12. continued.

Relative wealth group	Criteria for inclusion in selected relative wealth group					
	House condition	**Possessions**	**Occupation**	**Income/finance**	**Quality of life**	**Other criteria**
3	Small houses Bamboo and palm/sago House in poor condition House not complete yet Only 2 rooms in house House is a hut One room	Very old motorbike No motorbike May have motorbike No electrical equipment No valuable items TV No canoe	Farmers Farm for food, sell excess Seaweed farmers Seasonal workers (fishing) Tie seaweed Glean for food	Income not always enough Income meets daily needs Have fish and money No income Some can save to send children to university	Not enough food Just enough food Children don't go to high school or university No electricity Depend on family for food	Physically too weak to work No electricity Widows
4	Poor house condition House bamboo and palm Hut but ok condition House under construction House on wooden stilts No foundation or platform Only 2 rooms	No equipment Some electrical equipment	Grow onion or cassava Farm for food Have farms, sometimes fish	No regular income No income Income just enough for daily needs Income not enough	Sometimes not enough food Depend on others for food	Physically weak Widows No electricity Have land but small areas
5	Houses in very poor condition Hut of bamboo/palm Palm roof Hut borrowed	No possessions Possessions just enough to cook and eat	Farm for food	No income Sometimes earn money	Poor living conditions Depend on food donations from others	Widows Physically too weak to work Oldest people

6.5. Discussion

Wealth ranking can be used to provide a general picture of wealth within an area as perceived by local people. People's perceptions are a vital consideration when trying to create a successful management strategy; therefore people must be able to perceive links between management actions and an improved economic status. Managers need to understand how people perceive wealth and economic status so that they can focus interpretations of management success in a way that local people will understand. Additionally in this sense, local people and their perceptions represent a useful management aid.

This work has shown that peoples' perceptions of wealth can also be highly accurate in terms of reflecting actual household income within their own villages and this method represents an entirely cost and time efficient potential long-term monitoring technique.

6.5.1. Village wealth ranking

Villages for use in the second household survey and wealth ranking exercises were selected based on their wealth/well-being groups from the wealth ranking exercise and on their mean total annual village income. Where inconsistencies existed, a consideration of the criteria used to rank villages was included. Spatial separation was considered to include villages in appropriate wealth categories covering the geographical range of Kaledupa. Additionally variation in marine and coastal resource use dependence and livelihood strategies were considerations as a range in dependence and livelihood strategies was preferred.

Although Sombano and Sama Bahari had some of the highest mean annual incomes their wealth scores placed them in the poorest wealth group. Due to high variability (standard errors) in the mean annual income of Sombano village it was considered that based on the wealth criteria used and outlined in the current chapter, and author observations of this village, that it be included in subsequent survey and considered as one of the poorest villages. It could be the case that both Sombano and Sama Bahari had misleading income results which required further investigation. Sama Bahari was included in the subsequent survey as a *Bajo* village as was Mantigola. It was considered that two *Bajo* villages would be more than adequate to represent the *Bajo* people (according to population sizes), time constrains were also a consideration.

Umala was ranked in the poorest wealth group but had an intermediate mean annual income, again due to the wealth criteria used and outlined in the current chapter, and author observations of this village, it was included in the subsequent survey as one of the poorest villages.

Ambeua was consistently the wealthiest village with the highest income. Buranga and Langge coming second and third on the wealth ranking scale and having some of the highest incomes were included in the wealthiest group for subsequent data collection.

Darawa, La Ulua and Kasuwari were included in the intermediate wealth group in the subsequent survey due to their intermediate positions on both the wealth ranking and income scales. Additionally these villages were selected to have a wide geographical range, apparently different livelihood strategies from specialisation to diversification, and varying dependence on marine and coastal resources.

Pajam and Umala were also included in the poorest category for subsequent analysis. Both being the lowest ranked *Pulo* villages and Pajam also had one of the lowest annual incomes.

A wide intermediate category was used because relative extremes of highest and lowest wealth were apparent but there was a large range between these groups in terms of income and wealth ranking.

6.5.2. Household wealth ranking

Preliminary wealth ranking data was not used to decide the household types to include in the subsequent household survey. This was because Lagiwae was one of wealthier villages which may have been reflected by incomes and wealth groups hence annual income data for primary income generating activity was used (see chapter 7). The preliminary household survey was intended to trial and practice the method and to outline its feasibility for use in the study. It was also used to gain qualitative data on local wealth criteria.

The high percentage similarity between expected wealth category and wealth group as determined by wealth ranking indicates both the accuracy of the random stratified sampling method (chapter 7) in terms of the households selected for inclusion in each category based on primary activity (and the advice of *Kepala Desa's*), and in triangulation with income data (there being a significant correlation between income and wealth category as determined by wealth

ranking) and the accuracy of key local participants to suggest the relative wealth of households within a village.

6.5.3. Local wealth criteria

A number of important local wealth criteria were outlined within the current chapter. These criteria were associated mainly with house condition, household possessions; income and finance; and quality of life (such as the ability to send children to university). It is vital that any indicators of wealth are recognised at the local level so that changes in economic status will be apparent to local people, particularly if the changes are associated with management actions or environmental change.

6.6. Conclusions

This chapter (along with results from chapters 4 and 5) provided the rationale and verification for selecting villages and household types (based on primary household activity) to be included in the final household survey to attempt to identify and test potential economic performance criteria (chapter 7).

The village ranking was used to assist in the selection of appropriate villages across a range of wealth categories to be included in the subsequent survey.

The wealth ranking also elicited local perceptions of wealth and highlighted potential wealth indicators recognisable at the local scale (and important to local people) that were used along with initial household data to identify a series of potential economic performance criteria.

This work also provided an assessment of relative local economic status as perceived by local people at the village and household level and represents an important and cross-transferable participatory method that is highly cost and time efficient with a high level of accuracy.

Chapter 7. Identification of Economic Performance Criteria

7.1. Introduction

Worldwide natural resources are suffering from increasing levels of degradation (Randall 1991, Clark 1998, UNEP 2006a), a large contributory factor to which is extensive anthropogenic overexploitation (MEA 2005). As human populations continue to increase, demand for natural resources will also increase along with associated negative impacts. Utilisation of natural resources is essential to the continued well-being of dependent and indigenous communities and people need to be able exploit the resources available to them for food, livelihoods and raw materials. To this end, ways must be found to allow communities to continue to utilise natural resources in a sustainable manner and management must be conducted in a way that does not negatively impact the local economy. Management must therefore tackle the challenge of sustaining vital ecosystems whilst economically supporting local communities and growing populations.

The need to understand links and dependencies between socioeconomic and ecological ecosystem dynamics has adopted a more deliberative role in the development of coastal management (Bowen & Riley 2003). It has been shown that social, cultural, economic and political factors determine the success of environmental management initiatives far more than biological or physical factors (Fiske 1992, Kelleher & Recchia 1998, Roberts 2000, Mascia 2003). However there is an unbalanced representation in the literature between these disciplines, with social and economic effects and indicators vastly underrepresented (Pelletier *et al*. 2005). One of the major failings of existing management strategies results from non-compliance to management regulations by local communities. This is often due to the actual, perceived, or expected, economic losses to communities utilising natural resources for livelihoods and subsistence (Elliott *et al*. 2001).

Management is affected by and affects people so management must consider impacts on food security, livelihoods, financial benefits, local cultures, local environmental awareness, and local knowledge (Pomeroy *et al*. 2004b). A key role of management should therefore be to maintain or improve the economic status of local people and local people need to be able to identify the economic benefits of conservation actions (Margoluis & Salafsky 1998).

A common challenge found in all conservation and development projects is to measure the success of management interventions. To ensure desired conservation impacts occur, managers need to know which actions work and which do not. It is imperative that management actions have a positive impact on the local stakeholders that it should be designed to benefit. It should be demonstrated to local communities that pre-set goals can be accomplished and that any management actions are working to improve the economic situation of local people (Margoluis & Salafsky 1998). Many people will not notice any ecological changes directly (such as increases in fisheries catch), but they may notice some associated economic change, hence they must also be able to recognise the links between these changes.

Without credible economic analyses, proof of economic stability or improvement that is recognisable at the local level, and continual monitoring, there is a risk that initial enthusiasm for any management decision, strategy or action may diminish as economic performance is perceived or actually does fail to meet the presumed potential (Rudd *et al*. 2003). Within any policy making framework, structural constraints such as demographic, socioeconomic and competitive factors are important but local opinion and local choices are more important (Lindblad 2006).

Simple, cost effective and statistically robust methods are necessary to measure and monitor economic status. Considerable work is still required for the development of a concrete, integrated and commonly accepted methodology of valuing or measuring the components of, and relationships making up, ecological and economic systems (Fenech *et al*. 2003, Pelletier *et al*. 2005). The development of a series of Economic Performance Criteria (EPC) that could be used in conjunction with ecological or biological criteria would allow economic and ecological assessments to be carried out simultaneously.

Indicators are essential tools for monitoring the state of the environment (Chabanet *et al*. 2005, Hauge *et al*. 2005) and can be used to monitor the impacts of environmental change on human dependents (Pelletier *et al*. 2005). If based on rigorous scientific research they can be used to inform managers, policy makers and local communities of the effectiveness of management actions (Chabanet *et al*. 2005).

Specific economic indicators need to be identified that first consider the cultural and resource use complexities within the specified management unit, after which they can be used to determine the impacts of management decisions on local people, and potentially demonstrate the

economic value of management actions to local people and policy makers (Pomeroy *et al*. 2004b). A selection of indicators should be identified to understand economic performance within any given region at an appropriate, understandable and significant level and with high effectiveness (Pelletier *et al*. 2005).

7.1.1. Indicator definitions and applications

Indicators have long been in use as a tool to obtain information about issues as varied as human health, weather, economic welfare and the natural environment (Segnestam 2002). Indicators measuring events within ecosystems (of which humans are a significant component) originate from environmental assessment (Caddy 2004). Alfsen & Serbo (1993) defined an indicator as "*a number that refers to the state, response or development of important aspects of the environment*". Any variable measured at a given level can be termed a metric, and a metric constitutes a potential indicator (Pelletier *et al*. 2005). In the literature the terms measure, variable, parameter, analyte, metric and index have all been used to define indicators (Bowen & Riley 2003). Lenz & Malkina-Pykh (2000) and Segnestam (2002) made the distinction between and indicator and an index by stating that the latter is usually developed from a combination of indicators weighted together to describe environmental condition. For clarification of the terminology used within this work see table 7.1.

Table 7.1. Terminology used

Term	Explanation
Indicator	Characteristic of economic status that may be informative about changes
Criterion	Characteristic(s) on which an indicator is evaluated for its information, content or status
Performance	Measure of the relative economic success of households or villages
Framework	Method of evaluation and combination of various indicators or indices
Management unit	Area for which indicators and criteria are tested and applicable

A well publicised example of index construction is the United Nations Development Programme's Human Development Index (Hajkowicz 2006, UNDP 2007) which attempts to measure human well-being at the national level. A second example is the index of sustainable economic welfare (Daly & Cobb 1989) which aims to assess sustainability at the national level. Representation and understanding of economic changes at the local level, particularly with regards to the relationship to ecological change and management, remains limited.

Within the present study, an indicator can be seen as a qualitative or quantitative variable obtainable through field surveys or from models that can be directly linked to a research question or management objective (USAID 1996, Pelletier *et al*. 2005). It is a unit of information measured over time or space that documents changes in specific attributes (Margoluis & Salafsky 1998, Pomeroy *et al*. 2004a) and can allow researchers to gauge an aspect that is not directly measurable or is very difficult to measure (Pomeroy *et al*. 2004a). In general the purpose of indicators is to enhance communication, transparency, effectiveness and accountability in a natural resource management context (FAO 1999, Segnestam 2002). Pelletier *et al* (2005) stated two main desirable features of indicators 1) relevance to the assessment objective; and 2) effectiveness, or the reliability in terms of precision, accuracy and risk of an inaccurate assessment. Appropriate indicators must be selected based on the objectives of management (Clua *et al*. 2005, Pelletier *et al*. 2005).

In most cases it is necessary to develop more than one indicator. There is no set formula to determine if additional indicators are necessary or what they should be. Once draft indicators have been developed, they must meet the criteria for a good indicator, if not, they must be modified (Margoluis & Salafsky 1998).

Proxy indicators can be used as a substitute for an indicator that cannot be directly measured or assessed or for which assessment is overly complex and costly (e.g. income (Ferguson *et al*. 2002)). An example of a proxy indicator can be found in cultures where people invest their income in cattle, so the number of cattle that a household owns can serve as a proxy indicator for household wealth (Margoluis & Salafsky 1998).

Pomeroy *et al*. (2004b) suggested that indicators can be used to provide results for several purposes as follows:

1) To measure and demonstrate management effectiveness.

2) To measure, analyse and communicate changes and promote learning, knowledge sharing and a better understanding of the strengths and weaknesses of management actions.

3) To highlight changes needed in management plans and practices.

4) To help people understand how and why changes are made.

In the case of income assessment the use of household assets as a proxy for wealth has been shown in some cases to yield less error than direct income or expenditure data (Sahn & Stifel 2003).

The establishment of indicator-driven programmes to monitor coastal systems has increasingly moved to stress socioeconomic impacts and drivers on ecosystems but indicators to monitor these impacts on local communities require further work. The degree to which economic status and ecosystem health are linked in this way remains limited (Bowen & Riley 2003).

Indicators have the potential to enhance communication, transparency, effectiveness and accountability of management of highly complex systems and should provide a readily understandable tool to describe the state of the system to all interested parties (Garcia *et al*. 1999). Evaluating management success in addressing sustainability issues requires integration of a broad set of indicators within the ecological and economic disciplines (Bowen & Riley 2003).

7.1.2. What makes a good indicator?

According to Margoluis and Salafsky (1998) a good indicator has five essential attributes including measurability; preciseness; consistency; sensitivity; and simplicity as follows:

1) It must be ***measurable*** in qualitative or quantitative terms.

2) It must be ***precise*** i.e. precisely defined, specific and not ambiguous being interpreted by different people in the same way.

3) It must be ***consistent*** over time with observed effects due to changes in actual condition, not changes in the indicator (this applies only to proxy indicators as opposed to indicators that measure something directly). For example if money (or income) can be used as an indicator and this is measured over time, it must be considered that the value of money changes, however as a relative spatial measure this presents no problem.

4) It must be ***sensitive***, changing proportionately and in the same direction as changes in the condition or item being measured (again only apples to proxy indicators where the effect is not being directly measured). For example rice consumption would be a sensitive indicator if as household income increases so does the amount of rice they buy. However this may occur to a certain point but remain constant as households can only eat a certain amount of rice each month no matter how much money they earn.

5) It must be ***simple***: easy to measure with clear strengths and weaknesses.

Additional attributes to be considered associated with the methodology used to collect indicator data include accuracy and reliability; cost effectiveness; feasibility; and appropriateness (Margoluis & Salafsky 1998):

1) Accuracy and reliability: accuracy refers to the degree of error inherent in measurement; reliability to the degree to which results obtained are repeatable.

2) Cost-effectiveness: data collection must be financially viable and there will often be a trade off between accuracy and reliability, and financial and time resources available.

3) Feasibility: methods must be appropriate for the resources available for a study, certain techniques may require extensive knowledge in economic analyses and the use of specific computer programmes but this could not be repeated by people with no prior economic knowledge or computer access. Additionally, for example, it may not be possible to include every individual of the population in a survey so methods must be adapted to accommodate these situations.

4) Appropriateness: methods used should be environmentally and culturally sensitive.

Pommeroy *et al* (2004) suggest the use of scale analysis (relative values) rather than the use of more complex analytical economic techniques such as non-market and non-use valuation methods. This is both due to relative value being more meaningful to local people and the fact that continual monitoring using developed methods would most likely be undertaken by people lacking advanced economic analysis skills.

The performance of quantitative indicators can be measured by their relevance and effectiveness (Clua *et al*. 2005). Relevance illustrating the link between the indicator and the effect it is expected to indicate, and effectiveness outlining statistical power, precision, variability,

sensitivity, and the fact that reference values exist against which the indicator can be tested (Pelletier *et al*. 2005). Because "effectiveness" is a multi-dimensional concept, a range of different indicators should be used to determine the economic impacts of management actions (FAO 1999, Pomeroy *et al*. 2004b).

(OECD 2007) argue that a successful indicator should decrease the number of measures which would normally be required for an exact representation of a situation, and simplify the process of communication to managers, stakeholders and communities.

Indicators are specific and those developed outside of a reference system have little relevance and often fail (Garcia *et al*. 1999) therefore economic indicators must be context and site specific taking into account the complexities of the systems and communities involved.

A small set of well-selected indicators is usually the most effective approach (Segnestam 2002).

7.1.3. Indicator identification and criteria development

Garcia *et al* (1999) suggested that the development of a reference system, using indicators involves five key steps:

1) Specifying the scope of the system: including identification of the overall purpose; human activities to be covered; issues to address; and geographical boundaries in which the criteria can be used.

2) Framework development: to organise indicators in relation to relevant different dimensions (social, economic, or ecological).

3) Specification of criteria, objectives, potential indicators and reference values: dependent on the dimensions being considered and the scale involved.

4) Selecting final indicators and their reference points: from the potential indicators outlined in step three. The total number of indicators used within a framework (or performance criteria series) should be limited to a small number of most effective indicators based on some or all of the following complementary (Pelletier *et al*. 2005) or additional factors:

    a. Policy priorities

    b. Feasibility

c. Data availability
d. Cost-effectiveness (financial and time consumption)
e. Simplicity
f. Accuracy and precision
g. Robustness to uncertainty
h. Scientific validity
i. Environmental and cultural sensitivity
j. Communicability
k. Legality
l. Adequate documentation

5) Aggregation and visualisation of results: to facilitate use within a broader management system and improve accessibility to a wider audience, indicators must be presented in a form easily understandable by all stakeholders.

(FAO 1999) suggest that although there are many criteria for selecting good indicators there are three crucial factors that should be considered primarily 1) indicators must be scientifically valid and indicative of the objective they are intended to reflect using the best scientific information available; 2) they must be feasible and cost-effective for data collection; and 3) they must be easily understandable.

Spatial changes in indicators can provide highly meaningful and relative comparisons. Changes in indicators over time however can only be meaningfully interpreted in relation to economic development with an initial basis for comparison through the use of reference values, which can be identified benchmarks (FAO 1999, Garcia *et al*. 1999) or first assessment values (Clua *et al*. 2005). In terms of economic analysis the provision of economic benchmarks could be provided at the village or household level to outline indicator scales of wealth.

At the national level indicators can be used to provide a holistic picture of ecological or economic state; at the regional level, they can assist in the process of developing complementary strategies for the management of cross-boundary resources; and at the village or sub-district level (within selected geographical boundaries) indicators can provide an operational tool in

management as a bridge between objectives, management actions, and actual outcomes (FAO 1999).

Criteria represent the properties that will be affected by the management process, one of which is the economic status of local people. Objectives, indicators and reference points (or benchmarks) need to be clearly defined for any criteria (FAO 1999) to allow the criteria to be described by the indicators and relative to any reference points.

Data availability and/or ease of collection are major considerations when attempting to develop a series of indicators for continued future use, particularly at the local level (Margoluis & Salafsky 1998).

7.1.4. Performance indicators

Performance indicators are specific measures used to describe how well a particular programme is achieving its goals or objectives (USAID 1996). These indicators define the data required to measure progress or change, hence are a valuable management tool for making performance-based decisions about management actions and strategies (USAID 1996) based on real occurrences in a feedback loop type mechanism (Pelletier *et al*. 2005). Performance indicators should be direct, unambiguous, practical (financially and time feasible) and adequate reflecting directly the process they are required to measure, using an appropriate number of single measurements (USAID 1998).

Little attention has been given to performance measurement in local economic development, further work is required particularly in the context of how to use and manage public goods to enhance sustainable economic development (Lindblad 2006). In this sense indicators are best used as part of a performance evaluation cycle in the context of stated objectives and as a basis for comparison (Garcia *et al*. 1999).

7.1.5. The need for economic indicators

If one of the aims of environmental management is to improve the economic status of local people, then this status must be assessed and monitored. In its simplest form this assessment could be based on wealth (or income), however, the prevalence of multiple income sources, frequent migration, work overseas, and seasonally dependent work highlights the difficulties that

can be encountered when trying to measure income directly to assess economic status. Additionally as most households in developing countries do not keep income records, and income can be highly variable, it can be difficult and excessively time consuming to provide accurate figures (Pollnac & Crawford 2000). Therefore we need to recognise appropriate economic indicators to act as a proxy for income. Proxies are sometimes necessary interim substitutes when the use of a preferred indicator is not feasible (FAO 1999).

The definition and recording of a standardised set of indicators is of great importance (Pollnac 1998). There are several existing biological criteria for ecological monitoring, but limited economic criteria and both are required for successful outcomes in management.

There have been many studies into the ecological effects of management (Pelletier *et al*. 2005) but only a handful of economic analyses to assess the economic impacts of management e.g. (Hoagland *et al*. 1995, Farrow 1996). Protected areas have rarely been the focus of rigorous political analyses considering the full range of economic costs and benefits (Rudd *et al*. 2003). Some studies have reviewed some of the economic effects of marine protected areas e.g. (Dixon 1986, 1993, Hoagland *et al*. 1995, Pendleton 1995, Farrow 1996, Carter 2003) and others have discussed variants of the total economic value of coral reefs e.g. (Spurgeon 1992, Turner & Adger 1995, Cesar 1996, Moberg & Folke 1999, Cesar *et al*. 2003). However there have been few assessments on the net economic benefits of management directly (Hoagland *et al*. 1995). Even fewer studies exist that provide results or indicators that would be meaningful to local people and local policy makers. The perceptions of people affected by management actions is crucial and will effect the level of support or ignorance of management rules which will directly effect management success (Fiske 1992, Alder *et al*. 1994, Cocklin *et al*. 1998, Suman *et al*. 1999). The identification of locally recognisable indicators is therefore vital.

7.1.6. Potential economic indicators

Indicators must be discriminatory i.e. things that not everyone has or for which there is an apparent scale throughout the community. To obtain a valid indication of relative economic status it is important to use a number of variables, however an excessive number could make the method impractical for future replication (Barros & Victoria 2005).

One important aspect of economic status is wealth (Zinn *et al*. 1992, Pollnac & Crawford 2000, Pomeroy *et al*. 2004a), however this is often difficult to measure directly. Income often

correlates directly with wealth (although they are notably not the same thing), but income can be time consuming and financially costly to measure with any accuracy therefore other measures or proxies for wealth must be identified. Material lifestyle and assets can be one way to assess relative wealth within a community.

Material lifestyle

Material lifestyle can be used to asses the equity of monetary benefits throughout a community and is considered a good indicator of wealth (Montgomery *et al*. 2000, Pollnac & Crawford 2000, Filmer & Pritchett 2001, Ferguson *et al*. 2002, Pollnac *et al*. 2002, Pomeroy *et al*. 2004b, Barros & Victoria 2005). It can help understand economic status and relative wealth within communities and can be useful in determining changes in wealth where it is difficult, time consuming or costly to collect accurate income data. A positive economic impact of management actions resulting in increased wealth should result in an increase of material lifestyle scores (as an indicator) over time (Pomeroy *et al*. 2004b) and will result in spatial variation where wealth within a community or management unit is variable.

Material wealth can be measured using a list of assets related to house structure, furnishings and possessions (Pollnac & Crawford 2000). Housing quality can be a useful measure of the relative household wealth within a community; any lists of assets must be appropriate to the target area reflecting local conditions and perceptions of wealth (Pomeroy *et al*. 2004b).

Where lists of various material wealth indicators are combined it may be necessary for individual indicators to be weighted according to relative monetary value to more accurately reflect household wealth (Pollnac & Crawford 2000). However it may be more appropriate to scale items according to local ownership proportions (Zinn *et al*. 1992). When using a scale it is assumed that the indicators involved are homogenous and uni-dimensional with respect to the concept, and that the probability of ownership increases with the attribute (wealth). The greater the value of the attribute (greater wealth), the higher the probability of a positive response (i.e. ownership). The difficulty in acquiring a particular item can be estimated by the number of respondents possessing that item (Zinn *et al*. 1992). The Guttman scale (Guttman 1947) is both uni-dimensional and deterministic. This is because each relatively more valuable item is only obtained after acquisition of a series of less valuable items. An alternative scaling method stochastic cumulative scaling is a non-parametric alternative to the Guttman scale whereby there is equal opportunity for any respondent to acquire any item at any time without owning any less

valuable items (Mokken 1971, Coombs *et al*. 1978, Mokken *et al*. 1986). Using both scales a relative wealth score based on ownership of specific items can be calculated (Zinn *et al*. 1992). In some cases it is not necessary to weight or scale items as simple additions of positive responses may be adequate to directly reflect local relative wealth (Zinn *et al*. 1992, Segnestam 2002).

It is important to note that within cultures giving little importance to materialistic gains, increased wealth may not be indicated by material lifestyle or household assets alone, this may well be the case within *Bajo* communities.

Alternative indicators

Various alternative and additional indicators of wealth exist and are fairly well documented in the literature e.g. (Montgomery *et al*. 2000, Pollnac & Crawford 2000, Filmer & Pritchett 2001, Ferguson *et al*. 2002, Pollnac *et al*. 2002, Segnestam 2002, Pomeroy *et al*. 2004b, Barros & Victoria 2005, Pelletier *et al*. 2005, Rodriguez *et al*. 2006). Some of the potential indicators are as follows:

- Land ownership: can be a good indicator related to the social and economic structure of communities and is often recorded in village records (Pollnac & Crawford 2000).

- Human health: can also sometimes be an appropriate indicator of economic status as with improved livelihoods and income, and overall wealth within a community, it could be expected that the quality of human health should increase (Pollnac & Crawford 2000, Pomeroy *et al*. 2004b). At the very least the facilities available to treat health related problems should show an increase.

- Alternative sources of income: this refers to dependence on natural resources and livelihood diversity (David & Cillaurren 1992, Ruddle *et al*. 1992, Jennings & Polunin 1996). Work in the fisheries sector is often regarded as employment of the last resort due to limited educational requirements (FAO 1999). Changes in paid labour or livelihood structure can indicate a changing economy and local economic success (Pollnac *et al*. 2002).

- Community infrastructure: is a general measure of community economic development and includes community services such as hospitals and schools; and physical

infrastructure such as roads or utilities (Pomeroy *et al*. 2004b). It can provide spatial and temporal comparisons of economic status and relative village wealth.

- Access to markets: is a measure of number and types of market available to local people to buy and sell goods. Livelihoods are often linked to markets so changes in their structure is vital to the economic status of local people and may reflect new livelihood opportunities (Pomeroy *et al*. 2004b)

- Education: years of formal education are frequently related to economic status so it is an important indicator which is easily and quickly accessible through interview (Pollnac & Crawford 2000, Pollnac *et al*. 2002, Barros & Victoria 2005, Rodriguez *et al*. 2006).

- Food security: according to (FAO 2006) '*food security exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life. Household food security is the application of this concept at the family level. Food insecurity exists when people are undernourished as a result of the physical unavailability of food, their lack of social or economic access to adequate food, and/or inadequate food utilisation.*'

- Protein consumption: fish provides a more than two-thirds of the animal protein consumed by developing countries, particularly rural coastal communities, however per capita availability of fish in some countries has decreased in recent years due to declining catches and export of high value species, as demands increase so does the risk of unsustainable practices, changes in per capita fish consumption and fish consumption as a percentage of total animal protein consumption could be important indicators of food security (FAO 1999, Zann 1999, Leopold *et al*. 2004, FAO 2005).

- Ownership of livestock is often suggested as one of the key factors differentiating households in terms of wealth in some communities (Rodriguez *et al*. 2006).

- Number of household members (and potentially the ratio of producers to non-producers) (Pollnac *et al*. 2002, Pomeroy *et al*. 2004b, Barros & Victoria 2005).

- Access to amenities e.g. freshwater for drinking and washing, toilets, electricity.

This list is by no means exhaustive but covers some of the most commonly stated indicators in the literature. Choice of indicators is very case specific and depends on the availability of data

and resources within a particular area or project. In some areas an indicator may be appropriate whereas in others it may be highly inappropriate. The benefits of a set of indicators rather than a combined index means that different areas may be comparable on at least some levels using some of a range of available indicator data (Segnestam 2002).

7.2. Chapter aim

The aim of this work was to use economic data to identify key economic criteria that could be used to evaluate the relative economic performance of natural resource management programmes.

To monitor economic systems and change, simple, cost effective and statistically robust methods are required (in the same way that those methods have already been developed for biological monitoring programmes). A key role of management should be to improve (or at the very least maintain) the economic status of local people to ensure local compliance to rules and any chance of a successful outcome. We need to monitor economic status and ensure no losses occur due to economically inappropriate management schemes. So we need to look into ways of identifying key economic indicators that could be used to assess and monitor economic status and rates of economic change over time. The Kaledupa case study has provided extensive socioeconomic data that will be used to identify and test a series of potential economic performance criteria.

Social science methods were used to gather data which was tested using scientific analytical techniques and the combination of social, economic and ecological data will provide a truly multidisciplinary research technique appropriate for management policy development.

This work focused on the identification of quantitative indicators, although the use of qualitative indicators can be appropriate in more data-poor situations, however, when data is available, it is best to measure variables at the highest level of measurement. If variables can be measured at the ratio or interval level, they should not be measured at the nominal or ordinal level (Bernard 2000).

7.3. Methods

Semi-structured interviews were used in the field to gather information from 165 households in 2006. Information gathered using the household survey technique was entirely quantitative. 11 villages were included in the household survey and were selected for inclusion according to varying wealth (based on mean total household income; wealth ranking and author observations), and including both *Bajo* and *Pulo* cultures (table 7.2.). Villages were also selected to give a relatively large (as far as possible to maintain categories) geographical spread throughout Kaledupa and Kaledupa Selatan (the two *Kecamatens*). Villages were classified on a relative scale as *wealthiest*, *intermediate*, and *poorest*. Two *Bajo* villages were included in the survey, but were not ranked according to relative wealth before hand due to the extreme variability within these villages.

Table 7.2. Villages used in a household survey of the Kaledupa sub-district of Wakatobi marine national Park, Indonesia. Villages selected for inclusion according to relative wealth and included two *Bajo* villages.

Wealth category	Village
Wealthiest	Ambeua
	Buranga
	Langge
Intermediate	Darawa
	Kasuwari
	La Ulua
	Pajam
Poorest	Sombano
	Umala
Bajo	Sama Bahari
	Mantigola

A stratified random sampling technique was used within selected villages whereby random sampling of households from each of three wealth strata was undertaken again using *wealthiest*, *intermediate* and *poorest* categories. The intermediate category was further stratified according

to primary household activity/occupation with seaweed cultivators, fishers and farmers being the target groups. This was done to achieve a sample including a range of intermediate households because the wealthiest and poorest households based on income were clearly identifiable, but the intermediate households had a wide range of incomes (chapters 4 and 5). All within village stratification was based on primary household activity/occupation (table 7.3.). A range of primary household activities were identified for each wealth category because not all activities were carried out in every village. For example in some villages there were no civil servants, and traders represented the wealthiest households resulting in variable wealth ranges between villages.

Table 7.3. Intra-village stratification according to relative household wealth. Relative wealth assumed according to primary household activity or occupation.

Within village wealth strata	Sub-strata	Target primary household activity/occupation
Wealthiest	N/A	Civil service/Middleman/Trade
Intermediate	Upper intermediate	Seaweed cultivation
	Middle intermediate	Fishing
	Lower intermediate	Agriculture
Poorest	N/A	No activity/seaweed tying/local crafts/no income*

* No activity was for households where no one worked; no income was for households where there were workers but no income or only excess materials sold (e.g. fishing or farming mainly for food).

The names of household heads from within each required wealth strata (according to primary household income) were listed by the head man of each village. From the lists generated 3 respondents from each stratum were randomly selected for inclusion in the survey. This resulted in 15 respondents being selected from each village giving a total sample size of 165 households.

7.3.1. Key informant interviews

The village head of each village was also interviewed as a key informant to provide information about their village. 11 key informant interviews were therefore conducted for this part of the work.

Prior to carrying out survey work in any village within any given year or project, permission had to be sought from the *Kepala Desa* (village head) of that village. After permission was granted, the *Kepala Desa* was interviewed as a key informant to provide specific information about their village and lists of potential household survey respondents from which individual household were randomly selected for inclusion in the subsequent survey. Village data was used to describe community infrastructure and data was collated and presented in narrative format that could be compared spatially and temporally in a qualitative manner. Key informant interview structure for 2006 is given in appendix 2.

Key informant interviews were semi-structured and comprised of 13 questions split into 4 sections as follows:

a) Population

b) Economic activity

c) Infrastructure and amenities

d) Health

Again, support for the research and a village guide was also provided by the *Kepala Desa*.

7.3.2. Household survey detail

The household survey consisted of a semi-structured questionnaire with 53 questions split into 10 sections as follows:

a) Identification (of household)

b) Respondent background

c) Household characteristics

d) Respondent occupation/livelihood activities

e) Marine and coastal resource use

f) Occupation/livelihood activities of other household members

g) Food security

h) Finance

i) Exposure to information

j) Environmental awareness

There was a final section which included any additional observations by the interviewer that might be relevant to the interview outcome.

The aim of the household survey was to elicit background demographic, economic and social information and collect data that could be use to measure the economic performance (or relative economic status) of individual households. Potential indicators were those criteria outlined by local people in wealth ranking activities (chapter 6), along with additional potential indicators as outlined in the literature (section 7.1.6.). The 2006 survey structure is given in appendix 5.

7.3.3. Data collection for potential economic criteria and indicators

Potentially appropriate indicators to assess wealth were determined from local wealth criteria outlined in wealth ranking exercises because this allowed identification of household items or features that indicated relative wealth within the local community and that would be directly recognisable by the local community. Items included were those things likely to be bought or upgraded as soon as the household was economically able. As wealth can be well represented in the possessions of a household (Zinn *et al*. 1992), and this was strongly reflected in the criteria outlined by local people within the wealth ranking exercises, household assets and material lifestyle were strongly focused upon in the household survey (table 7.4.).

Additionally livelihood diversity was considered a potential indicator thus detailed information was gathered within the household survey, although this is a highly complex issue as outlined in chapter 5.

Detailed income data was also collected as a basis for verification and triangulation and as a baseline against which to test potential economic performance criteria (methods as in chapter 4, section 4.2.3.).

Table 7.4. Potential indicators of relative local wealth and method of data acquisition within the Kaledupa sub-district of Wakatobi Marine national Park, Indonesia.

Potential indicator	Criteria	Method of data collection	Specific questions asked
Household construction	Main material of walls*	Observation	N/A
	Main material of floor	Observation	N/A
	Main material of roof	Observation	N/A
	Platform/foundation material	Observation	N/A
	Number of sleeping rooms	SSI**	How many sleeping rooms in your house?
Household structure	Number household members	SSI	How many people live in your house?
	Ratio producers to dependents	SSI	What ages are household members? What are the activities of household members?
Access to amenities	Toilet	SSI	Does your house have a toilet?
	Freshwater	SSI	Does your house have a well? How long does it take to reach the well?
	Electricity	SSI	Does your house have electricity?
Material lifestyle	Household assets	SSI	Does your house have any of the following? Radio; CD player; TV; Electric fan; Fridge; Generator;; Other electrical item Mobile phone Canoe; Motorboat Motorbike; Car
	Fuel use	SSI	What fuel does your household cook with?
	Land ownership	SSI	Does your household own any land? What size is the plot?
	Livestock ownership	SSI	Do you own any livestock? (detail required)
Education	Household head education	SSI	What is the highest level of education that the household head has attained?
Food security	Food limitation	SSI	Were there any days in the last month/year when your household did not have enough food?
	Protein consumption	SSI	How often does your household eat fish?

* The main material used for household construction was that material covering more than 50% of the relevant surface. ** SSI = semi-structured interview.

7.3.4. Economic weighting and initial scoring

Household assets, construction materials, and educational attainment of the household head were relatively weighted (or scored) according to proportionate basic unit price. Price information was gathered from key informant interviews with local traders, house owners, and those in possession of valuable items. Assets were scored by simple addition and a final economic performance score generated by summing constituent indicator scores.

7.3.5. Feasibility of potential economic performance criteria

Data from both 2005 and 2006 household surveys, key informant interviews and author observations were initially used to assess the feasibility of the potential economic performance criteria before further detailed analysis and statistical testing. Potential criteria were rejected if they were deemed too difficult to measure, excessively time consuming to measure, or culturally inappropriate.

7.3.6. Statistical analyses

Income data again deviated significantly from a normal distribution which could not be rectified by transformation, therefore ANOSIM was carried out using the computer package PRIMER (Clarke & Warwick 1994)**.** A one way ANOSIM was used to validate differences between annual incomes generated within the selected household wealth categories based on primary household activity.

Testing of potential economic performance criteria

Household income data was assumed to be within a specific range within household wealth categories hence it was deemed appropriate to use a multiple regression analysis (assuming income as the dependent variable) to identify potential economic performance criteria. This method was used to create a household construction indicator (household materials) and household structure indicator (household occupants) from the potential criteria outlined. Multiple regression with some assumptions overlooked was used simply as an exploratory tool (Dytham 2005) to generate further hypotheses to be tested using appropriate correlation analyses and ANOSIM. Based on an initial multiple regression of criteria, those criteria having no significant effect were removed one by one and the remaining criteria retested. A spearman rank order

correlation was also used to confirm criterion as having significant relationships with household income or not.

For the material lifestyle criteria multiple regression was not suitable as individual criterion scores were not scaled (simply owned or not owned). In this case criteria outcomes (0 or 1) were summed to give a material lifestyle score. Due to non-normality within the scores a Spearman rank-order correlation was used to test the relationship between material lifestyle score and total annual household income. For the same reason a Spearman rank-order correlation was also used to test the relationship between education and total annual household income, education also being previously weighted.

Once confirmed, the series' of Economic Performance Criteria (EPC) for each indicator were summed to create a household economic performance score. A Spearman rank-order correlation was used to test the relationship between household economic performance score and total annual household income.

Economic performance (EP) scores deviated significantly from a normal distribution which could not be rectified by transformation, therefore ANOSIM was carried out to investigate differences in EP scores between household wealth categories and validate the selected criteria**.**

A Mann-Whitney U test was used to investigate the significance of differences in EP score between the two Kecamaten, Kaledupa and Kaledupa Selatan. The test was chosen as the most powerful non-parametric test available for analysis of non-normal data between two groups.

7.4. Results

7.4.1. Initial feasibility testing of potential indicators

A number of potential criteria were rejected due to non-feasibility within the locale before indicators and criteria were analysed and statistically tested for their effectiveness and reliability (table 7.5.).

Criteria were initially assessed according to the following factors:

1) Ease of measurement: based on a scale from very easy to very difficult depending on the method and ease of eliciting a response through interview.

2) Time consumption: related to the time required to elicit an answer to a particular question. Time consumption was based on a scale from negligible, where researcher observation was appropriate; to very high, where additional explanations and further questions were required to elicit the required measure.

3) Cultural appropriateness: if criteria required discussion of culturally inappropriate topics they were not suitable for inclusion in a long term monitoring programme hence were not included in further analysis.

Any particular strengths or weaknesses of each criterion were also considered.

Table 7.5. Feasibility of potential economic performance indicators and associated criteria as applied to the Kaledupa sub-district of Wakatobi Marine national Park, Indonesia.

Potential Indicator	Criteria	Feasibility			Strengths	Limitations	Accept/ reject*
		Ease of measurement	Time consumption	Culturally appropriate			
Household construction	Main material of walls	Very easy	Negligible	N/A	Simple, consistent		Accept
	Main material of floor	Very easy	Negligible	N/A	Simple, consistent		Accept
	Main material of roof	Very easy	Negligible	N/A	Simple, consistent		Accept
	Platform/foundation material	Very easy	Negligible	N/A	Simple, consistent		Accept
	Number of sleeping rooms	Easy	Minimal	Yes	Consistent		Accept
Household structure	Number household members	Easy	Variable	Yes	Simple	Requires further explanation	Accept
	Ratio producers to dependents	Easy	High	Yes		Not simple, sensitive or consistent	Reject
Access to amenities	Toilet	Easy	Minimal	Yes		Not sensitive	Reject
	Freshwater	Easy	Minimal	Yes	Simple	Not consistent	Reject
	Electricity	Easy	Minimal	Yes	Simple, consistent		Accept
Material lifestyle	Household assets	Easy	Minimal	Yes	Simple, consistent, sensitive		Accept
	Fuel use	Difficult	High	Yes		Not sensitive, complicated	Reject
	Land ownership	Difficult	Minimal	Yes		No land ownership records	Reject
	Livestock ownership	Difficult	Minimal	Yes		Not sensitive, few livestock	Reject
Education	Household head education	Easy	Minimal	Yes	Simple, consistent, precise	Not temporally sensitive	Accept
Food security	Food limitation	Very difficult	High	No			Reject
	Protein consumption	Very difficult	Very high	No		Highly complex	Reject

* For further analysis

Fish consumption was rejected as an indicator because detailed data would be required, perhaps in the form of a household food diary, on the exact quantities of fish consumed annually and that data was not available or feasible to collect. Information that could be collected on fish consumption within the household surveys was highly variable and unreliable as people were unsure how much fish they consumed within any given time period, the process of information elicitation for this potential indicator was also extremely time consuming. Additional complications included the consumption of fish not bought but caught by a household member, bartered, or received as a gift from family or neighbours. No data was available on fish size or weight consumed. The diet of respondents often depended on what was available at the market, their income in any given week, and was seasonally variable. Discussion of diet was also deemed inappropriate within the Kaledupan culture with many respondents not comfortable discussing the subject of food; in fact the discussion of income and finance was far more acceptable to local people.

Fishing equipment was removed as this was entirely biased towards fishing households (and without fishing equipment contributing to the household asset score, there was a stronger correlation with total household income).

7.4.2. Village economic status

Clear differences were apparent in the general economic status (or state of development) between villages. These differences were highlighted through researcher observations and interviews with respective *Kepala Desas* (village heads). Basic village demographics are given in table 7.6.

The most densely populated village was Sama Bahari a *Bajo* village. Although no data exists for Mantigola (*Bajo*), it can be expected that this village would also have a relatively high population density due to the nature of *Bajo* villages being based on houses built on stilts over the sea. Houses are built close together due to limited available space and for protection against the elements. Within the *Pulo* villages, Buranga, Ambeua and Langge were the most densely populated, Sombano and Pajam were the least densely populated.

All villages had access to an electricity source of some kind, although not all households were connected. There exists a power station on Kaledupa that provides electricity to Ambeua,

Buranga, Langge, La Ulua, Kasuwari, Umala and Mantigola. Other villages have their own diesel fuelled generators.

All villages had access to fresh water through a series of wells. Most villages had suitable freshwater wells within their boundaries, some however, did not. Sombano had a well 2km outside the village boundaries which provided the closest freshwater access. Clearly *Bajo* villages had no direct freshwater access hence they had to bring water by canoe from the closest available wells on land. Darawa also had no fresh water of its own and had to collect freshwater from the neighbouring village of Lentea on the next island.

All villages had primary schools; Ambeua, Umala and Kasuwari also had junior schools and La Ulua provided the only high school in the sub-district. School access was not restricted to village inhabitants hence children travelled from all other villages to attend school.

The presence of tarmac roads and public transport was limited in all villages and all roads were in poor condition. Motorbikes provided the major form of transport; however a few local buses (minivans) were also in operation linking most villages.

There were three markets in the sub-district; the only daily market with regular stalls was in La Ulua which therefore provided a centre of trade for the whole of Kaledupa.

Health facilities were extremely lacking and there was no qualified doctor in the sub-district. There was a single hospital in Lagiwae which was unmanned. No health records were kept for any of the villages and knowledge on the subject of health of disease was highly limited.

Table 7.6. Basic village demographics for 11 villages within the Kaledupa sub-district of Wakatobi Marine National Park Indonesia. Land size data provided by the Kaledupan *Camats* office (local governmental leader) (Kecamatan Kaledupa 2006)

Village	Area (km^2)	Population density (population/km^2)	Household density (houses/km^2)	Kinder garden	Primary school	Junior school	High school	Wells	Electricity service	Land line telephone	Mobile phone cover	Public transport	Paved/tarmac road	Market	Guest house
Ambeua	4.5	258.4	72.0	1	2	2	0	75	1	1	1	1	1	0	1
Buranga	3.0	336.0	105.3	1	2	0	0	8	1	2	1	1	1	1	0
Langge	3.5	244.9	65.4	1	1	0	0	15	1	1	0	0	0	1	0
Darawa	5.5	102.5	33.6	1	1	0	0	0	1	0	0	0	0	0	0
Kasuwari	11.0	98.7	26.2	1	1	1	0	0	1	1	0	0	0	0	0
La Ulua	5.0	179.0	48.4	1	2	0	1	29	1	0	1	1	1	1	1
Pajam	8.0	98.9	22.0	1	1	0	0	0	1	1	0	0	1	0	0
Sombano	7.5	78.9	16.9	1	1	0	0	3	1	0	0	0	0	0	0
Umala	9.0*	152.3*	34.7*	0	2	1	0	10	1	0	0	0	0	0	0
Mantigola**	-	-	-	0	1	0	0	0	1	0	0	0	0	0	0
Sama Bahari**	1.5	631.3	167.3	0	2	0	0	0	1	0	1	0	0	0	0

* Umala and Mantigola separate sub-village data not available, data for Horuo village combining both sub-villages. ** *Bajo* villages

A description of the economic features of each village, as perceived by the respective *Kepala Desas* (village heads) follows:

Ambeua: Ambeua was considered to have a stable population due to successful family planning programmes within the village and the migration of high school students to university outside of the Wakatobi with few returning after graduation. Farming was considered the most important economic activity and was often a supplementary activity; there were few fishing households. There was no hospital, clinic or doctor but eight nurses or midwives providing home visits. Disease was thought to be decreasing due to improved freshwater access (more wells), water filtration, and the availability of medicines.

Buranga: Buranga was the first capital village of Kaledupa and had a jetty and large market area which remained mostly empty. As the village became too large, mangrove area was reclaimed along the coast and Ambeua was formed with a new jetty and access road. The population in Buranga was thought to be increasing due to very high birth rates. Seaweed was considered to be the most important economic activity for the village with fishing and farming also important. There was one clinic in Buranga with two midwives and a nurse.

Langge: The population in Langge was considered to be increasing due to a large number of people returning to the village after leaving to work elsewhere. Seaweed was considered to be the most important economic activity however a large percentage of the village were involved with agriculture as a supplementary activity. There were no medical facilities or trained medics.

Darawa: The population was thought to be slowly increasing due to younger marriages and ages of conception. Seaweed was the most important economic activity. There were no medical facilities or medics, people relying on traditional remedies. Major ailments required evacuation. There was no freshwater on the island locale for Darawa, some people collect rainwater. The village collectively bought and runs a generator.

Kasuwari: The population was thought to be increasing due to younger marriages and ages of conception. Fishing was the most important economic activity with seaweed increasing in importance. Most villagers were involved in agriculture as a supplementary activity. There were no medical facilities or medics. Health was thought to be improving due to awareness of the need for clean drinking water. There was a filtered public toilet and sanitation awareness programme.

La Ulua: The population was considered to be stable due to a successful family planning programme. Farming was perceived to be the most important economic activity but fishing and trade were also considered important. Seaweed used to be important but limited availability of space for cultivation has prevented further growth. Conflict exists between La Ulua and Sama Bahari for shallow subtidal space and boat access. La Ulua is the location of the major Kaledupan market and as such is a centre of trade for all villages. There are no medical facilities but one nurse, for serious ailments evacuation is required.

Pajam: The population is thought to be increasing due to a high birth rate. Farming is considered the most important economic activity, with fishing also important. There are no medical facilities; a nurse visits to immunise babies. Traditional remedies are relied upon with evacuation required for anything serious. Environmental issues were important to the *Kepala Desa* and numerous awareness posters (covering overfishing, destructive fishing, and mangrove deforestation) were displayed on numerous houses including that of the *Kepala Desa*. Park rangers were encouraged to run environmental awareness programmes in the village.

Sombano: The population was perceived to be increasing due to returning migrants. Seaweed was the most important economic activity. No medical facilities were available but a nurse visited once monthly. In 2006 a tap system was installed with the aim of providing one tap for every three houses from a rainwater collection tank.

Umala: The population was considered to be increasing due to outsiders moving to the village to marry and limited family planning awareness. Fishing was the most important economic activity. There was a clinic building but no staff or supplies, traditional medicine was relied on before visiting a hospital in Lagiwae village. The number of wells has increased in recent years which all villagers were said to be proud of.

Sama Bahari *(Bajo):* The population was perceived to be increasing rapidly due to a very high birth rate. Fishing was the most important economic activity with seaweed cultivation slowly growing in importance. Fish fences were not highly regarded as they were considered to restrict available fishing grounds and fishing mobility. No medical facilities or medics were available in the village. Dirty water and sanitation problems existed and there was a very low awareness of environmental health issues particularly with regard to clean drinking water. There have been some sanitation and clean water awareness programmes from various medics but they often use

Bahasa Indonesia and not the *Bajo* language hence people were unable to understand or mistrusting of the medics. The village had two generators for electricity provision.

Mantigola (Bajo): The population was perceived to be increasing due to people moving into the village from other *Bajo* villages in the Wakatobi. The invertebrate fishery (mainly sea cucumber) was thought to be the most important village economic activity. The village had no medical facilities or medics. Traditional healing methods were used with evacuation if necessary, although the traditional methods were preferred. Electricity supply was from a power station on the Kaledupa mainland.

7.4.3. Household survey

Data collected within the household survey was used to investigate the suitability of potential economic performance criteria. Target households for inclusion in the survey were selected according to their relative wealth as predicted by the primary household activity. Not all target occupations or activities were present in every village hence wealth categories according to primary activity/activity showed some variation between villages (table 7.7.).

Table 7.7. Target households for inclusion in a household survey of the Kaledupa sub-district of Wakatobi Marine National Park, Indonesia. Households were selected according to relative wealth as expected by primary household activity, and two *Bajo* villages were included. Intermediate wealth category sub-divided into upper, middle and lower (L, M, U).

Village wealth category	Village	Household wealth category		Target primary household activity
Wealthiest	Ambeua	Wealthiest		Civil service
		Intermediate	L	Seaweed cultivation
			M	Fishing
			U	Agriculture
		Poorest		No income*
	Buranga	Wealthiest		Trade
		Intermediate	L	Seaweed cultivation; fishing
			M	Seaweed cultivation
			U	Agriculture
		Poorest		No activity; seaweed tying; no income*
	Langge	Wealthiest		Civil service; work overseas
		Intermediate	L	Seaweed cultivation
			M	Fishing/seaweed
			U	Agriculture
		Poorest		Seaweed tying/local crafts/no income*
Intermediate	Darawa	Wealthiest		Middleman
		Intermediate	L	Seaweed cultivation
			M	Fishing; fishing/seaweed
			U	Agriculture; seaweed
		Poorest		No income*
	Kasuwari	Wealthiest		Civil service
		Intermediate	L	Seaweed cultivation
			M	Fishing
			U	Agriculture; agriculture/carpentry
		Poorest		No income*
	La Ulua	Wealthiest		Trade
		Intermediate	L	Seaweed cultivation
			M	Fishing
			U	Agriculture
		Poorest		No activity; no income*

* No income refers to subsistence farming or fishing for food, selling excess when available; no activity refers to households without any livelihoods.

Table 7.7. continued.

Village wealth category	Village	Household wealth category		Target primary household activity
Poorest	Pajam	Wealthiest		Civil service/Middleman
		Intermediate	L	Agriculture; fishing
			M	Fishing
			U	Agriculture
		Poorest		No income*
	Sombano	Wealthiest		Civil service/Middleman
		Intermediate	L	Seaweed cultivation
			M	Fishing
			U	Agriculture
		Poorest		No activity; no income*
	Umala	Wealthiest		Civil service; Middleman; Trade
		Intermediate	L	Seaweed cultivation
			M	Fishing
			U	Agriculture
		Poorest		No activity; no income*
Bajo	Sama Bahari	Wealthiest		Middleman
		Intermediate	L	Seaweed cultivation; fishing
			M	Fishing
			U	Fishing; seaweed
		Poorest		No income; mangrove*
	Mantigola	Wealthiest		Civil service; seaweed; fishing
		Intermediate	L	Seaweed cultivation; seaweed/fishing
			M	Fishing
			U	Agriculture; fishing; seaweed
		Poorest		Seaweed cultivation (occasional)

* No income refers to subsistence farming or fishing for food, selling excess when available; no activity refers to households without any livelihoods.

Analysis using ANOSIM confirmed significant differences in mean annual household income between the intermediate and wealthiest households (*global r 0.219; $p < 0.001$*); poorest and wealthiest households (*global r 0.642; $p < 0.001$*); and intermediate and poorest households (*global r 0.211; $p < 0.05$*).

Within the intermediate household wealth category there were significant differences in mean annual income between seaweed cultivation and agriculture (*global r 0.079; $p < 0.05$*) and between fishing and agriculture (*global r 0.157; $p < 0.05$*), but not between fishing and seaweed cultivation. Additionally there was no significant difference between mean household income of agriculturists and the poorest household category.

There was no significant difference in income categories between villages; hence data could be grouped according to household wealth category.

7.4.4. Testing of potential economic performance criteria

Indicator: household construction

Potential criteria: material construction of floor; walls; foundation; and roof; and number of sleeping rooms.

Initial regression analysis indicated that only floor material and number of sleeping rooms had a significant relationship with household income (table 7.8.). With removal of each non-significant criteria (starting with the least significant, wall material), overall significance of other indicators did not change. There were no significant correlations between wall material, roof material or foundation material and household income.

Table 7.8. Multiple regression analysis: household construction criteria against total annual household income for households within the Kaledupa sub-district of Wakatobi Marine National Park, Indonesia (n = 119).

Criterion		**t**	***p***
Floor material		3.30	0.001
Wall material		0.30	0.765
Roof material		-0.33	0.738
Foundation material		-1.54	0.127
Number of sleeping rooms		2.28	0.025
	R^2	F	*p*
Regression	0.31	10.30	< 0.001

There was a significant correlation between floor material and total annual household income ($r_s = 0.580; p < 0.001$); and between number of sleeping rooms and total annual household income ($r_s = 0.384; p < 0.001$). Combining the floor material and number of rooms score also gave a significant correlation ($r_s = 0.559; p < 0.001$).

Indicator: household structure

Potential criteria: number of men; number of women; number of children; number of adults; total number of household occupants.

Multiple regression analysis was carried out using number of adults and number of children only, due to the direct relationship between some other potential criteria (i.e. total household occupants and constituents and number of adults and constituents). A Spearman rank-order correlation confirmed no significant relationship between other single household structure criteria and household income. There was no significant relationship between number of children and household income; however number of adults had a significant positive relationship with household income (table 7.9.).

Table 7.9. Multiple regression analysis: household structure criteria against total annual household income for households within the Kaledupa sub-district of Wakatobi Marine National Park, Indonesia (n = 119).

Criterion		**t**	***p***
Number of adults		2.49	0.014
Number of children		-1.18	0.239
	R^2	F	*p*
Regression	0.06	3.82	0.025

There was a significant correlation between number of adults and total annual household income ($r_s = 0.246; p < 0.05$).

Indicator: education

Potential criteria: educational attainment of household head.

As this indicator consisted of a single measurable criterion a Spearman rank-order correlation was carried out directly. There was a highly significant correlation between the educational attainment of the household head and the total annual household income ($r_s = 0.547; p < 0.001$).

Indicator: material lifestyle

Potential criteria: household assets

Electricity was included within the household assets criteria as an internal asset and something that would directly improve household material lifestyle (allowing for ownership and use of electrical items).

Fishing equipment was removed as this was entirely biased towards fishing households and was not representative of the whole population.

Material lifestyle consisted of a number of indicators but with a simple 1 or 0 outcome. Hence assets were combined to give a total household assets score and a Spearman rank-order correlation was carried out directly. There was a highly significant correlation between the household asset score and the total annual household income ($r_s = 0.621; p < 0.001$).

7.4.5. Testing of household economic performance score

There was a highly significant correlation between the final household economic performance (EP) score, combining all indicator scores, and total annual household income ($r_s = 0.638; p < 0.001$).

Households in the wealthiest category had the highest mean EP score of 17.6 ± 1.02; households in the intermediate category a mean of 10.9 ± 0.50; and those in the poorest category the lowest mean score of 4.35 ±0.44 (figure 7.1.).

Analysis using a one way ANOSIM confirmed significant differences in mean EP score between household wealth categories (*global r 0.458; p < 0.001*). Pairwise tests indicated highly significant differences between all three wealth categories as follows: intermediate and

wealthiest (*global r 0.254; p < 0.001*); intermediate and poorest (*global r 0.585; p < 0.001*); and poorest and wealthiest households (*global r 0.863; p < 0.001*).

There was again no significant difference in wealth categories between villages or between the two *Kecamaten*.

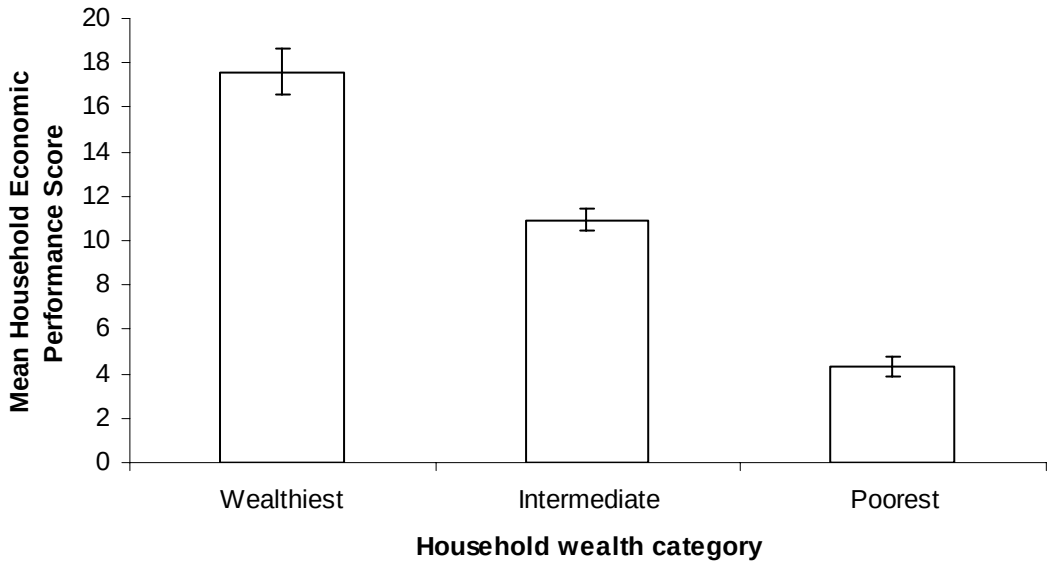

Figure 7.1. Mean Economic Performance Score for households within three wealth categories as defined by assumed household income based on primary household activity. Households from 11 villages in the Kaledupa sub-district of Wakatobi Marine national Park, Indonesia (mean ± SE) (n = 119).

ANOSIM pairwise analysis on a breakdown of the intermediate wealth category into its constituent target occupations and included as separate categories with wealthiest and poorest outlined no significant difference in mean EP score between the three intermediate categories, but highly significant differences again between all other categories (table 7.10.).

Table 7.10. ANOSIM pairwise comparisons between mean Economic Performance Scores for households within different wealth categories in 11 villages in the Kaledupa sub-district of Wakatobi Marine National Park, Indonesia. ** indicates $p < 0.001$. * indicates $p < 0.05$.

Household wealth category	Wealthiest	Upper intermediate	Middle intermediate	Lower intermediate	Poorest
Wealthiest	-	*	**	**	**
Upper intermediate		-			**
Middle intermediate			-		**
Lower intermediate				-	**
Poorest					-

Data from the 2005 household survey also showed a significant correlation between total annual household income and a modified household EP score for all Kaledupan villages ($r_s = 0.463; p < 0.001$). EP score was modified as it did not include the educational attainment of the household head (education was included in the survey but the respondents education was noted and the respondent was not in every case the head of the household). Data from the 2005 household survey also showed a significant correlation for the 11 villages included in the 2006 household survey ($r_s = 0.453; p < 0.001$).

Village level analysis again gave the wealthiest category the highest mean modified EP score (10.18 ± 0.38) and the poorest category the lowest mean modified EP category (7.63 ± 0.55). The intermediate category had a mean modified EP score of 8.10 ± 0.36 and the Bajo villages a mean modified EP score of 8.17 ± 0.54 (figure 7.2.).

Figure 7.2. Mean Modified Economic Performance Score for 11 villages within three wealth categories as defined local wealth ranking activities and mean total annual village income. Households from the Kaledupa sub-district of Wakatobi Marine national Park, Indonesia (mean ± SE) (n = 234).

Analysis using a one way ANOSIM confirmed significant differences in mean EP score between village wealth categories (*global r 0.077; p < 0.001*). Pairwise tests indicated significant differences between the wealthiest villages and *Bajo* villages (*global r 0.083; p < 0.05*); the wealthiest and poorest villages (*global r 0.166; p < 0.001*); and the wealthiest and intermediate villages. Differences in modified EP score were not significant between *Bajo* and poorest villages; *Bajo* and intermediate villages; or intermediate and poorest villages.

Differences in mean modified EP score were also apparent between individual villages; Ambeua again had the highest score and Pajam the lowest. Those villages in the poorest or *Bajo* categories had significantly higher variation than the other two categories (figure 7.3.).

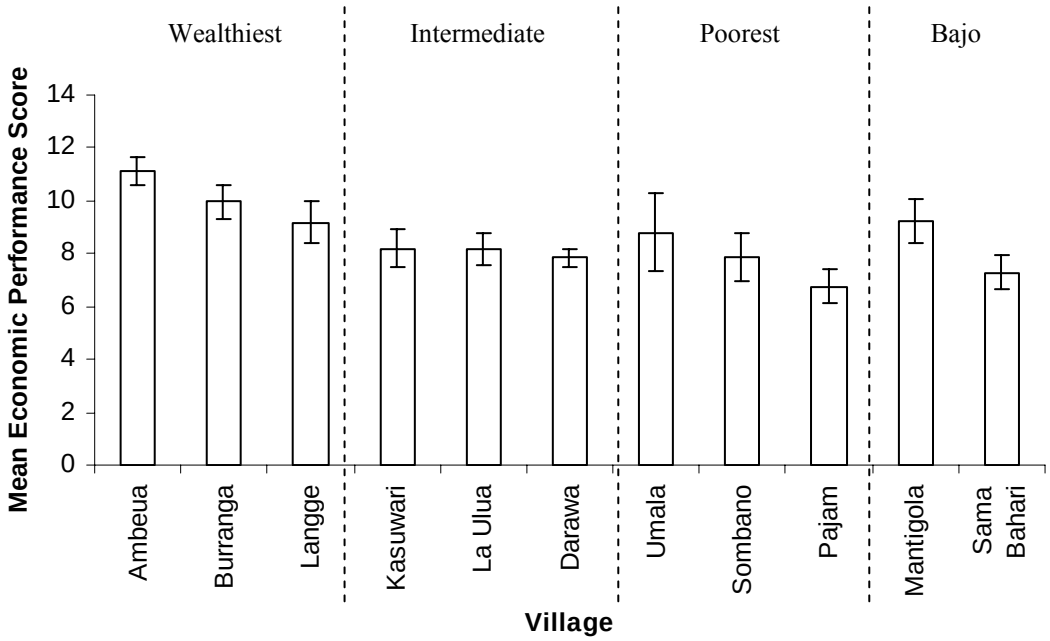

Figure 7.3. Mean Economic Performance Score for 11 villages in the Kaledupa sub-district of Wakatobi Marine national Park, Indonesia (mean ± SE) (n = 234). Village wealth categories shown above and categories separated by dashed line.

Analysis of mean village modified EP score using a one way ANOSIM confirmed significant differences in modified EP score between villages (*global r 0.073; p < 0.001*). Pairwise tests indicated that Ambeua had a significantly higher modified EP score than any other village except Buranga. All pairwise comparisons are shown in table 7.11.

Table 7.11. ANOSIM pairwise comparisons between mean modified Economic Performance Scores for 11 villages in the Kaledupa sub-district of Wakatobi Marine National Park, Indonesia. ** indicates $p < 0.001$. * indicates $p < 0.05$.

Village	Ambeua	Buranga	Langge	Darawa	Kasuwari	La Ulua	Pajam	Sombano	Umala	Mantigola	Sama Bahari
Ambeua	-		*	**	**	**	**	**	*	*	**
Buranga		-		*			*		*		*
Langge			-	*							
Darawa				-			**	*	**		
Kasuwari					-						
La Ulua						-					
Pajam							-				
Sombano								-			
Umala									-		
Mantigola										-	
Sama Bahari											-

Using household survey data from 2005 (randomly selected 10% of households) there was also a significant difference in the mean modified EP scores between the two *Kecamaten* (Kaledupa and Kaledupa Selatan) ($W = 52651.5$; $p < 0.001$). Mean (± SE) EP score for Kaledupa was 9.09 ± 0.21 (n = 234) and 8.11 ± 0.24 (n = 180) for Kaledupa Selatan.

7.4.6. Identification of economic benchmarks

A summary of all indicator scores and individual economic performance criteria and sub-criteria scores and percentage distributions throughout household wealth categories are given in table 7.12.

Table 7.12. Summary of indicator scores and individual economic performance criteria and sub-criteria scores and percentage distributions for 11 villages within the Kaledupa sub-district of Wakatobi Marine National Park, Indonesia (wealthiest: n = 28; intermediate n = 70; poorest n = 20).

Indicator	Criteria	Sub-criteria	Wealthiest	Intermediate	Poorest	Total sample
Household construction	Main material of floor (percentage distribution):					
	Earth		0.0	0.0	10.0	1.7
	Bamboo		14.3	35.7	85.0	39.0
	Bamboo and wood		0.0	10.0	0.0	5.9
	Wood		53.6	44.3	5.0	39.8
	Concrete and wood		0.0	1.4	0.0	0.8
	Concrete		17.9	7.1	0.0	8.5
	Tile		14.3	1.4	0.0	4.2
	No. sleeping rooms (mean ± SE)		2.82 ±0.23	1.97 ±0.10	1.05 ±0.14	
Score (mean ± SE)			6.32 ± 0.44	4.36 ± 0.21	2.05 ± 0.20	
Household structure	Number of adults (mean ± SE)		2.75 ± 0.21	2.73 ± 0.15	1.65 ± 0.22	-
Material lifestyle	Household assets (percentage distribution)	Electricity	92.9	74.3	30.0	71.2
		Radio	53.6	7.1	0.0	16.9
		CD	75.0	37.1	0.0	39.8
		Generator	25.0	4.3	0.0	8.5
		TV	89.3	54.3	0.0	53.4
		Mobile	57.1	8.6	0.0	18.6
		Fridge	50.0	8.6	0.0	16.9
		Elec. Fan	60.7	8.6	0.0	19.5
		Canoe	28.6	52.9	25.0	42.4
		Motorboat	21.4	32.9	25.0	28.8
		Motorbike	67.9	27.1	0.0	32.2
		Car/truck	10.7	0.0	0.0	2.5
Score (mean ± SE)			6.32 ± 0.48	3.16 ± 0.26	0.55 ± 0.17	
Education	Educational attainment of household head (mean ± SE)		3.5 ± 0.33	1.8 ± 0.16	0.35 ± 0.21	
Total annual Household income (US$) (mean ± SE)			2290 ± 359	617.9 ± 84.4	112 ± 25.4	
Mean economic performance score (± SE)			**18.89 ± 1.05**	**12.04 ± 0.55**	**4.60 ± 0.50**	

The poorest households had only electricity, canoes and motorboats as material assets. 30% of the poorest households had electricity compared to 92.9% and 74.3% of the wealthiest and intermediate households respectively. A small percentage of the wealthiest households owned cars, no intermediate or poor households owned cars. A greater percentage of wealthy households possessed every asset apart from canoes and motorboats both of which a greater percentage of intermediate households owned.

In terms of household construction only the poorest households had no flooring material (i.e. bare earth). The greatest percentage of poorest households had bamboo floors. The greatest percentage of both intermediate and wealthy households had wooden floors.

It can be assumed with a high level of confidence that currently the highest economic status for an individual household would be indicated by an EP score of 16.79-20.99 (mean ± 2 SE); the intermediate households would have a score of 10.94-13.14 (mean ± 2 SE) and the poorest households a score of 3.6-5.6 (mean ± 2 SE).

At the village level, the wealthiest villages (those with the highest economic status) will be those villages having the highest mean EP score according to a random sampling method (as in the 2005 household survey). Additional considerations at the village level are the presence of village amenities, facilities and roads. All data outlines Ambeua as the village with the highest economic status, which is reflected by mean household income, mean modified EP score, local wealth ranking, and the presence of schools and roads, and access to freshwater. The village with the lowest economic status was Pajam, reflected by mean annual household income but amenities are severely lacking in both *Bajo* villages making their economic status lower, even though their incomes may be relatively high.

7.5. Discussion

It is often the case (as in the Kaledupa sub-district) that there is limited availability of resources to support and provide the research and monitoring required to achieve the outcomes of protected area management. This is generally the result of scarce local government and NGO (Non-government organisations) resources in terms of both time and money. Hence some kind of rapid economic appraisal is required (Fürst *et al*. 2000) and this was the basis for the selection of potential economic performance criteria to monitor and measure relative economic status on the local scale. Additionally, potential indicators were initially identified based on local perceptions of wealth as outlined in the wealth ranking exercises (chapter 6).

Indicators or indicator dependent scores to rate a specific aspect of management provide a way to measure changes over time and space where perhaps changes in a specific attribute are not directly measurable or are very difficult to measure (Margoluis & Salafsky 1998, Pomeroy *et al*. 2004a). Income, which is not the same as but is well correlated with wealth (Zinn *et al*. 1992), can be extremely difficult and time consuming to measure with any accuracy (Ferguson *et al*. 2002). Responses require validation and triangulation which can be extremely costly in terms of time and money. An alternative as presented herein is to ask respondents a series of questions that are easily understandable, inoffensive and unambiguous. Wealth ranking can be then used to verify indicated wealth or economic status (see chapter 6).

A key factor when identifying performance indicators is that the criteria used reflect both positive and negative changes in economic status and as such they can be used to monitor economic performance through management initiatives. The criteria must be sensitive enough to detect changes in the short term, for example annually. The criteria outlined here were chosen with this in mind.

7.5.1. Initial feasibility testing of potential indicators

Before indicators and criteria were analysed and statistically tested for their effectiveness and reliability, a number of potential criteria, such as food security, livestock accounting and land ownership, were rejected due to non-feasibility within the Kaledupa sub-district. These criteria were deemed inappropriate as they required culturally insensitive questioning, or they were extremely time costly and difficult to measure, or impossible to measure, hence would not be

adequate parameters to use within any longer-term monitoring strategies utilising locally available resources.

Twelve household asset sub-criteria were selected to represent the material lifestyle indicator and generate a material lifestyle score. These sub-criteria included eleven household assets and electricity (an amenity but within the household boundaries). A large number of assets were included to reduce the requirement for item weighting or scaling in the field (Segnestam 2002).

The aggregation of indicators into a single index gives clear messages and an overview of a particular situation (Segnestam 2002, Parris & Kates 2003) hence one of the objectives of the current work was to be able to provide an overall economic score for households and villages that was easily comparable. The aggregation of individual indicators can however become ambiguous when items with differing units are combined and requires weighting of data (Zinn *et al*. 1992, Segnestam 2002). The use of a series of separate indicators (rather than a single index) allows for flexibility within the aspects included for management purposes. This flexibility is related to which indicators to include within any given management framework (or desired outcomes) to allow an entirely relevant picture of the economic and or ecological situation. This would allow managers to be presented with an outline of the key problem areas and those areas perhaps requiring some investment of time or money. Also on the national scale a series comprised of individual separable scores allows certain indicators be included or used in wider level comparisons, such as nationally where some data for other areas may exist (Segnestam 2002). Hence the current work incorporated both.

The level of educational attainment of the household head was also included as a potential economic performance indicator and was weighted more heavily towards high school and university attendance as fees had to be paid for these and often required households' ability to save money.

The variables selected for testing were considered to be simple to measure, culturally appropriate, and timely, they also fully complied with local rules, norms and customs.

7.5.2. Village economic status

Population density change can be an important indicator of economic status as it has implications for overcrowding and limitation of access to available amenities; however it can also imply economic growth within an area depending on the specific context. Where the *Bajo* villages are

most densely populated, this may be due to a highly increased birth rate with limited increase in local workers or economic input. In Ambeua on the other hand, as one of the most densely populated *Pulo* villages, increased population density might be considered an indicator of economic growth as people may migrate to this village for available work. This means that population density or change *per se* may not be a good indicator of economic performance.

In some villages the population was considered to be increasing because of the return of previous migrants and the influx of outsiders through marriage. In this case the population increase could be indicative of economic growth (and potentially improvement) (Marquette *et al*. 2002) as people may be returning because work is available and add to the work force. However, it was considered within some villages that population increase was due to an uncontrolled birth rate within the village and marriages and childbirth occurring at an earlier age. In these cases population growth may not indicate economic improvement and a population rate increasing and placing demand on natural and manufactured resources (and access to freshwater) may result in a highly negative impact on the village economy and is often linked with poverty (Shyamsundar 2002).

It is important to note that the perceptions of the *Kepala Desa's* (village head) did not routinely follow the perceptions of other local people or village records in terms of overall village economic status (or description). This could be due to an overenthusiastic sense of pride that each may have in their own village.

Village level economic information needs only to be qualitative to allow the identification of target areas to improve the village economic status (and the well-being of villagers). Simple quantitative indicators are useful such as the number of schools, wells, or the presence of a village electricity supply so that areas for improvement, to move villages perhaps into the next wealth category, can be identified. Livelihood diversity could also be a good indicator of village ability to cope with change and to help focus efforts for alternative incomes with an improved economic return.

7.5.3. Household survey

Individual wealth categories were not significantly different between villages, which confirm the selection of target households based on primary household income as an accurate way to assume relative wealth within the Kaledupan community. Villages differed significantly in their total

mean household incomes (chapter 4) due to varying proportions of households within each of the wealth categories and the random sampling method outlined this trend. Differences in economic performance scores and incomes within the same wealth categories between villages were not expected.

An additional reason that it is important to find some measure of household wealth is because if household wealth is modest, there is a tendency towards limited participation in the management process (Zinn *et al*. 1992), which in itself implies the additional requirement for outreach activities to attain successful management outcomes. This was apparent in Ambeua in particular where within the 2006 economic survey (targeting the poorest households) the poorest households withheld income information, perhaps due to a feeling of inadequacy within a relatively wealthy village, the highest ranking in the region in terms of wealth (as perceived by local people and confirmed by 2005 household survey income data).

7.5.4. Economic performance criteria

When attempting to gain useful information from local people, questions had to be highly specific to avoid confusion and inaccurate or variable answers due to variable interpretations. For example in the initial household survey one of the questions asked was '*how many rooms are there in your house?*' Which led to some people assuming this as total rooms and others as sleeping rooms, hence the use of the word 'sleeping' within the question led to higher precision (and simplicity of the question with no further explanation required), in the 2006 household survey.

Household structure (in terms of number of adults) was considered to be an appropriate indicator of household economic status as there was a significant correlation of this indicator with household income. The association however, was not as strong as for other indicators. This could be due to the fact that in many wealthy households there may be a single key earner (perhaps a civil servant) whose income is one of the highest in the sub-district, but because of this they support a number of family members of working age but who do not need to work. In contrast, in poorer households, a greater number of adults means a greater number of workers in most cases which clearly influences total household income positively.

Household economic well-being has been estimated in the past based on analysis of material possessions with ranges of income from specific activities estimated from key informant

interviews (Pollnac & Crawford 2000). This work has taken a new approach and collected detailed household income data which was used to identify household and village-level economic indicators which could be used to routinely monitor local economic status in a time and cost efficient manner.

For time series data, perceived quality of life could be an additional indicator of economic change within villages and is important to monitor how people perceive their economic status to be changing as a result of any management actions or inactions. Perception data is simple and quick to collect with a series of simplified Likert-scale type questions (see appendices 3 and 5).

7.5.5. Economic performance score

The highest household economic status was indicated by an EP score of 16.79-20.99; the intermediate households had a score of 10.94-13.14 and the poorest households a score of 3.6-5.6 (all ± 2 SE). Other households could be identified by varying EP scores between these benchmarks according to the economic performance criteria outlined above.

At the village level, the wealthiest villages (those with the highest economic status) are those villages having the highest mean EP score according to a random sampling method (as in the 2005 household survey). Additional considerations at the village level are the presence of village amenities, facilities and roads. All data outlines Ambeua as the village with the highest economic status, which is reflected by mean household income, mean modified EP score, local wealth ranking, and the presence of schools and roads, and access to freshwater. The village with the lowest economic status was Pajam, reflected by mean annual household income, mean modified EP score, and wealth ranking. Amenities were severely lacking in both *Bajo* villages making their economic status lower, even though their incomes may be relatively high.

For *Bajo* villages, it is most likely that people are accustomed to having to travel to collect freshwater (traditionally living as sea nomads), and their materialistic lifestyle in terms of household structural quality may not be important to many *Bajo* people (Saat 2003). However, household possessions and assets are becoming increasingly important with people buying televisions before perhaps replacing roofs because they have the income to do so. The total EP score will reflect this and as such provides an adequate method for comparison of *Bajo* households and villages as well as *Pulo* households and villages.

The EP score was significantly different between the two *Kecamaten*, Kaledupa and Kaledupa *Selatan*, indicating an improved economic status within the Kaledupa *Kecamaten*. Differences at this level are important locally as there is general competition between *Kecamatens* which could lead to an increased sense of imperative for the lagging *Kecamaten* to improve their EP score. However, the use of an inclusive monitoring programme must ensure that improvement in the short term is not to the detriment of the environment in the short or long term.

The economic performance score is capable of reflecting changes in economic status in a multidirectional sense i.e. both positive and negative change will be reflected using the final score. At the household level, the household assets will best reflect this in the short term as improved economic status will result in the ability to purchase more items; a worsening economic status will be directly reflected by a decrease in household assets in the short term. Electricity was considered locally to be an expendable amenity and if households could no longer afford it they would disconnect their sources and remove their meters, rendering electrical items useless, in which case they could be omitted from the score. Over time if conditions improved the electricity could be reconnected and additional assets purchased, if the situation worsened further, households would sell items such as motorbikes and redundant electrical equipment.

Clearly the education of the household head would not reflect a worsening economic situation directly over time but it provides an excellent spatial comparison tool and at the village level over time it could be expected that inevitable economic development should result in improved educational attainment of local people. If the score does not increase it could also be considered that there is a negative impact on the economy reflected by stagnation and no growth in terms of improved wealth or well-being.

Although it might be expected that a worsening status would result in the loss of personal or family belongings, assets or amenities this may not always be the case. In a thriving economy comprising high or at least positive economic growth, limited or no accruing of assets must be considered to be a relative loss of economic status. This is particularly true within the SE Asian culture of exponential growth in demand for the latest in technological innovation.

With economic development and improvement there is economic growth which could be indicated by an increase in the number of new houses within a village and potentially population expansion. In this sense the number of sleeping rooms in these houses over the longer time-scale

would indicate an improvement in economic performance (in a household survey carried out using a random sampling technique). This would be a direct measure therefore of economic performance. The same is true for the educational attainment of the household head. Household assets represent a more sensitive indicator in the short term, but are also suitable for long term monitoring. Criteria must have the ability to monitor both spatial and temporal changes to be effective as a management tool.

As a management tool, the score could be used to ensure that economic status is not impacted by inappropriate management actions. In conjunction with data outlined in this work (chapters 4, 5, and 6) any proposed management actions, such as closed areas, could be mitigated for in the appropriate places with appropriate measures before the management action is applied. Economic status and performance over time could then be monitored using the score.

7.5.6. Economic benchmarks

Research has provided economic benchmarks indicating what is required for a household or village to be placed in a wealthy, intermediate or poor wealth category. The scale could be expanded and graded further to give an extended series of categories in between each major category and provide simple targets for villages or households to reach the next improved category based on EP score and specific EP criteria. At the village level, if EP does not change and economic status remains static, background data must be considered on livelihood diversity, natural resource use patterns and alternative sources of income. Additionally villages should try to invest in amenities that may be limiting the economy such as limited freshwater access or electricity supply.

The poorest wealth category provides a benchmark of the current lowest EP scores. This benchmark should be used to ensure no villages or households dip below this score and this category should perhaps be targeted by local government for improvement based on data provided herein.

An increase in the current highest score from the wealthiest category would indicate further economic improvement and development in the area as a whole, and it should be imperative that the poorer fractions of the community are also improving correspondingly. In terms of natural resource management and conservation this is particularly important for those people previously overexploiting natural resources, so that there is no need for reversion to a detrimental activity.

For the poorest fractions of the community, alternatives should be made available that are sustainable from the outset.

Criteria also show what specific villages or households (or groups) need, in term of economic improvement to move to the next level (of development); this information can also be used by local government to focus actions/funds (if available) on specific issues or villages most in need of support.

Scale construction with clear benchmarks is required to facilitate meaningful comparisons of households and villages over time with changes clearly directional. Rates of change would also be useful and measurable using the proposed criteria. The use of a simple economic performance score can be translated into a rate of change if monitored regularly to provide a picture of economic development throughout the management unit.

7.5.7. Frameworks

Clear frameworks are required to organise indicators in a way that managers, policy makers and local people can understand, particularly where multiple aspects are concerned such as ecology (or ecosystem quality) and local economic status. Information must be presented in a way that reflects changes within each or the current status of each as impacted by the other.

Where communities are highly dependent on natural resources changing economic status could directly reflect changes in the natural resource base (positive or negative). It has been suggested (Simonit & Perrings 2005) that market prices are inadequate to reflect changes, however, economic status if used in conjunction with ecological data collection may be an appropriate indicator.

To combine economic and ecological indicator data a framework is useful to structure the indicators in a way that facilitates interpretation and ensure all aspects of a given management issue are taken into account (Segnestam 2002, Bowen & Riley 2003). Various frameworks exist with highly variable structures from specific project based (Segnestam 2002) to pressure-state-response type frameworks (OECD 1994, 2000, Bowen & Riley 2003). Alternatively simple frameworks identifying indicators based on major areas or themes related to a specific project can be used (Winograd *et al*. 2000).

7.6. Conclusions

The methodology presented herein could be applied to any area where the economic status of local human communities requires measurement and monitoring. It is important that these types of measures and indicators are situation specific. Their development requires an understanding of local resource use patterns, livelihoods, wealth, and status, as presented within the current work, to be able to provide meaningful results that can be applied and understood by all stakeholders.

Indicators are specific and those developed outside of a reference system have little relevance and often fail (Garcia *et al*. 1999) therefore economic indicators must be context and site specific taking into account the complexities of the systems and communities involved.

The indicators selected for the Kaledupa sub-district would adequately reflect short and long-term changes in economic status or well being, and outline important spatial variations. The indicators reflect economic well-being and well-being changes over time indicative of a changing economic status. The economic performance of villages, the two *Kecamaten*, and of the sub-district as a whole can be monitored this way spatially and temporally. Specifically the economic performance score, based on the series of economic performance criteria as outlined for specific indicators, could be used in the short or long term to identify whether management intervention has a positive or negative impact on economic status.

The participation of local people is essential for indicators to be useful (Segnestam 2002), hence indicators were developed based on local wealth perceptions, however indicator results must also be easily understandable by local people impacting the economic and ecological environment on a daily basis. Hence frameworks are a useful tool to disseminate findings. The identified criteria should be used alongside already accepted methods of ecological assessment, which also requires local context and understanding, so that the whole ecosystem inclusive of the human fraction is sustainable and protected. Economic performance information could also be put into context with resource prices for which may be an indicator of resource scarcity (Kgathi *et al* 2005).

At the national level local economic performance (and economic status) can feed into the major area of economic assessment under economic structure to contribute to the monitoring of sustainable development (UNDSD 2001).

Chapter 8: General Discussion

In order to understand and potentially mitigate for the impacts of global environmental change we need to understand the impact of such changes on systems in which humans play an important role (Dasgupta 2001, Barbier 2005). We need to monitor both ecological and economic changes, the impacts of environmental change on ecosystems and the impacts of ecosystem change on dependent human communities. Integration of ecological, social and economic disciplines and inclusion of the human element in all monitoring and management activities is essential for environmental, ecological and socioeconomic sustainability.

One of the major failings of past management strategies is lack of local compliance (Elliott *et al*. 2001), mainly due to the actual, perceived, or even just expected, economic losses to those communities utilising marine natural resources for livelihoods and subsistence. So a key role of management should be to improve the economic status of local people. Monitoring of economic status should be included, in addition to biological monitoring, to ensure no losses occur due to economically inappropriate management strategies. There needs to be a focus on the interactions between economic and ecological systems and links between changes in each must be made clear to local communities through appropriate feedback mechanisms which they can understand.

However, it can be difficult to link local and regional ecological change with the behaviours and utilisation patterns of human dependants (Haber *et al*. 2006). Areas where the link can still be clear include small island communities with a high dependence on natural resources for food, income and raw materials.

This work has outlined the complexities that must be understood for any chance of a successful management outcome because understanding the human aspects of any natural resource use is essential for effective management, particularly community-based coastal resource management (Pollnac & Crawford 2000). Additionally as local people will inherently determine the level of direct impacts on natural resources they must be considered as part of the ecosystem and their aspirations for improved living standards without detriment to the environment should be a target of management. An understanding of natural resource use patterns and quantification of financial dependence on natural resources in specific regions are required to avoid economically inappropriate management actions that as a result will ultimately fail. Detailed information is required if managers are to demonstrate the potential effectiveness, i.e. the benefits and impacts

of marine and coastal resource management (Pollnac & Crawford 2000). Additionally, shared experiences and knowledge transfer from village to village may be important as island communities are heterogeneous in their approaches to management therefore shared experiences could result in the identification of best practices.

The aims of the current project have been successfully achieved with the following five major outcomes:

1) An understanding of the natural resource use patterns of the Kaledupa sub-district has been gained and allowed a description of some of the major complexities that must be understood for the chance of management success. The extent of direct dependence on natural resources has been quantified and is high.

2) The direct financial value of marine and coastal based incomes has been estimated and compared with other income sources to outline the major economic significance of these resources. Alternative potentially sustainable livelihoods have been identified.

3) Livelihood diversity patterns have been described and the complex nature of these patterns discussed.

4) Local perceptions of relative wealth were elicited to assist in the development of appropriate economic performance criteria that would be recognisable at the local level allowing simple understandable feedback.

5) Key economic criteria that could be used to evaluate the relative economic performance of natural resource management programmes in the area have been identified and trialled.

Outcomes have resulted in the development of cross-transferable methods and techniques that could be used to further the development of other natural resource management strategies. A baseline for further research within the Kaledupa sub-district has also been provided and further temporal detail could be incorporated in the future in a simple, time efficient and cost efficient manner.

8.1. The Kaledupa case study

The example of the Kaledupa sub-district can be used to outline the complexities that are involved in natural resource use and management, particularly where livelihoods are concerned, and it has highlighted the types of information that can be collected. Various data acquisition methods were used to develop an understanding of the whole sub-district economy which is a new approach. The large sample size included and the all encompassing survey also represents a novel approach which would allow the best strategic management measures to be identified and applied.

The study indicated several essential factors to consider when attempting management of natural resources depended upon by local communities with inter-village cultural differences and variable natural resource use patterns. It highlights the need to understand specific use patterns, and in particular varying dependence levels, for a successful management outcome.

This research has provided a method of measurement and monitoring of economic status and change that could be coupled with ecosystem health measurement and monitoring and used within specific frameworks to develop and implement management strategies that would have a real chance of success if all of this information is considered.

8.2. Natural resource use patterns and dependence

An understanding of natural resource use patterns and the varying levels of dependence within any given management unit is essential to design successful management strategies. This research outlined that even within a relatively small geographical area, and an area that could be considered as a management unit, there are extreme variations between villages and cultures in terms of the resource use patterns and levels of dependence of villages and individual households. When these patterns are understood, particular management actions can be targeted at specific cultures or villages for improved chances of success. It is vital that livelihoods are not negatively impacted without alternatives being provided, both for the well-being of dependent communities and ultimately the sustainability of the natural resource in use.

This study outlined the extremely high dependence on marine and coastal resources for food, livelihoods, and raw materials. So it is vital that management initiatives are introduced that are acceptable both economically to support local human populations, and ecologically. In addition

to the direct financial value of marine and coastal resources, other indirect and non-use values exist such as biological support systems or storm protection functions, which have not been considered, but which would dramatically increase the overall value of these natural resources (Costanza *et al*. 1997b). Therefore the financial values quoted herein can be considered minimum estimates. But for local dependent households it is income and well-being that are important so direct financial values are most meaningful to those people utilising and impacting (or having the potential to impact) ecosystems and management success on a daily basis. People are prepared to accept alternative sources of income and raw materials if the options presented are socially, culturally and financially feasible within an acceptable timeframe. Alternative, not additional livelihoods are required.

The use of fish fences within the Kaledupa sub-district is an example of extreme overexploitation (May 2003), this may be a case of Malthusian overfishing (Roberts 1995, McManus 1997, Marquette *et al*. 2002) where the population is overfishing to meet their immediate protein requirements (Markert 2005). Coblentz (1997) suggested that subsistence consumption of fish in some areas may be unsustainable implying that the growth in populations is outpacing that of food availability. In the Kaledupa sub-district where fish is currently a vital source of protein (the only source for the majority of the human population), alternative sources of protein must also be sourced to decrease the local demand and local market for fish.

8.3. Direct financial value of marine resource related incomes

Natural resource utilisation accounted for the largest percentage of the total annual net Kaledupan income, most of which was generated directly from the exploitation of marine and coastal resources. This illustrates the significance of the natural environment and specifically the importance of marine resources to this small island community.

Seaweed cultivation made up the greatest percentage of total income, with a large number of seaweed cultivators previously fishing for income. This could be due to improved livelihoods being available from seaweed or the need to move away from fishing as stocks decrease. Seaweed farming represents an alternative livelihood still dependent on the quality of the natural environment, but with reduced environmental impacts, however, detailed information on the impacts remain limited. The example shows that local people can accept alternative livelihoods that are financially viable and allow the continuation of a certain preferred lifestyle.

An additional potentially important alternative income source comes from tourism, which is currently minimal in the area, but for which there is a financial drive from regional government to increase its development. Regional and local governments have been looking for direct ways to enhance regional economies and tourism is high on their agenda. Intact, pristine reefs are essential for tourism development, and the net economic benefits from tourism are probably larger than any other direct use value, but the long term benefits of tourism are dependant on the level of tourism that can be maintained without resulting in environmental degradation (Birkeland 1997)**.** Therefore tourism must be carefully managed and monitored to ensure environmental sustainability.

8.4. Livelihood diversity

Various livelihood strategies exist within the study area. These include diversification for increased wealth as well as diversification to improve livelihood security. Specialisation is also apparent in some villages which is most likely due to persistent villager skills or resource availability. It is important to understand what, in terms of existing livelihood strategies, communities have, and use the existing resources and structures to help strengthen internal coping strategies (Moser 1998).

Within the study area, livelihood diversity patterns are highly complex. Variability exists between cultures, villages within the same culture, primary activity groups, high marine resource dependent groups and wealth groups. Understanding these complexities is essential for a successful management outcome maintaining livelihoods and ecosystems in the future and for developing new sustainable livelihoods strategies. Understanding diversity in terms of the reasons for exploitation will help to identify strategies to reduce primary income generation dependence on overexploited marine resources.

Village ability to adapt to environmental change may be reflected by livelihood strategies and their economic capacity to deal with the change (Wainger & Price 2004, Wainger *et al*. 2004). So the identification of livelihood strategies is an important step, as is the identification of possible gaps in village or household livelihood strategies, or in the market, that might allow for the introduction or development of alternative activities.

8.5. Wealth and wealth perceptions

Understanding local perceptions of wealth was essential to identify potential economic performance criteria important to and easily recognisable by local people. It is important that the outcomes of management actions are directly identified by local communities and that local perception reflects real situations, the understanding and presentation of feedback is vital.

Wealth strata within the study area were relatively simple to identify using the wealth ranking method. The wealth ranking method represented an accurate, efficient and simple way to identify households according to relative wealth. The method was closely matched to actual income data for the households being ranked which implies that local people have an acute awareness of wealth and economic status. This again highlights the need to link ecosystem health to economic status as this is clearly a way to gain the attention of local people and is something that must be translated throughout natural resource management strategies worldwide.

8.6. Development of economic performance criteria

Income data can often be questionable (Ferguson *et al*. 2002), reliable income data being difficulty and extremely timely to obtain, therefore indicators of income as a proxy for wealth are required to measure and monitor economic status in a time and cost efficient manner.

Income data was used within the current study to identify key economic criteria that could be used to evaluate the relative economic performance of natural resource management programmes. The study showed however that wealth ranking could also be used reliably as an indicator of relative wealth or income (verified in this study by the income data), which highlights it a very useful tool for future research and management applications.

The methodology used here could be applied on a wider scale or in alternative areas where there is high dependence on natural resources. The participation of local people is essential for indicators to be useful (Segnestam 2002), and they must be easily interpretable by local people, resource managers and policy makers. Additionally, economic performance measures could also feed into national statistics to contribute to the monitoring of sustainable development for nations (UNDSD 2001).

It is important to be aware that socioeconomic differences and competitive forces between communities can put strong pressure on local officials in a way that can shape public policy

(Lindblad 2006), therefore the economic status of villages is also important to understand from this viewpoint.

8.7. Concluding remarks

Worldwide natural resources are suffering from overexploitation and unsustainable use. As populations increase, demand for resources also increases, along with the associated negative anthropogenic impacts and the resources that are required for life will continue to diminish. Coral reefs are valuable resources that must be carefully managed to sustain economic development (Berg *et al*. 1998). Management of the world's natural resources is required and management plans must account for the protection of the human element which is inherently a part of the ecosystem.

As many of the world's poorest people are found living within or adjacent to the world's richest ecosystems it is no surprise that people exploit the resources available them to improve their own quality of life and economic status, and in many cases just to feed their families. Hence ways must be found to allow these communities to continue to develop and use natural resources to their advantage but in a sustainable manner, as per the United Nations definition of sustainable development (Brundtland 1987). However, resources are already in decline, world fisheries are diminishing, and in tropical regions (the Wakatobi no exception) fishers are finding it increasingly difficult to find fish and having to travel further to catch the fish they previously took for granted on their doorstep.

Human-ecosystem linkages are essential considerations in the global challenge of environmental sustainability. Ecosystems are directly affected by human activities and conversely human economies and human well-being is directly affected by the quality and maintenance of the natural environment. The economic system is part of and ultimately dependant on the ecological system (Goodland & Daly 1996). Therefore a key role of environmental management must be to protect the economic status and well-being of dependent human communities to achieve compliance to rules and regulations. Management systems must be adaptive and based on specific monitoring programme outcomes (Margoluis & Salafsky 1998), to provide the best possible mechanisms for sustainability in any given situation.

Measures of coral reef protection are sometimes presumed to conflict with economic growth, but this perception stems mainly from the failure to recognise that the magnitude of present and

future economic benefits from sustainable utilisation of reefs are much higher than the individual gains from short term destructive uses (Cesar 1996). Additionally, the maintenance of the environment is essential for the maintenance and improvement of human economies and well-being. Both biological and economic status must be measured and monitored to track management success and the current work has identified the key economic performance criteria that could be coupled with existing ecological criteria within any given framework to achieve this.

References

Adams AM, Evans TG, Mohammed R, Farnsworth J (1997) Socioeconomic stratification by wealth ranking: is it valid? World Development 25:1165-1172

Agarwal B (1990) Social security and the family: coping with seasonality and calamity in rural India. Journal of Peasant Studies 17:341-412

Alcamo J, Ash N, Butler C, Callicott J, Capistrano D (2003) Ecosystems and Human Well-being: a framework for assessment/Millennium Ecosystem Assessment, Vol. World Resources Institute, Island Press

Alder J, Sloan NA, Uktolseya H (1994) A comparison of management planning and implementation in three Indonesian marine protected areas. Ocean and Coastal Management 24:179-198

Alder PA, Alder P (2003) The reluctant respondent. In: Holstein JA, Gubrium JF (eds) Inside interviewing: new lenses, new concerns. Sage Publications, Thousand Oaks, London, New Delhi, p 153-174

Alfsen K, Serbo H (1993) Environmental quality indicators: background, principles and examples from Norway. Environmental and Resource Economics 3:415-435

Allison EH, Ellis F (2001) The livelihoods approach and management of small-scale fisheries. Marine Policy 25:377-388

Allison EH, Horemans B (2006) Putting the principles of the sustainable livelihoods approach into fisheries development policy and practice. Marine Policy 30:757-766

Alongi D (2002) Present state and future of the world's mangrove forests. Environmental Conservation 29:331-349

Amanor KS (1994) Ecological knowledge and the regional economy: environmental management in the Asesewa district of Ghana. Development and Change 25:41-67

Arunotai N (2006) Moken traditional knowledge: an unrecognised form of natural resources management and conservation. International Social Science Journal 187:139-150

Ashley C, Carney D (1999) Sustainable livelihoods: lessons from early experience, Department for International Development, http://www.livelihoods.org/info/docs/nrcadc.pdf, London

Ashley C, Start D, Slater R, Deshingkar P (2003) Understanding livelihoods in rural India: diversity, change and exclusion ODI Livelihood Options Study. Overseas Development Institute, http://www.livelihoodoptions.info

Ashworth JS, Ormond RFG, Sturrock HT (2004) Effects of reef-top gathering and fishing on invertebrate abundance across take and no-take zones. Journal of Experimental Marine Biology and Ecology 303:221-242

Atkinson P, Coffey A (2003) Revisiting the relationship between participant observation and interviewing. In: Holstein JA, Gubrium JF (eds) Inside interviewing: new lenses, new concerns, Vol 415-428. Sage Publications, Thousand Oaks, London, New Delhi

Aylward B, Barbier EB (1992) Valuing environmental functions in developing countries. Biodiversity and conservation 1:35-50

Balmford A, Bruner A, Cooper P, Costanza R, Farber S, Green RE, Jenkins M, Jefferiss P, Jassamy V, Madden J, Myers N, Naeem S, Paavola J, Rayment M, Rosendo S, Roughgarden J, Trumper K, Turner KR (2002) Economic reasons for conserving wild nature. Science 297:950-954

Banlina FT, Tung L (1992) FARMI's experiences of wealth ranking in the Philippines: different farmers have different needs. RRA Notes, IIED London 15:38-50

Barbier EB (1994) Valuing environmental functions: tropical wetlands. Land Economics 70:155-173

Barbier EB (2005) Natural resources and economic development, Vol. Cambridge University Press

Barros AJD, Victoria CG (2005) A nationwide wealth score based on the 2000 Brazilian demographic census. Revista de Saúde Pública 39:1-6

Bateman IJ, Carson RT, Day B, Hanemann M, Hanley N, Hett T, Jones-Lee M, Loomes G, Mourato S, Özdemiroglu E, Pearce D, Sugden R, Swanson J (2002) Economic valuation with stated preference techniques: a manual, Vol. Edward Elgar

Becker E, Jahn T, Sties I, Wehling P (1997) Sustainability: a cross-disciplinary concept for social transformations. Report on the Results of the first phase of the MOST Projct:

Towards Sustainable Development Paradips and Policies: Sustainability as a Concept of the Social Sciences, MOST Policy Papers 6. Institute for Social-Ecological Research. Supported by UNESCO, Paris

Begon M, Harper JL, Townsend CR (1996) Ecology: individuals, populations and communities. Third Edition, Vol. Blackwell Science Ltd, Oxford, UK

Begossi A (1995) Fishing spots and sea tenure: incipient forms of local management in Atlantic forest coastal communities. Human Ecology 23:387-406

Béné C, Mindjimba K, Belal E, Jolley T (2000) Evaluating livelihood strategies and the role of inland fisheries in rural development and poverty alleviation: the case of the Yaéré floodplane in North Cameroon International Institute of Fisheries Economics and Trade: Microbehaviour and Macroresults 9-14th July, Oregon

Berg H, Öhman MC, Troëng S, Lindén O (1998) Environmental economics of coral reef destruction in Sri Lanka. Ambio 27:627-634

Bergeron G, Morris SS, Benegas JMM (1998) How reliable are group informant ratings? A test of food security ratings in Honduras. World Development 26:1893-1902

Berman M, Kofinas G (2004) Hunting for models: grounded and rational choice approaches to analyzing climate effects on subsistence hunting in an Arctic community. Ecological Economics 49:31-46

Bernard HR (2000) Social Research Methods: qualitative and quantitative approaches, Vol. Sage Publications, Inc, Thousand Oaks, London, New Delhi

Biodiversity Conservation Network (1998) Analytical framework and communications strategy, WWF Biodiversity Support Program, Washington DC

Birkeland C (1997) Life and Death of Coral Reefs, Vol. Kluwer Academic Publishers

Bogale A, Taeb M, Endo M (2006) Land ownership and conflicts over the use of resources: Implication for household vulnerability in eastern Ethiopia. Ecological Economics 58:134– 145

Bowen RE, Riley C (2003) Socio-economic indicators and integrated coastal management. Ocean and Coastal Management 46:299-312

Brauer I (2003) Money as an indicator: to make use of economic evaluation for biodiversity conservation. Agriculture Ecosystems & Environment 98:483-491

Brewer J, Hunter A (2006) Foundations of multimethod research: synthesizing styles, Vol. Sage Publications, Inc, Thousand Oaks, London and New Delhi

Brundtland G (ed) (1987) Our common future: The World Commission on Environment and Development, Vol. Oxford University Press

Bryceson DF (1996) Deagrarianization and rural employment in Sub-Saharan Africa: a sectoral perspective. World Development 24:97-111

Bryman A (1988) Quantity and Quality in Social Research, Vol 18. Unwin Hyman Ltd, London

Bryman A (2004) Social Research Methods, Vol. Oxford University Press

Bunce L, Gustavson K, Williams J, Miller M (1999) The human side of reef management: a case study analysis of the socioeconomic framework of Montego Bay Marine Park. Coral Reefs 18:369-380

Bunce L, Pomeroy RS (2003) Socioeconomic monitoring guidelines for coastal managers in Southeast Asia: SocMon SEA, World Commission on Protected Areas (WCPA) and Australian Institute of Marine Science (AIMS)

Bunce L, Townsly P, Pomeroy RS, Pollnac RB (2000) Socioeconomic manual for coral reef management, Vol. Australian Institute of Marine Science

Burke L, Selig E, Spalding M (2002) Reefs at risk in Southeast Asia, Vol. World Resources Institute

Byers A (1994) Understanding behavioural motivations: a key to integrating conservation and development Fifth International Symposium on Society and Resources Management, Fort Collins, Colorado, 7-10 June

Caddy JF (2004) Current usage of fisheries indicators and reference points, and their potential application to management of fisheries for marine invertebrates. Canadian Journal of Fisheries and Aquatic Sciences 61:1307-1324

Campbell BM, Luckert MK (2002) Towards understanding the role of forests in rural livelihoods. In: Campbell BM, Luckert MK (eds) Uncovering the Hidden Harvest: Valuation Methods for Woodland and Forest Resources. CIFOR, Bogor, p 1- 16

Campbell JR (2001) Participatory rural appraisal as qualitative research: distinguishing methodological issues from participatory claims. Human Organization 60:380-389

Carlton JT, Geller JB, Reaka-Kudla ML, Norse EA (1999) Historical extinctions in the sea. Annual Review of Ecological Systems 30:515-538

Carter DW (2003) Protected areas in marine resource management: another look at the economics and research issues. Ocean and Coastal Management 46:439-456

Cavendish W (2002) Quantitative methods for estimating the economic value of resource use to rural households. In: Campbell BM, Luckert MK (eds) Uncovering the Hidden Harvest:Valuation Methods for Woodland and Forest Resources. CIFOR, Bogor, p 17-63

Cesar HSJ (1996) Economic analysis of Indonesian coral reefs, World Bank Environment Department

Cesar HSJ (2000a) Coral reefs: their functions, threats and economic value. In: Cesar HSJ (ed) Collected Essays on the Economics of Coral Reefs. CORDIO, p 14-39

Cesar HSJ (2000b) Coral reefs: their functions, threats and economic value. In: Cesar HSJ (ed) Collected Essays on the Economics of Coral Reefs. Cordio, Stockholm, p 14-32

Cesar HSJ (2002) The biodiversity benefits of coral reef ecosystems: values and markets. Report No. ENV/EPOC/GSP/BIO(2001)5/FINAL, Organisation for Economic Cooperation and Development

Cesar HSJ, Burke L, Pet-Soede L (2003) The economics of worldwide coral reef degradation, Cesar Environmental Economics Consulting

Cesar HSJ, Chong CK (2004) Economic valuation and socioeconomics of coral reefs: methodological issues and three case studies. In: Ahmed M, Chong CK, Cesar HSJ (eds) Economic Valuation and Policy Priorities for Sustainable Management of Coral Reefs. Worldfish Center, Penang, Malaysia, p 14-40

Cesar HSJ, Lundin CG, Bettencourt S, Dixon JA (1997) Indonesian coral reefs-an economic analysis of a precious but threatened resource. Ambio 26:345-350

Cesar HSJ, van Beukering P, Pintz S, Dierking J (2002) Economic valuation of the coral reefs of Hawaii, Hawaii Coral Reef Initiative Research Program, University of Hawaii

Chabanet P, Adjeroud M, Andrefouet S, Bozec Y-M, Ferraris J, Garcia-Charton JA, Schrimm M (2005) Human-induced physical disturbances and their indicators on coral reef habitats: a multi-scale approach. Aquatic Living Resources 18:215-230

Chambers R (1987) Sustainable livelihoods, environment and development: puttin poor rural people first, IDS Discussion Paper 240; Institute of Development Studies, Brighton, UK

Chambers R, Conway G (1992) Sustainable rural livelihoods: practical concepts for the 21st century, IDS Discussion Paper 296; Institute of Development Studies, Brighton, UK

Chambers R, Longhurst R, Pacey A (eds) (1981) Seasonal dimensions to rural povery, Vol. Frances Pinter, London

Christy Jr FT (1986) Special characteristics and problems of small-scale fisheries management in developing countries. In: Miles E, E. P, Stokes R (eds) Natural resource economics and policy applications. University of Washington Press, Seattle, U.S., p 118-151

Cinner J, Fuentes M, Harding S (2006) A baseline socioeconomic assessment of marine protected areas in Madagascar, WCS Marine Programme and CORDIO

Clark JR (1998) Coastal seas: the conservation challenge, Vol. Blackwell Science

Clarke KR, Warwick RM (1994) Changes in marine communities: an approach to statistical analysis and interpretation, Natural Environmental Research Council, Plymouth Marine Laboratory, Plymouth, United Kingdom

Clifton J (2005) Survey of Seaweed Cultivators within the Kaledupa Sub-region of Wakatobi Marine National park. Operation Wallacea (unpublished data)

Clua E, Beliaeff B, Chauvet C, David G, Ferraris J, Kronen M, Kulbicki M, Labrosse P, Letourneur Y, Pelletier D, Thebaud O, Leopold M (2005) Towards multidisciplinary indicator dashboards for coral reef fisheries management. Aquatic Living Resources 18:199-213

Coblentz BE (1997) Subsistence consumption of coral reef fish suggests non-sustainable extraction. Conservation Biology 11:559-561

Cochrane J (1993) Tourism and conservation in Indonesia and Malaysia. In: Hitchcock MJ, King UT, Darnwell MJG (eds) Tourism in Southeast Asia. Routledge, p 317-326

Cocklin C, Craw M, McCauley I (1998) Marine reserves in New Zealand: use right, public attitudes and social impacts. Coastal Management 26:213-231

Collier WL (1988) A preliminary study of employment trends in lowland Javanese villages, Agency for Agricultural Resrach and Development, Bogor, Indonesia

Common MS, Stagl S (2005) Ecological Economics: an introduction, Vol. Cambridge University Press

Cooke FM (2004) Symbolic and social dimensions in the economic production of seaweed. Asia Pacific Viewpont 45:387-400

Coombs CH, Coombs LC, Lingoes JC (1978) Stochastic cumulative scaling. In: Shye S (ed) Theory construction and data analysis in the behavioural sciences. Jossey-Bass, San Francisco, CA, p 280-298

Costanza R (ed) (1991) Ecological Economics: The Science and Management of Sustainability, Vol. Columbia University Press, New York

Costanza R, Cumberland J, Daly HE, Goodland R, Norgaard R (1997a) An introduction to ecological economics, Vol. St. Lucie Press

Costanza R, d'Arge R, de Groot R, Farber S, Grasso M, Hannon B, Limburg K, Naeem S, O'Neil RV, Paruelo J, Raskin RG, Sutton P, van den Belt M (1997b) The value of the world's ecosystem services and natural capital. Nature 387:253-260

Crabbe MJC, Smith DJ (2005) Sediment impacts on growth rates of Acropora and Porites corals from fringing reefs of Sulawesi, Indonesia. Coral Reefs 24:437-441

Crawford BR (2002) Seaweed farming: an alternative livelihood for small-scale fishers? Coastal Resources Center, University of Rhode Island, Narragansett, Rhode Island. Working Paper, p 22

Dahlgren CP, Kellison GT, Adams AJ, Gillanders BM, Kendall MS, Layman CA, Ley JA, Nagelkerken I, Serafy JE (2006) Marine nurseries and effective juvenile habitats: concepts and applications. Marine Ecology Progress Series 312:291-295

Dahuri R (1999) Coastal zone management in Indonesia: issues and approaches. In: Rais J, Dutton IM, Pantimena L, Plouffe J, Dahuri R (eds) Integrated coastal and marine resource management: Proceedings of the International Symposium, Malang, p 60-72

Daly H, Cobb J (1989) For the common good: redirecting the economy toward community, the environment, and a sustainable future, Vol. Beacon Press, Boston

Dalzell P, Adams TJH, Polunin NVC (1996) Coastal fisheries in the Pacific islands. Oceanography and Marine Biology An Annual Review 34:395- 531

Dasgupta P (2001) Human Well-Being and the Natural Environment, Vol. Oxford University Press

David G, Cillaurren E (1992) National fisheries development policy for coastal waters, small scale village fishing and food self reliance in Vinuatu. Man and Culture in Oceania 8:35-58

de Camargo SAF, Petrere MJ (2001) Social and financial aspects of the artisanal fisheries of Middle São Francisco River, Minas Gerais, Brazil. Fisheries Management and Ecology 8:163-171

de la Torre-Castro M, Rönnbäck P (2004) Links between humans and seagrasses:an example from tropical East Africa. Ocean and Coastal Management 47:361-387

de Vaus D (2002) Analysing social science data: 50 key problems in data analysis, Vol. Sage Publications, London, Thousaond Oaks, New Delhi

Diamond PA, Hausman JA (1994) Contingent valuation: is some number better than no number? Journal of Economic Perspectives 8:45-64

Dillman D (1978) Mail and telephone surveys: the total design method, Vol. Wiley, New York

Dirzo R, Raven PH (2003) Global state of biodiversity and loss. Annual Review of Environment and Resources 28:137-167

Dixon JA (1986) The role of economics in valuing environmental effects of development projects. In: Dixon JA, Hufschmidt MM (eds) Economic valuation techniques for the environment A case study workbook. John Hopkins University Press, p 3-10

Dixon JA (1989) Valuation of mangroves. Tropical Coastal Area Management 4:1-6

Dixon JA (1993) Economic benefits of marine protected areas. Oceanus Fall:35-40

Dixon JA (1997) Economic values of coral reefs: what are the issues? In: Hatziolos M, Hooten AJ, Fodor M (eds) Coral reefs: challenges and opportunities for sustainable management. World Bank, Washington D. C.

Dixon JA, Fallon Scura L, van't Hof T (1993) Meeting ecological and economic goals: Marine Parks in the Caribbean. Ambio 22:117-125

Dixon JA, Sherman PB (1990) Economics of protected areas: a new look at benefits and costs, Vol. Island Press, Washington D. C.

Dixon JA, Sherman PB (1991) Economics of protected areas. Ambio 20:68-74

Donohue M (1999) A Grammar of Tukang Besi, Vol. Mouton de Gruyter, Berlin, New York

Dore MHI, Webb D (2003) Valuing biodiversity: reality or mirage? Environmental monitoring and assessment 86:91-104

Dorenbosch M, Grol MGG, Christianen MJA, Nagelkerken I, van der Velde G (2005) Indo-Pacific seagrass beds and mangroves contribute to fish density and diversity on adjacent coral reefs. Marine Ecology Progress Series 302:63–76

Drakakis-Smith D (2000) Third world cities, Vol. Routledge, London

Duarte CM (2000) Marine biodiversity and ecosystem services: an elusive link. Journal of Experimental Marine Biology and Ecology 250:117-131

Dulvy NK, Sadovy Y, Reynolds J (2003) Extinction vulnerability in marine populations. Fish and Fisheries 4:25-64

Dulvy NK, Stanwell-Smith D, Darwall WRT, Horrill CJ (1995) Coral mining at Mafia Island, Tanzania: a management dilemma. Ambio 24:358-365

Dunn IG (1989) Development of inland fisheries under constraints from other uses of land and water resources: guidelines for planners., FAO Fisheries Circulars - C826, Rome

Dytham C (2005) Choosing and using statistics: a biologists guide, Vol. Blackwell Publishing, Oxford, UK

Edwards-Jones G, Davies B, Hussain S (2000) Ecological Economics An Introduction, Vol. Blackwell Science Ltd

Eklöf JS, Henriksson R, Kautsky N (2006) Effects of tropical open-water seaweed farming on seagrass ecosystem structure and function. Marine Ecology Progress Series 325:73-84

Elliott G, Mitchell B, Wiltshire B, Manan AI, Wismer S (2001) Community Participation in Marine Protected Area Management: Wakatobi National Park, Sulawesi, Indonesia. Coastal Management 29:295-316

Ellis F (1998) Household strategies and rural livelihood diversification. The journal of Development Studies 35:1-38

Ellis F (1999) Rural livelihood diversity in developing countries: evidence and policy implications. Natural Resource Perspectives 40:9 http://www.odi.org.uk/nrp/40.html

Ellis F (2000a) The determinants of rural livelihood diversification in developing countries. Journal of Agricultual Economics 51:289-302

Ellis F (2000b) Rural livelihoods and diversity in developing countries, Vol. Oxford University Press, Oxford, UK

English S, Wilkinson C, Baker V (1997) Survey manual for tropical marine resources, Vol. Australian Institute of Marine Science, Townsville

Erdman MV, Pet JS (1999) Krisman and DFP: some observations on the effect of the Asian financial crisis on destructive fishing practices in Indonesia. SPC Live Reef Fish Information Bulletin 5:22-26

Evans SM, Gill ME, Retraubun ASW, Abrahamz J, Dangeubun J (1997) Traditional management practices and the conservation of the gastropod (*Trochus nilitocus*) and fish stocks in the Maluku Province (eastern Indonesia). Fisheries Research 31:83-91

FAO (1999) Indicators for sustainable development of marine capture fisheries. Report No. 8, FAO Fishery Resources Division

FAO (2005) Increasing the contribution of small-scale fisheries to poverty alleviation and food security. Report No. 10, FAO, Rome

FAO (2006) What is meant by food insecurity and vulnerability? http://www.fao.org/spfs/ Accessed 16/04/2006

Farber S, Costanza R (1987) The Economic Value of Wetland Systems. Journal of Environmental Management 24:41-51

Farrow S (1996) Marine protected areas: emerging economics. Marine Policy 20:439-446

Feagin JR, Orum AM, Sjoberg G (eds) (1991a) A case for the case study, Vol. The University of North Carolina Press, Chapel Hill and London

Feagin JR, Orum AM, Sjoberg G (1991b) The nature of the case study. In: Feagin JR, Orum AM, Sjoberg G (eds) A case for the case study. The University of North Carolina Press, Chapel Hill and London, p 1-26

Fenech A, Foster J, Hamilton K, Hansell R (2003) Natural capital in ecology and economics: an overview. Environmental monitoring and assessment 86:3-17

Ferguson B, Tandon A, Gakidou E, Murray CJL (2002) Estimating permanent income using indicator variables. Evidence and information for policy cluster, World Health Organisation, Geneva, Switzerland

Fernandes L, Ridgley MA, van't Hof T (1999) Multiple criteria analysis integrates economic, ecological and social objectives for coral reef managers. Coral Reefs 18:393-402

Filmer D, Pritchett LH (2001) Estimating Wealth Effects without Expenditure Data-or Tears: An Application to Educational Enrollments in States of India. Demography 38:115-132

Fiske SJ (1992) Sociocultural aspects of establishing marine protected areas. Ocean and Coastal Management 18:25-46

Fitzpatrick J (2005) Development of the Marine Algae Industry in Hoga and Kaledupa. Operation Wallacea, p 5

Fox HE, Pet JS, Dahuri R, Caldwell RL (2003) Recovery in rubble fields: long-term impacts of blast fishing. Marine Pollution Bulletin 46:1024-1031

Fox JJ (1995) Fishing resources and marine tenure: the problems of Eastern Indonesian fishermen. In: Barlow C, Hardjono J (eds) Indonesia Assessment 1995: development in Eastern Indonesia. ANU, Canbera, p 163-173

Fürst E, Barton DN, Jiménez G (2000) The costs and benefits of reef conservation in the Bonaire Marine Park in the Netherlands Antilles. In: Rietbergen-McCracken J, Abaza H (eds) Environmental Valuation: a worldwide compendium of case studies. United Nations Environment Programme, Earthscan Publications Limited, p Chapter 11

Furze B, De Lacey T, Birckhead J (1996) Culture, conservation and biodiversity; the social dimension of linking local level development and conservation through protected areas, Vol. John Wiley and Sons

Garcia SM, Staples DJ, Chesson J (1999) The FAO guidelines for the development and use of indicators for sustainable development of marine capture fisheries and an Australian example of their application. Report No. CM 1999/P:05, International Council for the Exploration of the Sea, Bureau of Rural Sciences

Geider RJ, Delucia EH, Falkowski PG, Finzi AC, Grime JP, Grace J, Kana TM, La Roche J, Long SP, Osborne BA, Platt T, Prentice IC, Raven JA, Schlesinger WH, Smetacek V, Stuart V, Sathyendranath S, Thomas RB, Vogelmann TC, Williams P, Woodward FI (2001) Primary productivity of planet earth: biological determinants and physical constraints in terrestrial and aquatic habitats. Global Change Bilology 7:849-882

Ghirotti M (1992) A simple method for scoring housing conditions as income proxy in Ethiopia. RRA Notes, IIED London, http://wwwiiedorg/NR/agbioliv/pla_notes/pla_backissues/15html 15:43-47

Gilbert A, Janssen R (1998) Use of environmental functions to communicate the values of a mangrove ecosystem under different management regimes. Ecological Economics 25:323-346

Gillham B (2005) Research interviewing: the range of techniques, Vol. Open University Press, Berkshire, UK

Glavovic BC, Boonzaier S (2006) Confronting coastal poverty: building sustainable coastal livelihoods in South Africa. Ocean and Coastal Management 50:1-23

Goodland R, Daly HE (1996) Environmental sustainability: universal and non-negotiable. Ecological Applications 6:1002-1017

Gowdy JM (1997) The value of biodiversity:markets, society and ecosystems. Land Economics 73:25-41

Grandin BE (1988) Wealth Ranking in Smallholder Communities: A Field Manual, Vol. ITDG Publishing

Green CH, Tunstall SM (1991) Is the economic evaluation of environmental resources possible? Journal of Environmental Management 33:123-141

Grigg RW (1984) Resource management of precious corals: a review and application to shallow water reef building corals. Marine Ecology 5

Guijt I (1992) A user's note: wealth ranking by cards. RRA Notes, IIED London, http://wwwiiedorg/NR/agbioliv/pla_notes/pla_backissues/15html 15:65-69

Gullstrom M, De la Torre-Castro M, Bandeira SO, Bjork M, Dahlberg M, Kautsky N, Ronnback P, Ohman MC (2002) Seagrass ecosystems in the Western Indian Ocean. Ambio 31:588-596

Gunderson LH (2001) Managing surprising ecosystems in Southern Florida. Ecological Economics 37:371-378

Gustavson K (1998) Values associated with the local use of the Montego Bay Marine Park. Report No. #RPO 681-05, The World Bank

Guttman L (1947) The Cornell technique for scale and intensity analysis. Educational and Psychological Measurement 7:247-280

Haber H, Winiwarter V, Andersson K, Ayres RU, Boone C, Castillo A, Cunfer G, Fischer-Kowalski M, Freudenburg WR, Furman E, Kauffmann R, Krausmann F, Langthaller E, Lotze-Campen H, Mirtle M, Redman CL, Reenberg A, Wardell A, Warr B, Zechmeister H (2006) From LTER to LTSER: conceptualizing the socioeconomic dimension of long-term socioecological research Ecology and Society, p 13

Haeruman HJS (1988) Conservation in Indonesia. Ambio 17:218-222

Hajkowicz S (2006) Multi-attributed environmental index construction. Ecological Economics 57:122-139

Hanazaki N, Begossi A (2000) Fishing and niche dimension for food consumption of caiçaras from Ponto do Almada (Brazil). Human Ecology Review 7

Hanazaki N, Begossi A (2003) Does fish still matter? Changes in the diet of two Brazilian fishing communities. Ecology of Food and Nutrition 42:279-301

Hanley N, Shogren JF, White B (2001) Introduction to Environmental Economics, Vol. Oxford University Press

Hargreaves JR, Morison LA, Gear JSS, Makhubele MB, Porter JDH, Busza J, Watts C, Kim JC, Pronyk PM (2007) "Hearing the voices of the poor": Assigning poverty lines on the basis of local perceptions of poverty. A quantitative analysis of qualitative data from participatory wealth ranking in rural South Africa. World Development 35:212-229

Hauge KH, Olsen E, Heldal HE, Skjoldal HR (2005) A framework for making qualities of indicators transparent. ICES Journal of Marine Science 62:552-557

Hoagland P, Kaoru Y, Broadus J (1995) A methodological review of net benefit evaluation for marine reserves, Environment Department Papers: 27. World Bank

Hoegh-Guldberg O (1999) Climate change, coral bleaching and the future of the world's coral reefs. Marine and Freshwater Research 50:839-866

Hopley D, Suharsono (2000) The status of coral reefs in Eastern Indonesia, Vol. Australian Institute of Marine Science

Hubbard DK (1997) Reefs as dynamic systems. In: Birkleand C (ed) Life and death of coral reefs. Chapman and Hall, New York, p 43-67

IUCN (2002) Sustainable livelihoods: What makes a livelihood sustainable? IUCN news archives 2001-2005. Available from http://www.iucn.org/en/news/archive/2001_2005/mbsustliveli.pdf

Jennings S, Polunin NVC (1996) Fishing strategies, fishery development and socioeconomics in traditionally Fijian fishing grounds. Fisheries Management and Ecology 3

Johannes RE, Riepen M (1995) Environmental, economic and social implications of the live reef fish trade in Asia and the Western Pacific, The Nature Conservancy and the South Pacific Forum Fisheries Agency

Johda NS (1988) Poverty debate in India: a minority view. Economic and Political Weekly November:2421-2428

Kammerbauer J, Cordoba B, Escolan R, Flores S, Ramirez V, Zeldon J (2001) Identification of development indicators in tropical mountainous regions and some implications for natural resource policy designs: an integrated community case study. Ecological Economics 36:45-60

Kecamatan Kaledupa (2006) Rekapitulasi Laporan Penduduk Bulan (Desember) 2001-2005, Pemerintah Kabupaten Wakatobi: Kekamatan Kaledupa

Kelleher G, Recchia C (1998) Lessons from marine protected areas around the world. Parks 8:1-4

King LA, Hood VL (1999) Ecosystem health and sustainable commmunities: North and South. Ecosystem Health 5:49-57

King OH (1995) Estimating the value of marine resources: a marine recreation case. Ocean and Coastal Management 27:129-141

Kinsey DW, Hopley D (1991) The significance of coral reefs as global carbon sinks - response to Greenhouse. Palaeogeography, Palaeoclimatology, Palaeoecology (Global and Planetary Change Section) 89:363-377

Kirk J, Miller M (1990) Reliability and validity in qualitative research, Vol Volume 1. Sage, London

Kuntz NM, Kline DI, Sandin SA, Rohwer F (2005) Pathologies and mortality rates caused by organic carbon and nutrient stressors in three Caribbean coral species. Marine Ecology Progress Series 294:173–180

Labrosse P, Letourneur Y, Kulbicki M, Paddon JR (2000) Fish stock assessment of the Northern New Caladonian Lagoons: 3 - fishing pressure, potential yields and impact on management options. Aquatic living resources 13:91-98

Langton M, Rhea ZM, Ayre M, Pope J (2003) Composite Report on the Status and Trends Regarding the Knowledge, Innovations and Practices of Indigenous and Local Communities Relevant to the Conservation and Sustainable Use of Biodiversity. Regional report: Australia, Asia and the Middle East Convention on Biological Diversity. UNEP/CBD/WG8J/3/INF/4, Montreal, 8-12 December, p 161

Le Quesne T, McNally R (2005) The Green Buck: using economic tools to deliver conservation goals, a WWF field guide, WWF-UK

Lenz R, Malkina-Pykh IG (2000) Introduction and overview. Ecological Modelling 130:1-11

Leopold M, Ferraris J, Labrosse P (2004) Assessment of the reliability of fish consumption as an indicator of reef fish catches in small Pacific islands: the example of Ouvea Island in New Caledonia. Aquatic Living Resources 17:119-127

Levy R, Hollan D (1998) Person-centred interviewing and observation. In: Bernard HR (ed) Handbook of methods in cultural anthropology. AltaMira, Califonia, p 333-364

Lindblad MR (2006) Performance measurement in local economic development. Urban Affairs Review 41:646-672

MacMillan D, Hanley N, Lienhoop N (2006) Contingent valuation: Environmental polling or preference engine? Ecological Economics 60:299-307

Margoluis R, Salafsky N (1998) Measures of Success: Designing, Managing, and Monitoring Conservation and Development Projects, Vol. Island Press, Washington, D. C.

Markert J (2005) The Malthusian fallacy: Prophecies of doom and the crisis of Social Security. Social Science Journal 42:555-568

Marquette CM, Koranteng KA, Overa R, Aryeetey E (2002) Small-scale fisheries, population dynamics, and resource use in Africa: the case of Moree, Ghana. Ambio 31:324-336

Mascia MB (2003) The human dimension of coral reef marine protected areas: Recent social science research and its policy implications. Conservation Biology 17:630-632

May D (2003) A Preliminary Assessment of the Small-Scale Tropical Fisheries of Kaledupa Island, Wakatobi Marine National Park, SE Sulawesi, Indonesia, Operation Wallacea

May D (2005) Folk taxonomy of reef fish and the value of participatory monitoring in Wakatobi National Park, southeast Sulawesi, Indonesia. SPC Traditional Marine Resource Management and Knowledge Information Bulletin 18:18-34

May T (1999) Social Research: issues, methods and process, Vol. Open University Press, Buckingham, Philadelphia

McClanahan TR (1999) Is there a future for coral reef parks in poor tropical countries? Coral Reefs 18:321-325

McEnzie LJ, Lee Long WJ, Coles RG, Roder CA (2000) Seagrass-watch: community based monitoring of seagrass resources. Biol Mar Medit 7:393-396

McIntyre LJ (2005) Need to know: social science research methods, Vol. McGraw-Hill, New York

McManus JW (1988) Coral reefs of the ASEAN region: status and management. Ambio 17:189-193

McManus JW (1997) Tropical marine fisheries and the future of coral reefs: a brief review with emphasis on Southeast Asia. Coral Reefs 16:S121-S127

McManus JW, Menez LAB, Kesner-Reyes KN, Vergara SG, Ablan SMC (2000) Coral reef fishing and coral-algal phase shifts: implications for global reef status. ICES Journal of Marine Science 57:572-578

McMellor S, Smith D (2005) Monitoring programme report, Ras Mohammed National Park, 2005: conservation value index assessment of Ras Mohammed National Park, Corral Reef Resrach Unit, University of Essex and Operation Wallacea

McMellor S, Smith D (2006) Monitoring programme report, Ras Mohammed National Park, 2006: conservation value index assessment of Ras Mohammed National Park, Corral Reef Resrach Unit, University of Essex and Operation Wallacea

MEA (2005) Millennium Ecosystem Assessment. Ecosystems and Human Well-being: Synthesis, Vol. Island Press, Washington, DC

Mearns R, Shombodon D, Narangerel G, Turul U, Enkhamgalan A, Myagmarzhav B, Bayanjargal A, Bekhsuren B (1992) Direct and indirect uses of wealth ranking in Mongolia. RRA Notes, IIED London, http://wwwiiedorg/NR/agbioliv/pla_notes/pla_backissues/15html 15:29-38

Melana DM, Atchue III J, Yao CE, Edwards R, Melana EE, Gonzales HI (2000) Mangrove Management Handbook, Department of Environment and Natural Resources, Manila, Philippines through the Coastal Resource Management Project, Cebu City, Philippines

Messer E (1989) Methods for studying determinants of food intake. In: Pelto GH, Pelto PJ, Messer E (eds) Research methods in nutritional anthropology. The United Nations University, Tokyo, p 1-33

Millennium Ecosystem Assessment (2005) Ecosystems and Human Well-being: Synthesis, Vol. Island Press, Washington, DC

Minichiello V, Aroni R, Timewell E, Alexander L (1995) In-Depth Interviewing: Principles, Techniques, Analysis, Vol. Pearson Education Australia

Moberg F, Folke C (1999) Ecological goods and services of coral reef ecosystems. Ecological Economics 29:215-233

Moberg F, Ronnback P (2003) Ecosystem services of the tropical seascape: interactions, substitutions and restoration. Ocean and Coastal Management 46:27-46

Mokken RJ (1971) A theory and procedure of scale analysis, Vol. Mouton, The Hague, Paris

Mokken RJ, Lewis C, Sijtsma K (1986) Rejoinder to 'The Mokken scale': a critical discussion. Applied psychological measurement 10:279-285

Montgomery MR, Gragnolati M, Burke KA, Paredes E (2000) Measuring living standards with proxy variables. Demography 37:155-174

Moser CON (1998) The asset vulnerability framework: reassessing urban poverty reduction strategies. World Development 26:1-19

Mous PJ, Muljadi A, Purwanto, Pet JS (2005) Status of coral reefs in and around Komodo National Park. Results of a bi-annual survey over the period 1996 - 2002, The Nature Conservancy Southeast Asia Center for Marine Protected Areas, Sanur, Bali, Indonesia

Mumby PJ (2006) The impact of exploiting grazers (scaridae) on the dynamics of Caribbean coral reefs. Ecological Applications 16:747-769

Mumby PJ, Edwards AJ, Arias-Gonza´ lez JE, Lindeman KC, Blackwell PG, Gall A, Gorczynska MI, Harborne AR, Pescod CL, Renken H, Wabnitz CCC, Llewellyn G (2004) Mangroves enhance the biomass of coral reef fish communities in the Caribbean. Nature 427:533-536

Munro JL (1989a) Fisheries for giant clams (Tridacnidae: Bivalvia) and prospects for stock enhancement. In: Caddy JF (ed) Marine Invertebrate Fisheries: Their Assessment and Management. Wiley, Somerset, US, p 541-558

Munro M (1989b) Wealth ranking in sudan. RRA Notes, IIED London 7:24-28

Myers N (1996) Environmental services of biodiversity. Proceedings of the National Academy of Sciences of the United States of America 93:2764-2769

Myers N, Mittermeler RA, Mittermeler CG, da Fonseca GAB, Kent J (2000) Biodiversity hotspots for conservation priorities. Nature 403:853-858

Nadeau RL (2003) The wealth of nature: how mainstream economics has failed the environment, Vol. Columbia University Press, New York

Neefjes K (2000) Environments and Livelihoods, Strategies for Sustainability: Oxfam Development Guidelines, Vol. Oxfam academic

Ness B, Urbel-Piirsalu E, Anderberg S, Olsson L (2007) Categorising tools for sustainability assessment. Ecological Economics 60:498-508

Newcome J, Provins A, Johns H, Ozdemiroglu E, Ghazoul J, Burgess D, Turner K (2005) The Economic, Social and Ecological Value of Ecosystem Services: A Literature Review, Economics for the Environment Consultancy (eftec)

Njifonjou O, Satia BP, Angaman K (2006) Fisheries co-management and poverty alleviation in the context of the sustainable livelihoods approach: a case study in the fishing communities of Aby Lagoon in Cote d'Ivoire. International Journal of Sustainable Development and World Ecology 13:448-458

Norse EA (1993) Global marine biological diversity: A Strategy for Building Conservation into Decision Making, Vol. Island Press

Norton B (1991) Ecological health and sustainable resource management. In: Costanza R (ed) Ecological Economics: the science and management of sustainability. Columbia University Press, New York, p 102-117

Nunes PALD, van den Bergh JCJM (2001) Economic valuation of biodiversity: sense or nonsense? Ecological Economics 39:203-222

Nybakken JW (1997) Marine biology: an ecological approach (fourth edition), Vol. Addison-Welsley Educational Publishers Inc., New York

ODI (2003) Livelihood diversity and diversification. Understanding rural livelihoods: Key issues., Overseas Development Institute, London, UK

OECD (1994) Environmental Indicators, Organisation for Economic Cooperation and Development, Paris, France

OECD (2000) Frameworks to measure sustainable development, Organisation for Economic Cooperation and Development, Paris, France

OECD (2007) Online resources http://www.oecd.org. Organisation for Economic Co-operation and Development (accessed January 2007)

Öhman MC, Cesar HSJ (2000) Costs and benefits of coral mining. In: Cesar HSJ (ed) Collected essays on the economics of coral reefs. CORDIO, p 85-93

Ong JE (1993) Mangroves - a carbon source and sink. Chemosphere 27:1097-1107

OperationWallacea (2003) Community composition, density and diversity of Mangroves within the stakeholder managed area (SMA) in the Wakatobi National Park, South East Sulawesi, Operation Wallacea

Orth RJ, Carruthers TJB, Dennison WC, Duarte CM, Fourqurean JW, Heck KL, Randall Hughes A, Kendrick GA, Judson Kenworthy W, Olyarnik S, Short FT, Michelle W, Williams SL (2006) A global crisis for seagrass ecosystems. Bioscience 56:987-996

Osborne PL (2000) Tropical ecosystems and ecological concepts, Vol. Cambridge University Press, Cambridge, UK

Pandolfi JM, Bradbury RH, Sala E, Hughes TP, Bjorndal KA, Cooke RC, McArdle D, McClenachan L, Newman MJH, Paredes G, Warner RR, Jackson JBC (2003) Global trajectories of the long-term decline of coral reef ecosystems. Science 301:955-958

Parris TM, Kates RW (2003) Characterizing and measuring sustainable development. Annual Review of Environment and Resources 28:559-586

Patterson T, Gulden T, Cousins K, Kraev E (2004) Integrating environmental, social and economic systems: a dynamic model of tourism in Dominica. Ecological Modelling 175:121-136

Pauly D, Christensen V, Dalsgaard J, Froese R, Torres F (1998) Fishing down marine food webs. Science 279:860-863

Pauly D, Chua T-E (1988) The overfishing of marine resources: socioeconomic background in Southeast Asia. Ambio 17:200-206

Pearce D, Mäler K-G (1991) Environmental economics and the developing world. Ambio 20:52-54

Pearce D, Markandya A, Barbier E (1989) Blueprint for a green economy, Vol. Earthscan, London

Pearce D, Turner K (1990) Economics of natural resources and the environment, Vol. Harvester Wheatsheaf

Pelletier D, Garcia-Charton JA, Ferraris J, David G, Thebaud O, Letourneur Y, Claudet J, Armand M, Kulbicki M, Galzin R (2005) Designing indicators for assessing the effects of marine protected areas on coral reef ecosystems: a multidisciplinary standpoint. Aquatic Living Resources 18:15-33

Pendleton LH (1995) Valuing coral reef protection. Ocean and Coastal Management 26:119-131

Perrings C, Folke C, Mäler K-G (1992) The ecology and economics of biodiversity loss: the research agenda. Ambio 21:201-211

Pet-Soede C, Cesar H, Pet JS (1999) An economic analysis of blast fishing on Indonesian coral reefs. Environmental Conservation 26:83-93

Pet-Soede L, Erdman MV (2003) Rapid Ecological Assessment Wakatobi National Park, WWF and The Nature Conservancy

Pet-Soede L, Erdmann M (1998) An overview and comparison of destructive fishing practices in Indonesia. SPC Live Reef Fish Bulletin 4:28-36

Phillips A (1998) Economic values of protected areas Guidelines for protected area managers, IUCN The World Conservation Union

Pilgrim SE, Cullen LC, Smith DJ, Pretty J (2007) Hidden Harvest or Hidden Revenue? Local resource use in a remote region of Southeast Sulawesi, Indonesia. Indian Journal of Traditional Knowledge 6:150-159

Pilgrim SE, Smith D, Pretty J (in press) A cross-regional quantitative assessment of the factors affecting ecoliteracy: Policy and practice implications. Ecological Applications

Plummer R, FitzGibbon J (2006) People matter: The importance of social capital in the co-management of natural resources. Natural Resources Forum 30:51-62

Pollnac RB (1998) Rapid Appraisal of Management Parameters for Coral Reefs, Coastal Resources Center, University of Rhode Island, Narragansett, Rhode Island

Pollnac RB, Crawford BR (2000) Assessing behavioural aspects of coastal resource use. Report No. Coastal Resources Centre Coastal Management Report #2226, Coastal Resources Center, University of Rhode Island, Narragansett, Rhode Island

Pollnac RB, Crawford BR, Sukmara A (2002) Community-based coastal resources management: an interim assessment of the Proyek Pesisir field site in Benetan and Tumbak villages, North Sulawesi, Indonesia. Technical Report TE-02/01-E, University of Rhode Island, Coastal Resources Center, Narraganset, Rhode Island, USA

Pomeroy RS, Parks JE, Watson LM (2004a) How is your MPA doing? A guidebook for natural and social indicators for evaluating marine protected area management effectiveness, Vol. IUCN, Gland, Switzerland and Cambridge, UK

Pomeroy RS, Parks JE, Watson LM (2004b) The socio-economic indicators. In: How is your MPA doing? A guidebook for natural and social indicators for evaluating marine protected area management effectiveness. IUCN, Gland, Switzerland and Cambridge, UK, p 113-161

Pomeroy RS, Pollnac RB, Katon BM, Predo CD (1997) Evaluating factors contributing to the success of community-based coastal resource management: the Central Visayas Regional Project-l, Philippines. Ocean and Coastal Management 36:97-120

Pomeroy RS, Pollnac RB, Predo CD, Katon BM (1996) Impact evaluation of community-based coastal resource management projects in the Philippines, International Centre for Living Aquatic Resources Management (ICLARM) and University of Rhode Island

Pomeroy RS, Ratner BD, Hall SJ, Pimoljinda J, Vivekanadan V (2006) Coping with disaster: rehabilitating coastal livelihoods and communities. Marine Policy 30:786-793

Portney PR (1994) The contingent valuation debate: why economists should care. The Journal of Economic Perspectives 8:3-17

Prescott-Allen R (2001) The wellbeing of nations: a country by country index of quality of life and the environment, Vol. Island Press, Washington, Covelo, London

Preston DA (1989) Too busy to farm: under-utilization of farm land in Central Java. The journal of Development Studies 26:1-38

Pretty J (1989) Wealth ranking in sudan. RRA Notes, IIED London 7:24-28

Pretty J, Guijt I, Scoones I, Thompson J (1995) A Trainer's Guide for Participatory Learning and Action, IIED (International Institute for Environment and Development), London, UK

Pretty J, Smith DJ (2004) Social capital in biodiversity conservation and management. Conservation Biology 18:631-638

Pretty J, Subramanian S, Kempu Chetty N, Ananthakrishnan D, Jayanthi C, Muralikrishnasamy S, Renganayaki K (1992) Finding the poorest in a Tamil Nadu village: a sequence of mapping and wealth ranking. RRA Notes, IIED London 15:39-42

Pretty J, Ward H (2001) Social capital and the environment. World Development 29:209-227

Price ARG (2002) Simultaneous hotspots and coldspots of marine biodiversity and implications for global conservation. Marine Ecology Progress Series 241:23-27

Puglise KA, Kelty R (eds) (2007) NOAA Coral Reef Ecosystem Research Plan for Fiscal Years 2007 to 2011, Vol. Silver Spring, MD: NOAA Coral Reef Conservation Program. NOAA Technical Memorandum CRCP 1

Pyhälä A, Brown K, Adger WN (2006) Implications of livelihood dependence on non-timber products in Peruvian Amazonia. Ecosystems 9:1328-1341

Ramony S, Kalyan H, Chetha C, Sothunvathanak M (2003) Forest use and product flow in Chumkiri District, Kampot Province, Cambodia. In: McKenney B (ed) Economy and environment: case studies in Cambodia Report by Economy and Environment Program for Southeast Asia (EEPSEA) supported by the International Development Research Centre (IDRC); the Danish Ministry of Foreign Affairs (DANIDA); the Swedish International Development Cooperation Agency (Sida); the Ministry of Foreign Affairs, the Netherlands; the Canadian International Development Agency (CIDA); the MacArthur Foundation; and the Norwegian Agency for Development Cooperation (NORAD), p 1-8

Randall A (1987) Total economic value as a basis for policy. Transactions of the American Fisheries Society 116:325-335

Randall A (1991) The value of biodiversity. Ambio 20:64-67

Rapport D, Gaudet C, Constanza R, Epstein PR, Levins R (1998) Defining ecosystem health. In: Rapport D, Gaudet C, Constanza R, Epstein PR, Levins R (eds) Ecosystem Health: Principles and Practice. Blackwell Science Inc, Oxford, UK, p 18-33

Rea LM, Parker RA (2005) Designing and conducting survey research: a comprehensive guide, Vol. John Wiley and Sons Inc, San Francisco, California

Resosudarmo BP (ed) (2005) The politics and economics of Indonesia's natural resources, Vol. Institute of Southeast Asian Studies, Singapore

Reyes-Garcia V, Vadez V, Huanca T, Leonard WR, McDade T (2007) Economic development and local ecological knowledge: a deadlock? Quantitative research from a native Amazonian society. Human Ecology 35:371-377

Robbins LC (1935) An essay on the nature and significance of economic science, Vol. Macmillan, London

Roberts CM (1995) Effects of fishing on the ecosystem structure of coral reefs. Conservation Biology 9:988-995

Roberts CM (2000) Selecting marine reserve locations: optimality versus opportunism. Bulletin of Marine Science 66:581-592

Rodriguez LC, Pascual U, Niemeyer HM (2006) Local identification and valuation of ecosystem goods and services from Opuntia scrublands of Ayacucho, Peru. Ecological Economics 57:30-44

Rönnbäck P (1999) The ecological basis for economic value of seafood production supported by mangrove ecosystems. Ecological Economics 29:235-252

Roosevelt A (1987) The evolution of human subsistence. In: Harris M, Ross EB (eds) Food and evolution. Temple University Press, Philadelphia, p 565-578

Roscoe JT (1975) Fundamental research statistics for the behavioural sciences, Vol. Holt, Rinehart and Winston Inc

Ruane JM (2005) Essentials of research methods: a guide to social science research, Vol. Blackwell publishing, Oxford

Rudd MA, Tupper MH, Folmer H, van Kooten GC (2003) Policy analysis for tropical marine reserves: challenges and directions. Fish and Fisheries 4:65-85

Ruddle K, Hviding E, Johannes RE (1992) Marine resources management in the context of customary tenure. Marine Resource Economics 7:249-273

Ruitenbeek J (1994) Modelling economy-ecology linkages in mangroves: economic evidence for promoting conservation in Bituni Bay, Indonesia. Ecological Economics 10:233-247

Ruitenbeek J, Ridgley MA, Dollar S, Huber R (1999) Optimisation of economic policies and investment projects using a fuzzy logic based cost-effectiveness model of coral reef quality: empirical results from Montego Bay, Jamaica. Coral Reefs 18:381-392

Saat G (2003) The Identity and Social Mobility of Sama-Bajau. Sari 21:3-11

Sadovy Y (2005) Trouble on the reef: the imperative for managing vulnerable and valuable fisheries. Fish and Fisheries 6:167-185

Sadovy Y, Kulbicki M, Labrosse P, Letourneur Y, Lokani P, Donaldson TJ (2003) The humphead wrasse, *Cheilinus undulates*: synopsis of a threatened and poorly known giant coral reef fish. Reviews in Fish Biology and Fisheries 13:327-364

Sahn DE, Stifel D (2003) Exploring alternative measures of welfare in the absence of expenditure data. Review of Income and Wealth 49:463-489

Saith A (1992) The rural non-farm economy: processes and policies., International Labour Office, World Employment Programme, Geneva

Sala E, Knowlton N (2006) Global marine biodiversity trends. Annual Review of Environment and Resources 31:93-122

Salinas de Leon P (2006) The effect of mangrove forest on the fish assemblages of the *Thalassia hemprichii* and *Enhalus Acoroides* dominated seagrass beds of the Wakatobi National Marine Park, Indonesia. University of Wales, Aberystwyth

Sarch M-T (1992) Wealth ranking in the Gambia: which households participated in the FITT programme? RRA Notes, IIED London 15:14-20

Sather C (1997) The Bajau Laut. Adaption, history, and fate in a maritime fishery society of South-East Sabah, Vol. Oxford University Press., Oxford, UK

Sather C (2002) Commodity trade, gift exchange and the history of maritime nomadism in southeast Sabah. Nomadic Peoples 6:20-24

Scherr SJ, White A, Kaimowitz D (2002) Making Markets Work for Forest Communities, Forest Trends, Washington, D.C.

Schutkowski H (2006) Human Ecology: biocultural adaptations in human communities, Vol 182. Springer, Berlin Heidelberg, Germany

Scoones I (1995) Investigating difference - applications of wealth ranking and household survey approaches among farming households in southern Zimbabwe. Development and Change 26:67-88

Scoones I (1998) Sustainable rural livelihoods: a framework for analysis, IDS Working Paper 72, Institute of Development studies, Sussex, UK

Segnestam L (2002) Indicators of Environment and Sustainable Development: theories and practical experience. Report No. Paper No. 89, The World Bank Environment Department, Washington, D. C.

Seppala P (1996) The politics of economic diversification: reconceptualizing the rural informal sector in south-east Tanzania. Development and Change 27:557-558

SFLP (2006) A primer on sustainable livelihoods in artisanal fisheries, Sustainable Fisheries Livelihoods Programme, DFID; FAO, http://www.sflp.org/eng/007/pub4/aprimer.doc

Shackleton CM, Shackleton SE (2006) Household wealth status and natural resource use in the Kat River Valley, South Africa. Ecological Economics 57:306-317

Sheil D, Liswanti N (2006) Scoring the Importance of Tropical Forest Landscapes with Local People: Patterns and Insights. Environmental Management 38:126-136

Shepherd S, Terry A (2004) The Role of indigenous communities in natural resource management: the Bajau of the Tukangbesi Archipelago, Indonesia. Geography 89:204-213

Shyamsundar P (2002) Poverty-Environment Indicators. Report No. Paper No. 84, The World Bank

Simonit S, Perrings C (2005) Indirect economic indicators in bio-economic fishery models: agricultural price indicators and fish stocks in Lake Victoria. ICES Journal of Marine Science 62:483-492

Simpson R, Sedjo RA, Reid JW (1996) Valuing biodiversity for use in pharmaceutical research. Journal of Political Economy 101:163-185

Smith DJ, Pilgrim SE, Cullen LC (2007) Coral Reefs and People. In: Pretty J, Ball A, Benton T, Guivant J, Lee D, Orr D, Pfeffer M, Ward H (eds) Sage Handbook on Environment and Society. Sage Publications, London, p Chapter 35 (pages 1081-1117)

Smith I (1981) Improving fishing incomes when resources are overfished. Marine Policy 5:17-22

Smith LED, Nguyen Khoa S, Lorenzen K (2005) Livelihood Functions of Inland Fisheries: Policy Implications in Developing Countries. Water Policy 7:359-383

Smith SV, Kinsey DW (1976) Calcium Carbonate Production, Coral Reef Growth, and Sea Level Change. Science 194:937 - 939

Soegiarto A, Polunin NVC (1981) The marine environment of Indonesia., International Union for the Conservation of Nature and Natural Resources/World Wide Fund for Nature Indonesia Programme (IUCN/WWF), Bogor, Indonesia

Sopher DE (1977) The sea nomads: a study of the maritime boat people of Southeast Asia, Vol. National Museum Publications, Singapore

Spash CL, van der Werff ten Bosch JD, Westmacott S, Ruitenbeek J (2000) Lexicographic Preferences and the Contingent Valuation of Coral Reef Biodiversity in Curaçao and Jamaica. In: Gustavson K, Huber RM, Ruitenbeek J (eds) Integrated Coastal Zone Management of Coral Reefs: decision support modelling. The International Bank of Reconstruction and Development/The World Bank, Washington D. C., p 97-117

Spurgeon JPG (1992) The economic valuation of coral reefs. Marine Pollution Bulletin 24:529-536

Spurgeon JPG (2001) Valuation of Coral Reefs: The Next 10 Years "Economic Valuation and Policy Priorities for Sustainable Management of Coral Reefs" an International Consultative Workshop, ICLARM, Penang, Malaysia

Suman D, Shivlani M, Milon JW (1999) Perceptions and attitudes regarding marine reserves: a comparison of stakeholder groups in the Florida Keys marine sanctuary. Ocean and Coastal Management 42:1019-1040

Temu AE, Due JM (2000) Participatory rural appraisal approaches versus sample survey data collection: a case of smallholder farmers well-being ranking in Njombe District, Tanzania. Journal of African Economies 9:44-62

Tisdell CA (2005) Economics of environmental conservation, Vol. Edward Elgar Publishing Ltd

TNC (2007) Coral Triangle Center, The Nature Conservancy (TNC), http://www.coraltrianglecenter.org/

Tomascik T, Mah AJ, Nontji A, Moosa MK (1997a) The Ecology of the Indonesian Seas: Part I, Vol VII. Periplus Editions (HK) Ltd

Tomascik T, Mah AJ, Nontji A, Moosa MK (1997b) The Ecology of the Indonesian Seas: Part II, Vol VIII. Periplus Editions (HK) Ltd

Tschakert P, Coomes OT, Potvin C (2007) Indigenous livelihoods, slash and burn agriculture, and carbon stocks in Eastern Panama. Ecological Economics 60:807-820

Tun K, Chou LM, Cabanban A, Tuan VS, Philreefs, Suharsono, Sour K, Lane D (2004) Status of coral reefs, coral reef monitoring and management in Southeast Asia, 2004. In: Wilkinson CR (ed) Status of coral reefs of the world: 2004, Vol 1. AIMS, p 235-276

Turner KR, Adger NW (1995) Coastal zone resources assessment guidelines. Report No. LOICZ Reports and Studies No. 4, Land-Ocean Interactions in the Coastal Zone (LOICZ)

Twyman C (2000) Livelihood opportunity and diversity in Kalahari wildlife management areas, Botswana: Rethinking community resource management. Journal of Southern African Studies 26:783-806

UN (2002) Report of the World Summit on Sustainable Development, Johannesburg, South Africa, 26 August-4 September, United Nations, New York: A/CONF.199/20

UN (2006) The Millennium Development Goals Report, United Nations, New York

UN (2007) Millennium Development Goals. http://www.un.org/millenniumgoals/index.html

UNDP (2005) Sustaining the environment to fight poverty and achieve the MDG's: the economic case and priorities for action, UNDP, UNEP, IIED, IUCN, WRI

UNDP (2007) Human Development Report 2006 http://hdr.undp.org/hdr2006/statistics/indices/default.cfm. UNDP

UNDSD (2001) Indicators of sustainable development: framework and methodologies: background paper no. 3, United Nations Commission on Sustainable Development, 9th session, 16-27 April 2001, New York

UNEP-WCMC (2006) In the front line: shoreline protection and other ecosystem services from mangroves and coral reefs., Vol. UNEP-WCMC, Cambridge, UK

UNEP (2006a) Marine and coastal ecosystems and human well-being: A synthesis report based on the findings of the Millennium Ecosystem Assessment, UNEP

UNEP (2006b) Report of the eighth meeting of the parties to the Convention on Biological Diversity. In: UNEP/CBD/COP/8/31 (ed) Convention on Biological Diversity, Curitiba, Brazil, 20-31 March 2006

Unsworth RKF (2007) Aspects of the ecology of Indo-Pacific seagrass systems. University of Essex

Unsworth RKF, Powell A, Hukom F, Smith DJ (2007) The ecology of Indo-Pacific Grouper (Serranidae) species and the effects of a small scale no take area on grouper assemblage, abundance and size frequency distribution. Marine Biology DOI 10.1007/s00227-007-0675-3

Unsworth RKF, Wylie E, Bell JJ, Smith DJ (2006) Diel trophic structuring of Seagrass bed fish assemblages in the Wakatobi Marine National Park, Indonesia. Estuarine, Coastal and Shelf Science Doi:10.1016/j.ecss.2006.10.006

USAID (1992) Policy determination 19, definition of food security, United States Agency for International Development, Washington, DC

USAID (1996) Performance monitoring and evaluation tips no. 6: selecting performance indicators, USAID Centre for Development Information and Evaluation

USAID (1998) Performance monitoring and evaluation tips no. 12: guidelines for indicator and data quality, USAID Centre for Development Information and Evaluation

Uychiaoco AJ, Gomez ED, Cesar HSJ, Geronimo RC, Lim MT, Nguyen TA, Estrada MA, Mcglone D, Bantang J (2004) Towards and economic value of the biological diversity of coral reefs The 10th International Coral Reef Symposium, Okinawa, Japan

Valentine JF, Kenneth L, Heck KL, Cinkovish AM (2002) Impacts of seagrass food webs on marine ecosystems: a need for a broader perspective. Bulletin of Marine Science 7:1361-1368

van Zyl H, Store T, Leiman A (2000) Valuing time spent collecting water in a Kenyan town. In: Rietbergen-McCracken J, Abaza H (eds) Environmental Valuation: a worldwide compendium of case studies. United Nations Environment Programme, Earthscan Publications Limited, p Chapter 1

Vosti SA, Reardon T (eds) (1997) Sustainability, growth and poverty alleviation: a policy and agroecological perspective, Vol. Johns Hopkins University Press, Baltimore, MD, USA

Wackernagel M, Schulz NB, Deumling D, Callejas Linares A, Jenkins M, Kapos V, Monfreda C, Loh J, Myers N, Norgaard R, Randers J (2002) Tracking the ecological overshoot of the human economy. Proceedings of the National Academy of Sciences of the United States of America (PNAS) 99:9266-9271

Wainger L, Price EW (2004) Evaluating quality of life, economic vulnerabilities and drivers of ecosystem change. Environmental monitoring and assessment 94:69-84

Wainger LA, King DM, Cantrell JA (2004) Development of indicators to assess economic vulnerabilities to to changes in ecosystem services: case studies of counties in Maryland, USA. Environmental Management 34:730-747

Walters RDM, Samways MJ (2001) Sustainable dive ecotourism on a South African coral reef. Biodiversity and conservation 10:2167-2179

Watson R, Pauly D (2001) Systematic distortions in world fisheries catch trends. Nature 414:534-536

Wells M, Brandon K, Hannah L (1991) People and parks: linking protected area management with local communities, World Bank, USAID, WWF-USA, Washington DC

Wells SM, Alcala AC (1987) Collceting of corals and shells. In: Salavat B (ed) Human impacts on coral reefs: facts and recommendations. Antenne Museum EPHE, French Polynesia, p 13-27

Wenger C (2003) Interviewing older people. In: Holstein JA, Gubrium JF (eds) Inside interviewing: new lenses, new concerns. Sage Publications, Thousand Oaks, London, New Delhi, p 111-130

White AT (1987) Effects of construction activity on coral reef and lagoon systems. In: Salavat B (ed) Human impacts on coral reefs: facts and recommendations. Antenne Museum EPHE, French Polynesia, p 185-193

White AT, Barker V, Tantrigama G (1997) Using integrated coastal management and economics to conserve tourism resources in Sri Lanka. Ambio 26:335-344

White Paper (1997) Eliminating World Poverty: A Challenge for the 21st Century. White Paper on International Development, Presented to Parliament by the Secretary of State for International Development by Command of Her Majesty, London

Whitten T, Mustafa M, Henderson GS (1987) The Ecology of Sulawesi, Vol IV. Periplus Editions (HK) Ltd

Whittingham E, Campbell J, Townsly P (2002) Poverty and reefs: a global overview, Innovation Centre Exeter University, DFID

Whittington D (2002) Improving the performance of contingent valuation studies in developing countries. Environmental and Resource Economics 22:323-367

Wilkinson C (ed) (2002) Status of Coral Reefs of the World: 2002, Vol. Australian Institute of Marine Science

Wilkinson C (ed) (2004) Status of Coral Reefs of the World: 2004, Vol 1. Australian Institute of Marine Science

Wilkinson CR (1996) Global change and coral reefs: impacts on reefs, economies and human cultures. Global Change Biology 2:547-558

Wilson EO (2002) The future of life, Vol. Little, Brown and Alfred A. Knopf, Inc, London, UK

Winograd M, Aguilar M, Farrow A, Segnestam L (2000) Conceptual framework for the development and use of water indicators, The World Bank, Washington, D.C., US

Worboys GL, Lockwood M, De Lacey T (2005) Protected area management: principles and practice, Vol. Oxford University Press

World Bank (2000) Voices from the village: A comparative study of coastal resource management in the Pacific islands (vol 2), World Bank Report

Zann LP (1999) A new (old) approach to inshore resources management in Samoa. Ocean and Coastal Management 42:569-590

Zann LP, Vuki VC (2000) The status and management of subsistence fisheries in the South Pacific. Ocean Yearbook 14, Vol. The International Ocean Institute and University of Chicago Press, Chicago, US

Zar JH (1974) Biostatistical analysis, Vol. Prentice-Hall, Englewood Cliffs

Zinn FD, Henderson DA, Nystuen JD, Drake WD (1992) A stochastic cumulative scaling method applied to measuring wealth in Indonesian villages. Environmental Planning A 24:1155-1166