ECOMAMA

INTERUNIVERSITY MASTER PROGRAM IN ECOLOGICAL MARINE MANAGEMENT

Estimating the value of Goods and Services in a Marine Protected Area: The Case of Watamu Marine National Park and Reserve, Kenya

By
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Abstract

Marine and coastal ecosystems provide a wide range of goods and services that support the livelihoods of human population as well as *inter alia* maintain vital environmental functions and processes, supports biodiversity and protect shorelines. These ecosystems are persistently exposed to anthropogenic threats ranging from conversion to other land uses, overexploitation, and pollution to unsustainable management practices. The impacts of climate change and other natural causes add to the degradation. Often, decision making seldom take into consideration the actual value of these ecosystems resulting mostly in gross undervaluation of these goods and services. Marine Protected Areas (MPAs) have been established with a purpose of conserving biodiversity and promoting ecotourism. This study determined the monetary value of goods and services within the Watamu Marine National Park and Reserve, the distribution of conservation benefits and costs amongst stakeholders and the costs of biodiversity conservation. We determined a TEV of EUR 103,818.36 ± 63.30 ha^{-1} $year^{-1}$. This value does not include the values of fuelwood, timber, carbon sequestration and coastal protection that we derived in different units. We established that local communities are highly dependent on these ecosystem goods and services with most of them relying on fishing or fishery related activities. Tourism activities associated with the MPA was the main economic activity in the area attracting tourists and supporting livelihoods. However, an unequal distribution of benefits amongst stakeholders from ecosystem goods and services was observed. This is exacerbated by low levels of education and poverty coupled with limited resources mostly leading to conflicts amongst stakeholders or resource users. Boat operators and owners who earn their income directly from tourism benefited more than the other stakeholders. Indirect use values accounted for more than two thirds of the total economic value. We established that the costs of biodiversity conservation are high though appreciation of the value is low. Our overall estimate indicates that maintaining the protected area is more economically beneficial in the long-term. In line with the Secretariat of the Convention on Biological Diversity (CBD), this study forms a step towards integrating protected areas into wider landscapes, seascapes and sectoral plans and strategies while demonstrating that MPAs are of important national economic benefit.

Keywords: Biodiversity, MPA, CBD, Fisheries, livelihoods, ecosystem goods and services, TEV

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Prize of the Belgian Development Cooperation

ReCoMaP INDIAN OCEAN

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List of Abbreviations

BMU	Beach Management Unit
CBD	Convention on Biological Diversity
CBO	Community Based Organization
CPI	Consumer price index
CV	Contingent Valuation method
KFS	Kenya Forestry Department
KMFRI	Kenya Marine Fisheries and Research Institute
KWS	Kenya Wildlife Service
MA	Millennium Ecosystem Assessment
MPA	Marine Protected Area
NGO	Non Governmental Organization
NEM	North East Monsoon
PPP	Purchasing power parity
SEM	South East Monsoon
WTA	Willingness-to-accept
WTP	Willingness-to-pay

CHAPTER ONE

1.0 Introduction

The benefits provided by natural ecosystems are both widely acknowledged, though poorly understood (Daily *et al.* 1997). Unfortunately, ecosystems are poorly understood, scarcely monitored, and (in many cases) undergoing rapid degradation and depletion. Often the importance of ecosystem services is widely appreciated only upon their loss and only in some cases – like bioprospecting access agreements or direct payments for habitat conservation – capture demand for biodiversity directly. As Constanza *et al.* (1997) highlights this, "*the economies of the Earth would grind to a halt without the services of ecological life-support systems, so in one sense their total value to the economy is infinite*". However, globally, these natural ecosystems are under enormous pressure from growing demands caused by human economies. Growth in human populations and prosperity translates into increased conversion of natural ecosystems to agricultural, industrial, or residential use. This generally leads to increased demand for ecosystem inputs, such as fresh water, fiber, and soil fertility, as well as increased pressure on the capacity of natural ecosystems to assimilate our waste, either by polluting air or/and water. Thus, human society development results in higher demands from natural ecosystems, whose capacity to meet the demands have been greatly reduced. Stating that natural ecosystems and the services they provide are valuable immediately leads to the question: how valuable? This is an important question because other things are valuable as well.

Costanza *et al.* (1997) "The value of the world's ecosystem services and natural capital" Attempts to answer this question by extrapolation with previous and new data. They estimate a value of $33 trillion for ecosystem services across the globe. Though their methods and result were criticized, the paper served its purpose by bringing attention to and provoking discussion on the topic of ecosystem service valuation. Maintaining ecosystems, whether through protected areas or through some other mechanism, requires expenditure of resources, and there are often many competing claims on these resources.

Kenya has successfully established protected areas for years. These include both marine and terrestrial protected areas. Along the Kenyan coast, there are five marine and four coastal forests protected areas, which have been successfully managed. The main focus on management of these protected areas has been biodiversity conservation and ecotourism. Marine protected areas (MPAs) have proliferated globally in the past three decades. However, inadequate funding often prevents these management regimes from fulfilling their missions. Due to the diverse ecosystem goods and services, coupled with an equally diverse stakeholders and high levels of poverty in all marine and coastal protected areas, conflicts in resource exploitation and interests have emerged. Unfortunately, economic values associated with MPAs and the natural resources they protect are rarely considered in decision-making and policy development. This has mainly resulted in the overexploitation of some resources at the expense of others, resulting in most resources being under-valued and over-exploited, while others are not even considered with resultant ecosystem degradation. This may be associated with the wide-spread poverty amongst coastal communities.

Appreciating the diverse array of ecosystem goods and services, and establishing their real worth may be a step towards safeguarding common resources, placing the right price tags, and further imparting responsibilities to coastal communities to sustainably exploit and conserve these delicate resources. Thus, valuation may form a step towards the alleviation of poverty for most coastal communities, while guiding managers and policy makers in assigning alternative uses and costing ecosystem goods and services appropriately. Managers have become increasingly aware that successful protection of marine ecosystems is dependent not only upon an understanding of their biological and physical processes, but also their associated social and economic aspects. This valuation forms one of the many types of protected area assessment, which can and should be used for different purposes and at different scales in support of wise use, management and decision making. The combination of management information, ecological monitoring and the proposed valuation may be viewed as essential in providing information needed for establishing strategies, policies and management interventions to maintain the ecological character of the protected area.

The wanton degradation of marine and coastal ecosystems not only results in biodiversity losses, but also socio, economic and cultural demise of coastal communities, who are dependent on these ecosystems for goods and services. Therefore to address the need for healthy ecosystems, promote biodiversity conservation, alleviate poverty and promote ecosystem resilience in the wake of the looming climate change challenges, the full appreciation of the worth of marine and coastal resources may be essential. This may address issues of market failures, perverse incentives, and the unequal distribution of costs and benefits. This study therefore sets out to establish a culture of recognition for ecosystem goods and services, otherwise recognized as "free" public services and assign a cost them.

1.1 Threats to ecosystems and efforts to conserve

The World over, uncontrolled exploitation of fish, mangroves and other marine resources has led to their rapid loss with an uncertain potential of their recovery. In Kenya, human economic activities have been named as the major threats to the health and viability of marine ecosystems such as coral reefs, seagrass beds and mangroves. These activities include over-fishing, destructive fishing (such as use of dynamite and cyanide), overharvesting of mangroves (Dahdouh-Guebas *et al.* 2000) and other marine products (such as shells), conversion and pollution of natural habitats (Emerton and Tessema 2001) and as a result of the rapid growing human population into urban centers and rapid expanding tourism. Approximately 40% of the world human population resides in coastal areas, which are just 10% of the earth surface. The El Niño Southern Oscillation (ENSO) is the most recent cause for coral mortality. These human pressures and climate change factors thus reduce the capacity of marine and coastal ecosystems to provide goods and services with high social importance (Remoundou 2009) by threatening their stability.

MPAs have been described as regulatory tools established in order to conserve natural or cultural resources of the ocean and manage use through zoning (Hoagland *et al.* 2001; Kaunda-Arara and Rose 2004; Sumaila and Charles 2002) such as allowing coexistence between fishing and tourism (Kaunda-Arara and Rose 2004). "*They are also passive management strategies designed like seasonal closures and catch quotas, which allow for the recovery of an overexploited resource base*" (Carter 2003). Generally, they assist in protection of critical habitats, allowing for recovery of heavily exploited species, buffers against management errors and restocking adjacent areas. Thus, they allow for a spill over of fish to the adjacent fished areas (McClanahan and Kaunda-Arara 1996; McClanahan and Mangi 2000; Kaunda-Arara and Rose 2004) compensating for the effects of reduced fishing area. The purpose of MPAs is therefore to assist in the conservation of biodiversity and promotion of tourism. This is in form of both direct and indirect revenue such that countries are able to balance economic development with environmental protection (Dixon and Sherman, 1990; Mathieu *et al.* 2003) apart from biodiversity protection function of national parks.

Kenyan MPAs and reserves are crucial for marine life including habitats such as coral reefs, mangroves and seagrass beds. A valuable set of ecosystem goods and services to the public are derived from these habitats. These goods and services include among others carbon sequestration, seafood, firewood, recreation, tourism, storm protection and cultural and religious values (Sanchirico 2000; Rönnbäck *et al*. 2007). Thus, their economic value is measured in terms of what we are willing to pay for a commodity, less the cost of supplying it (Barbier *et al.* 1997). "*Valuation ultimately refers to the contribution of an item to meeting a specific goal*" (Costanza and Folke 1997).

1.2 Economic valuation

1.2.1 An overview of the concept

Value refers to the "*degree to which an item contributes to an objective or condition of a system*" (Farber *et al.* 2002). Economic valuation often measures what the communities or stakeholders are willing-to-pay (WTP) less the costs in order to acquire the good or service or the willingness-to-accept (WTA) compensation for a loss. Since WTA estimates are often higher than WTP, the WTP estimates are often used. The concept of economic valuation involves identification of goods and services derived from the ecosystem and their ultimate monetary value. The framework that is commonly used is the Total economic value (TEV) to define the utilitarian value of ecosystems. TEV is divided into use and non-use values.

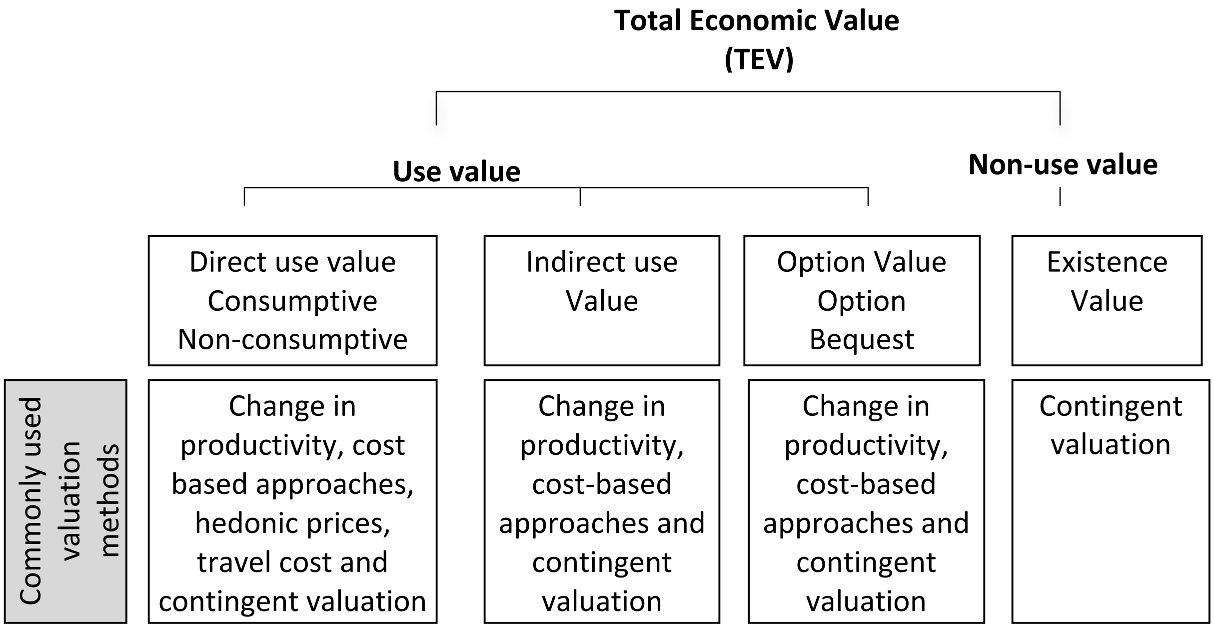

Figure 1: Total economic value. Source: Adapted from Pagiola *et al.* (2004); MA (2005)

The use value consists of direct, indirect and option value. It refers to the "value of ecosystem services that are used by humans for consumption or production purposes" (MA 2005). Direct use values are ecosystem goods and services that are used directly by man. They include both consumptive (extractive) such as food products, medicines and timber for construction and non-consumptive (non-extractive) uses such as recreation, research and education. People visiting or residing in the ecosystem benefit from direct use values. In MA (2005), this category corresponds to both provisioning and cultural services.

Indirect use values such as storm protection function, water purification, nutrient cycling and carbon sequestration are more functional and their benefits are not consumed directly but extend away from the ecosystem itself. In MA (2005) definition, this category would correspond to both regulatory and supporting services.

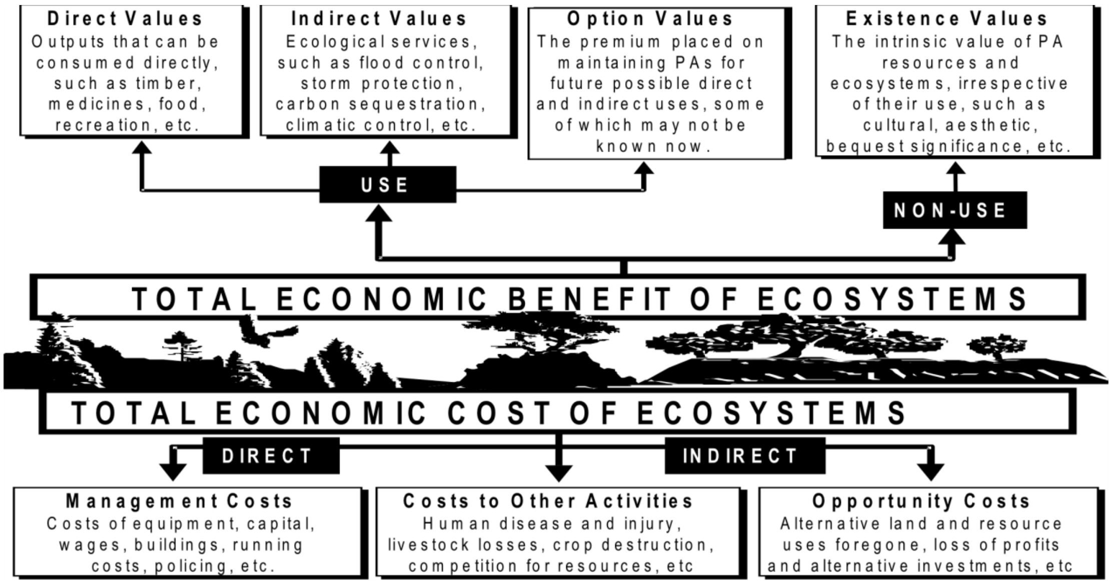

Figure 2: Total economic value of the Ecosystems**.** (Source: Adapted from IUCN, 2005)

Option value refers to those goods and services not used presently but have the potential of being used either directly by oneself (option value) or indirectly by others or heirs (bequest value) in the future. Examples include provisioning, regulating and cultural services. Some authors also distinguish the quasi option value (Hein 2006). Thus, quasi option value is the expected value of the information derived from delaying exploitation and conversion of the ecosystem today.

Non-use value, also referred to as existence value is the satisfaction derived by merely knowing that the resource continues to exist even if they never expect to use that resource directly themselves. The non-use value of ecosystem services is often considered the hardest to estimate since it is reflected in people's behavior (Pagiola *et al.* 2004). These values can be summarized in the following equation

$$TEV = UV + NUV = (DUV + IUV + OUV) + (BV + EV)$$

Where TEV – Total Economic Value; UV – Use Value; NUV – Non-use value; DUV – Direct use value; IUV – Indirect use value; OUV – Option use value; BV – Bequest value and EV – Existence value

Table 1: The goods and services identified in this study.

Use value			Non-use value	
Direct use value	*Indirect use value*	*Option value*	*Bequest value*	*Existence value*
Extractive	Carbon sequestration √	Biodiversity x	Habitats √	Existence √
Fishing √	Habitat /refuge √	Habitats x	Species √	
Fuelwood √	Nutrient retention √	Species x		
Timber √	Coastal protection √			
Non-extractive	Biological control √			
Education and research √	Waste regulation √			
Recreation √				

(√ Indicates value determined; x indicates value not estimated).

1.2.2 Ecosystem goods and services

Ecosystem services have been defined and classified variously by different authors (Costanza *et al*. 1997; Turner *et al.* 2000; MA 2005; Hein 2006). Costanza *et al*. (1997) begin by defining ecosystem functions. They refer "*variously to the habitat, biological or system properties or process of ecosystem*" (Costanza *et al*. 1997). Thus, ecosystem goods and services refer to "the benefits human populations derive, directly or indirectly, from ecosystem functions" (Costanza *et al*. 1997). Ecosystem services "*are the goods or services provided by the ecosystem to society*" (Hein 2006). According to MA (2005), ecosystem services refer to the benefits people obtain from ecosystems. These include provisioning services such as food and water; regulating services such as flood and disease control; cultural services such as spiritual, recreational and cultural benefits; and supporting services such as nutrient cycling that maintain the conditions for life on Earth.

Costanza *et al.* (1997) stresses that without the services of ecological life systems, the economies of the earth would grind to a halt. MA (2005) lumps goods, services and cultural benefits into one group referred to as "ecosystem services" since its difficult to determine whether a benefit provided by an ecosystem is a "good" or a "service". Consideration of the scales at which ecosystem services accrue to the different stakeholders is important in valuation in order to support decision-making for ecosystem management (Hein 2006). According to MA (2005), the following ecosystem services categories can be derived from coral reef and mangrove ecosystems, which are the main ecosystems in this study;

Table 2: Categories of ecosystem services for coral reefs and mangroves according to MA (2005)

Ecosystem services	Definition	Coral reefs	Mangroves
Regulating	Benefits obtained from the regulation of ecosystem processes.	Coastal protection Formation of beaches and islands	Coastal protection Regulation of erosion and sedimentation Water quality maintenance Climate regulation Carbon sequestration
Provisioning	Products obtained from ecosystems such as food.	Subsistence and commercial fisheries Fish and invertebrates for the ornamental aquarium trade Pharmaceutical products Building materials	Subsistence and commercial fisheries Aquaculture Honey Fuel wood Building materials Traditional medicines
Cultural	Nonmaterial benefits people obtain from ecosystems through spiritual enrichment, cognitive development, reflection, recreation, and aesthetic experience such as aesthetic values.	Tourism and recreation Spiritual and aesthetic appreciation Education and research	Tourism and recreation Spiritual – sacred sites Education and research
Supporting	Ecosystem services necessary for the production of all other ecosystem services. Including supporting services in valuation may lead to double counting since their value is reflected in the other types.	Cycling of nutrients Nursery habitats	Cycling of nutrients Nursery habitats

Source: Adapted from MA (2005); UNEP-WCMC (2006); Hein (2006).

1.2.3 Global Value of Marine Ecosystems

A number of authors have calculated the global value of the world's marine ecosystems. Under a total reef area of 284,000 km^2, Cesar *et al.* (2003) estimate the potential net benefit stream for the world coral reefs to be a total of USD 29.8 billion per year. On condition that these reefs are well managed and left intact, they calculated the fisheries value to be USD 5.7 billion, tourism and recreation USD 9.6 billion, coastal protection USD 9.0 billion and biodiversity USD 5.5 billion per year. Costanza *et al.* (1997) on the other hand, estimate the total annual economic value of the world's mangroves as more than USD 900 000 per km^2 while that of coral reefs they estimate to be about USD 600 000 per km^2. Brander *et al.* (2006) estimated the annual value of mangroves to be USD 2800 per hectare.

1.2.4 Mangrove utilization

1.2.4.1 Introduction

Mangrove forests occur worldwide in the (sub) tropics intertidal zones serving a multitude of uses (Table 2) including among others as habitats for terrestrial and marine organisms (Nagelkerken 2008). Their utilization is worldwide and often small scale (Walters 2005) in the rural coastal communities (Walters *et al.* 2008). Some of the most important direct uses of mangrove trees to these communities include use as fuelwood, charcoal and construction (Dahdouh-Guebas *et al.* 2000; Walters 2005; Rönnbäck *et al.* 2007; Walters *et al.* 2008). In (sub) tropics where they occur, mangrove forests have experienced deforestation and degredation by man including urbanization and illegal logging for fuelwood and timber for construction (Rönnbäck *et al.* 2007).

1.2.4.2 Mangrove utilization in Mida Creek

Rational use of mangrove has usually been prevented by "*the sectorial approach of mangrove resource management, lack of community inputs into management efforts, the poverty status of many indigenous coastal communities, and a lack of awareness amongst decision makers about the true values of mangroves*" (Kairo *et al.* 2001). For many coastal communities Mida Creek inclusive, mangrove dependence is high. Thus, wood and non-wood products from mangroves are used for different purposes (Dahdouh-Guebas *et al.* 2000; Rönnbäck *et al.* 2007; Walters *et* *al.* 2008) including their most valued purpose as sources of wood (Walters 2005). Harvesting is however both size and species selective, with more effort spent on finding the suitable trees for construction purposes and that are rated with high value in the market (Dahdouh-Guebas *et al.* 2000; Walters *et al.* 2008). Fishing and other marine related activities are the principal income sources of the communities in the creek with many households relying on forest products for fuel and construction of houses.

In Mida Creek, mangroves cover an approximate 1746 ha (Kairo *et al.* 2002). Cutting of trees is illegal, though a decline in mangrove cover has been reported due to overexploitation (Dahdouh-Guebas *et al.* 2000; KWS 2011). Traditionally, mangrove trees in Kenya have been used for fuelwood and building poles (Dahdouh-Guebas *et al.* 2000; Kairo *et al.* 2002) and recently in construction of restaurants, hotels and holiday resorts (Kairo *et al.* 2002). Fuelwood is obtained from the terrestrial forest or from the harvesting of old trees in the forest. However, there is an annual license fee of Kshs.100 charged *per annum*. The sale of mangrove products is usually to supplement income from other marine activities (Walters *et al.* 2008). See Dahdouh-Guebas *et al.* (2000) for details on utilization of mangrove products by both subsistence and commercial users in the creek.

Table 3: Traditional uses of mangroves in the Mida-Creek

Species name	Local names (Kiswahili, Giriama)	Uses	Parts used
Avicenia marina	mchu	Bed posts, chair legs, table legs, fencing posts, charcoal, low quality commercial firewood, crushing pole, crushing mortar, serving dishes, drums, boat ribs, board games (bao)	Thick stems
		Firewood (for home use)	Dead stems
		Insecticides	Green stems
Bruguiera gymnorrhiza	Muia, mkoko wimbi	High quality commercial firewood and charcoal, construction poles, roof supports, boat paddles, oars, handcart handles, axe handles, pounding poles	Thick mature stems
		drums, bee hives	Old hollow stems
Ceriops tagal	Mkandaa, mkoko, mtune, mkoko mwekundu	Construction poles, paddles, oars, medium quality commercial firewood	Mature and young stems
		Dyes (including tanning compounds)	Bark of stems
		Fishing traps	Young flexible stems
Lumnitzera racemosa	Kikandaa, mkaa pwani	Medium quality commercial firewood and charcoal	Mature stems, dead stems
Sonneratia alba	mlilana	Canoes, boat ribs, paddles, masts, fishingnet floats, timber for window and door frames, medium quality charcoal and firewood	Thick mature stems
Rhizophora mucronata	Mkoko, mkoko mwenye	Construction poles, high quality commercial charcoal and firewood	Thick mature stems and young stems
		Dyes (including tanning compounds), medicines and ointments	Barks of stems and roots
		Fishing traps	Roots
		Weapons	Young stems
Xylocarpus granatum	mkomafi	High quality timber for bed construction, window and door frames, medium quality commercial firewood and charcoal	Mature stems
		ointments	Crushed fruit

Source: Adapted from Dahdouh-Guebas *et al.* (2000).

Mangrove species occurring in the creek include *Rhizophora mucronata* (L.) Lam*, Ceriops tagal* (Perr.) C.B. Robinson*, Bruguiera gymnorrhiza* (L.) Lam.*, Avicennia marina* (Forssk.)*, Sonneratia alba* Sm.*, Lumnitzera racemosa* Willd., and *Xylocarpus granatum* Koen, (Dahdouh-Guebas *et al.* 2000; Kairo *et al.* 2002; Rönnbäck *et al.* 2007) and each is utilized traditionally for different specific purposes (Dahdouh-Guebas *et al.* 2000). The most harvested mangrove poles for construction include mazio and boriti with butt diameter between 8.0 and 13 cm respectively (Kairo *et al.* 2002). Apart from the direct values, mangroves also provide a wire array of services that support both social (Barbier *et al.* 1997; Spaninks and Benkering 1997) and economic activities (Spaninks and Benkering 1997) in the park and reserve**.** According to the Kenya Forest Department, mangroves occupy 64,426.9 ha (or 3%) of the forest cover; however the estimated area of mangroves varies from 50,000 to 100,000 ha depending on the survey and author (Kairo and Dahdouh-Guebas *in press*).

1.2.5 Coral reefs and fisheries

1.2.5.1 Coral reef goods and services

The coral reefs along the Kenyan coast are fringing reefs. In the Watamu MPA, the reef is a linear lagoonal coral reef (McClanahan *et al.* 2002). Like mangroves, these coral reefs provide a diverse range of goods and services to the populations living in coastal Kenya. Many of the benefits they provide are non-use values and therefore have a non-market value. Reefs and reef-based resources are often considered as their primary means of food production, source of income and livelihood (Ahmed *et al.* 2004). Coral reefs also provide ecosystem services such as coastal protection, spawning and breeding grounds and nurseries for fish and a variety of marine organisms. They also offer physical and biological support to mangroves, seagrass beds and the open ocean (Moberg and Folke 1999).

However, these ecosystems are threatened by overfishing and due to the increasing number of fishermen in the area. Other threats include destructive fishing practices (such as poison fishing), increased tourism, sedimentation, coral bleaching as a result of climate change and pollution caused by agricultural and industrial activities. This can lead to a replacement of hard coral by erect alga (McClanahan *et al.* 2002; Nordemar *et al.* 2007). A decline in reef cover and coral health leads to a significant loss of income from the main activities such as fishing and recreation

(Ahmed *et al.* 2004) for the communities as well as to the government for instance in terms of tourism decline.

Table 4: Goods and ecological services of coral reef ecosystems

Goods		Ecological services					
Renewable resources	Mining of reefs	Physical structure services	Biotic services		Biogeochemical services	Information services	Social and cultural services
			Within ecosystems	Between ecosystems			
Sea food products	Coral blocks, rubble and sand for building	Shoreline protection	Maintenance of habitats	Biological support through 'mobile links'	Nitrogen fixation	Monitoring and pollution record	Support recreation
Raw materials for medicines	Raw materials for producti on of lime and cement	Build up of land	Maintenance of biodiversity and a genetic library	Export of organic production, and plankton to pelagic food webs	CO_2/Ca budget control	Climate record	Aesthetic values and artistic inspiration
Other raw materials (seeweed and algae for agar, manure, etc.)	Mineral oil and gas	Promoting growth of mangroves and seagrass beds	Regulation of ecosystem processes and functions		Waste assimilation		Sustaining the livelihood of communities
Curio and jewellery		Generation of coral sand	Biological maintenance of resilience				Support of cultural, religious and spiritual values
Live fish and coral for the aquarium trade							

Source: Adapted from Moberg and Folke (1999).

1.2.5.2 Fisheries management

Like the rest of the Kenyan Coast, Watamu fisheries are typical multi-gear and multispecies artisanal fisheries. Finfish and shellfish catch is derived from the shallow-water mangrove, coral reef and seagrass ecosystems (McClanahan *et al.* 2008). The fishing gears used vary (McClanahan and Mangi 2001), though the main gears used are line-fishing, traps, seine nets and gill nets. Thus, fish species are regularly harvested from inshore, within the creek and territorial sea areas and offshore (by commercial ring net fishers) in the Exclusive Economic Zone (EEZ), which runs from three to 200 miles offshore.

Methods that help in the prevention of overexploitation, poor catches and poverty around the world have focused on opening new fisheries such as offshore, artificial reefs or aggregation fisheries, eliminating destructive gear and closed areas such as marine parks (McClanahan and Mangi 2001). Marine Parks in Kenya like in other countries of the world were therefore established to promote tourism and protection of the resource from extraction (Cinner *et al.* 2010). These MPAs (Watamu, Malindi, Mombasa and Kisite) and marine reserves (Kiunga, Malindi-Watamu, Mombasa and Mpunguti) contain seagrass beds, coral reefs and mangroves but are ecologically and economically dominated by coral reefs (Muthiga 2003). The fisheries resources of Kenya are managed by the Fisheries Department under the Fisheries Act, and, where designated as Protected Areas, by the Kenya Wildlife Service (KWS) under the Wildlife and Conservation Act (Mangi 2007) while the Forestry Department manages the mangroves as forest reserves. Thus, fisheries management mainly concentrates on conservation of fish populations by applying fisheries regulations such as restricting gear type, fish and catch size or closing waters (Cinner *et al.* 2010; McClanahan and Arthur 2001) to enable for recuperation of fish populations (McClanahan and Arthur 2001).

Kenya's MPAs have two types of management: where no resource extraction is allowed referred to as Marine National Parks or closed areas and where use of fishing gear is restricted referred to as Marine National Reserves (McClanahan 2004). Consequently, marine parks are encompassed within larger marine reserves where fishing gear types are restricted (Mangi 2007) though fishing ground sites are reported to be heavily fished with effort >4 fishers km^{-2} day^{-1} (McClanahan *et al.* 2010). Such an arrangement enhances a wider multi-use marine management. Elsewhere, fishermen prefer rotational to permanent closures due to the perception that temporary closures are a form of traditional resource management and that resources are not 'locked away' forever (Williams *et al.* 2006) though it is not an effective method in conservation (McClanahan and Arthur 2001). Bartlett *et al.* (2009) argues that it may still have some ecological benefits causing an increase in abundance and biomass of targeted fishes and in taxa vulnerable to fishing; thus an effective fisheries management tool. However, in order to ensure conservation and sustainable management of these ecosystems, management measures by various stakeholders have been developed (McClanahan *et al.* 2006) such as mangrove plantation. Such efforts are however hindered by the fact that some stakeholders often benefit or incur costs more than others and over time.

1.3 Justification of the valuation

With the increasing human populations in coastal areas, marine biodiversity and productivity is increasingly being threatened (Sanchirico *et al.* 2002). Economic costs and benefits of MPAs though understood (Dixon 1993) and considering their importance in management and decision making process is rarely quantified. The quantification of the value of ecosystem goods and services and incorporating them in economic analyses is crucial for the conservation of these benefiting ecosystems (Hein *et al.* 2006; Koch *et al.* 2009) "*so that they can provide the services that humans want and need*" (Barbier *et al.* 2008). Yet, the challenge is usually getting their true value.

Valuation of ecosystem goods and services has not been attempted exclusively in Kenyan Marine parks and reserves. Studies have focused on conservation benefits (Ransom and Mangi, 2010), trade-offs in values assigned to ecological goods and services (Hicks *et al.* 2010), management on fisheries, while recently, others have used MA approach to value cost of resources (Brown *et al.* 2007). The MA (2005) gives three basic motivations for economic valuation;

"*To be able to assess the overall contribution of ecosystems to social and economic well-being, establish how and why economic actors use ecosystems as they do and to assess the relative impact of alternative actions so as to help guide decision-making*."

The benefits provided for by ecosystem services are often underestimated in decision-making (Hein *et al.* 2006). Costanza *et al.* (1997) argue "*ecosystem services are not fully 'captured' in commercial markets or adequately quantified in terms comparable with economic services and manufactured capital, they are often given too little weight in policy decisions*". Valuation cannot be avoided, since we make choices (Costanza and Folke 1997; Costanza *et al.* 1998; Costanza *et al.* 2007) and tradeoffs concerning the environment (Barbier *et al.* 2008; Hicks *et al.* 2009), which implies we are doing valuation (Constanza and Folke 1997; Costanza *et al.* 1998).

Though economic valuation is essential if decisions are to be made concerning the environment, Gowan *et al*. (2006) argue that it might be considered of minor importance in some cases such as in ecosystem-enhancing measures. Recognition of multiple values derived from ecosystem services will lead to new solutions for conservation practice (Shuang *et al.* 2010). Valuation of goods and services will enhance efforts aimed at conservation and sustainable use of the resources over destructive use. Valuation also contributes in explaining the importance of resources in the park and reserve by providing information on current status of fish stock and fish landing and exploitation and use of other resources such as mangroves. Thus, the management plans for the park and reserve will focus also on the resources that have not received much attention in the past as well as those that are already known as well as offering all stakeholders equal opportunities. Valuation will enhance balancing of different interests of stakeholders with compromise solutions made to balance use of ecosystem services. This will therefore enhance efforts of better policy formulation and decision-making (Turner *et al.* 2003) for sustainable management. Thus, scarce resources will be allocated fairly among competing demands (Turner *et al.* 2003). Moreover, providing education to beneficiaries about the values supported by coastal and marine ecosystems such as mangroves, seagrasses and coral reefs like in this study will increase awareness both locally and globally.

1.4 Study objectives

The main objective of this study is to undertake an economic valuation of ecosystem goods and services within the Watamu Marine Park and Reserve in order to guide sustainable use of resources and management strategies.

The specific aims include the following:

- To establish the distribution of income among stakeholders from the available ecosystem services.
- To determine the value of goods and services within the MPA and Reserve
- To establish the cost of management of Watamu Marine Park and Mida Creek Reserve.

CHAPTER 2

2.0 Materials and Methods

2.1 Study area

Watamu Marine National Park and Reserve is situated approximately 80km to the north of Mombasa and 25km to the South of Malindi. The Watamu-Malindi complex was the first MPA to be established in Africa. The Park and Reserve, established in 1968 has a centralized national management approach which until recently did not involve community participation (McClanahan *et al.* 2005). Before separation into Watamu and Malindi National Parks, the complex consisted of a park (16km^2) and reserve covering 245km^2. The reserve (03°21′S, 39°59′E) was gazetted under the Wildlife Conservation Management Act in 1976 (Government of Kenya 1976).

The Park is bounded by a fringing reef that makes it a "*massive lagoon with conspicuous islands surrounded by patches of flat eroded inner reef*" (Kaunda-Arara and Rose 2004). Habitats include mangroves, seagrass beds, coral reefs and sand and mud flats. With a total area of 1746ha, the Mida Creek area has 7 species of mangroves dominated by *R. mucronata* and *C. tagal* (Kairo *et al.* 2002), 12 species of seagrasses and many species of coral with diverse species of fish, crabs and turtles. No consumptive utilization (Emerton and Tessema 2001; Eklöf *et al.* 2008) is allowed in the MPA, while in the Reserve, fishing activities only using traditional methods (such as traps, hook and line and 2.5 inch mesh size net) are permitted. Tourist diving, snorkeling (Emerton and Tessema 2001) and viewing of corals and fish from glass-bottomed boats and research, takes place in both the park and reserve. Main hotels around the Park include the Watamu beach, Blue bay, Ocean sports, Temple point, Hemingways and Turtle bay beach club. All the revenues collected by the Park are sent to the KWS headquarters in Nairobi. The KWS Headquarters then allocates the funds to the park for its operational activities.

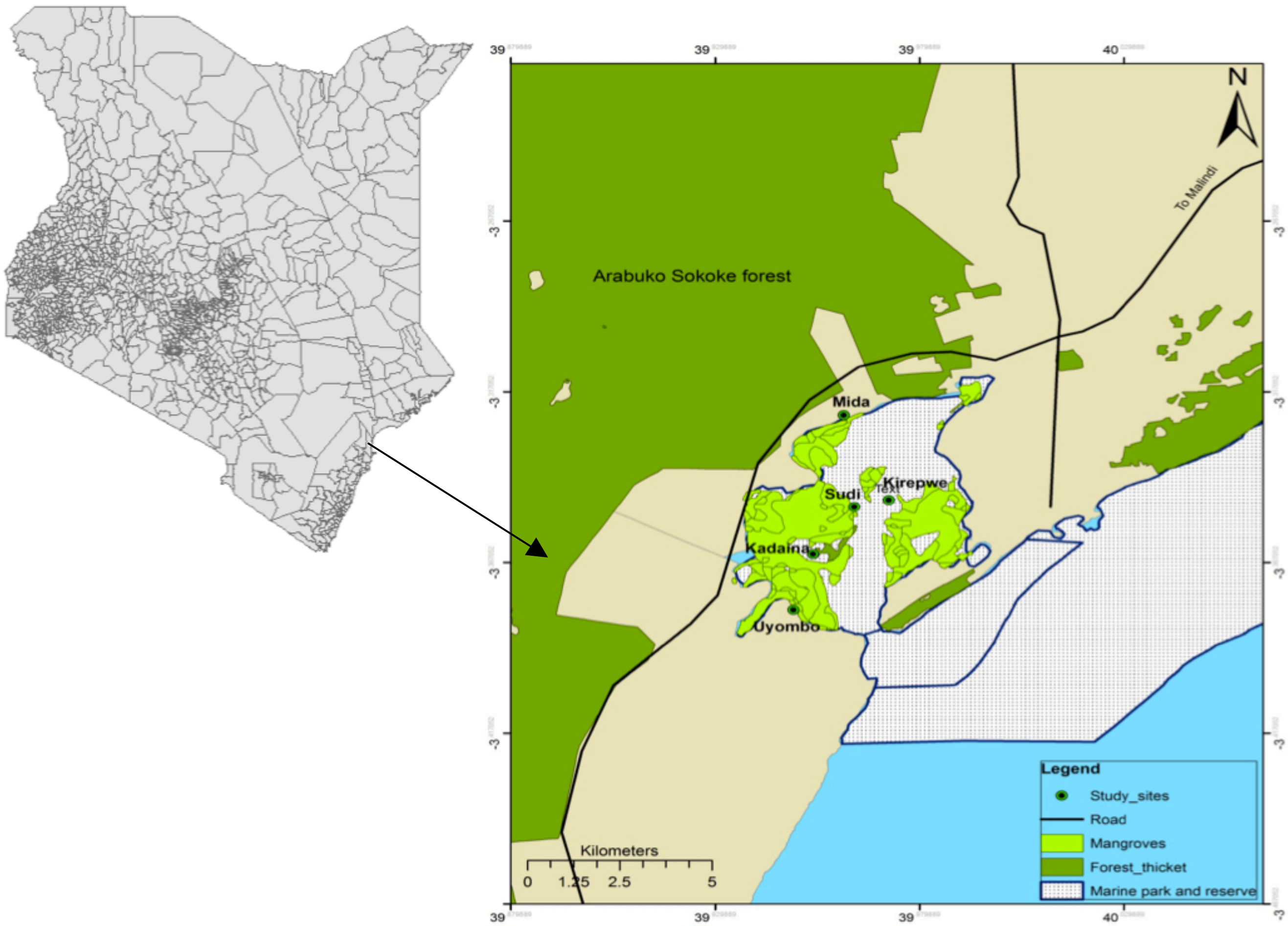

Figure 3: Map of Watamu showing the study area (Watamu Marine Park and Mida Creek Reserve)

Close to the Park is Watamu "town" with a population of around 1900 inhabitants comprising local and foreign residents. Local residents are Kenyan citizens while foreign residents include non-citizens staying and/or working in the country. Other trading centres include Gede on the Malindi-Mombasa "highway" and Timboni between Gede and Watamu centres. The Creek on the other hand has an area of 31.6km^2 (Dahdouh-Guebas *et al.* 2000) with over 750 families that have settled along the shore since 1936 (Omodei-Zorini and Contini 2000; Omodei-Zorini *et al.* 2004) separated into Uyombo and Kirepwe (with villages such as Dongokundu, Dabaso and Sita). Agriculture accounts for 50% of total income of 4,345 USD (453 USD per capita), of the communities, with other sources of livelihood including fishing and fish trading, hotel employment, livestock husbandry, crab harvesting (Omodei-Zorini *et al.* 2004), collection of firewood from the mangroves and trade in farm produce (Dahdouh-Guebas *et al.* 2000; Omodei-

Zorini *et al*. 2004) accounting for the other 50%. Households also supplement their income with subsistence farm produce and fish.

Like seagrasses and coral reefs, the mangrove forest is vital for the marine life around the park and reserve. There are however reports of logging (Dahdouh-Guebas *et al.* 2000; Omodei-Zorini *et al.* 2004) threatening this and other services including coastal stabilization and flood control. This has been countered by efforts to replant mangroves by different organizations and protection of the already established forests. Overfishing and use of destructive fishing methods has also been reported which has enhanced efforts to conserve the resource as a marine protected area.

2.2 The area as a Man and Biosphere Reserve (UNESCO)

In 1979, the then Malindi-Watamu reserve complex was recognised and designated as a Man and Biosphere Reserve (UNESCO 2011) by UNESCO. Thus, though under Kenya's sovereign jurisdiction, the Malindi-Watamu reserve complex must share its experience and ideas nationally, regionally and internationally within the World Network of Biosphere Reserves (WNBR). This is because, since it was designated as a Man and Biosphere Reserve, it acts as a learning site for the sustainable management of other marine parks and reserves in the world.

The major features around the area include rocky, muddy and sandy beaches, a variety of coral species, seagrass beds, coral cliffs and mangrove tree species in the Mida Creek. Thus research around the park and reserve has focused on coral reef fishes and fisheries management (McClanahan and Obura 1995; McClanahan *et al.* 2002), mangrove ecology and utilization (Dahdouh-Guebas *et al.* 2000; Dahdouh-Guebas 2001; Omodei-Zorini *et al.* 2004), seagrass beds (Eklöf *et al.* 2009) and on socio-economic factors. This is also in response to natural factors such as siltation due to the affluence from the Sabaki river in the north, the rapid human expansion, tourism and fisheries.

2.3 Justification for choice of site

Watamu Marine Park and Reserve was the first MPA in Kenya and Africa and holds approximately 42 years since it was established. It also boosts of crucial passage of birds, turtle nesting areas, coral reefs, seagrasses and an extensive mangrove forest in the Reserve. It was designated as a Man and Biosphere Reserve because of these globally important assets. Mangrove, coral reef and seagrass ecosystems in the Park and Reserve provide important goods and services to human society but have been degraded and overexploited over the years. Thus, the mangrove cover has declined remarkably (Dahdouh-Guebas *et al.* 2000; Omodei-Zorini *et al.* 2004; KWS 2011) and there has been overfishing and use of destructive gear (Mangi and Roberts 2007; Cinner 2010). This coupled with conflicts between user groups due to community heterogeneity (various social and activity groups) and therefore differing interests and benefits from the presence of the MPA (Malleret-King 2000) and widespread poverty in local communities. Actually, these problems have not been solved and have sometimes been elusive to quantitative estimation.

Recognition of the value of ecosystem goods and services by the local community and policy makers is necessary to induce further action towards conservation in Watamu Marine Park and Reserve as well as other coastal areas in Kenya. Moreover, it would be easier for the MPA to meet its objectives including management of marine resources, biodiversity protection, sustainable livelihoods for local communities, reducing conflicts, managing tourism activities and education and awareness (Muthiga 2009) if the value of ecosystem goods and services are recognized. The study forms a baseline for valuation of ecosystem goods and services in MPAs in Kenya, which has not received much attention. It aims to highlight biodiversity importance in Watamu MPA and Reserve, promote community participation and appreciation of the resources by community and policy makers. This is expected to lead to successful management of marine ecosystems supported by the local community who depend on them for their livelihood and food security (Malleret-King 2000) such that they can benefit from the resource whilst utilizing it sustainably.

2.4 Economic valuation methods

2.4.1 Overview of economic valuation methods

The choice of valuation methodology is determined by various conditions and factors. It depends on whether the collection of the data was based on observed or hypothetical questions. A number of techniques have been commonly used in valuation (Table 5).

Revealed preference techniques are based on observed behaviour of producers and consumers. The methods indirectly infer values from people's behaviour in surrogate markets hypothesized to be related to the ecosystem of interest. The use of this technique applies to good traded on the market for consumptive use. Examples include; Travel cost method, production function approach, recreational demand analysis, hedonic pricing and averting behaviour model (Barbier 2000).

Table 5: The main economic valuation techniques

Technique	Approach	Limitations	Quality check/ Indicators
Market Prices (MP)	An accounting procedure to value environmental goods and services traded in markets. It can also be extended to other nonmarket ecosystem service benefits by observing how changes in provision affect the prices or qualities of other marketed goods.	• Only applicable where market data is available • Market price may not offer a true reflection of marginal social costs and benefits • Lower bound estimates • Sensitive to functional form	• Any price distortions due to market imperfections or policy failure should be corrected • Assessment of market capacity included • Examination of changes in real prices over time • Appropriate functional form for demand curve
Production Function (PF) Also known as dose–response technique	Involves tracing the impact of a physical change in the quantity or quality of an ecosystem service along a series of pathways to ascertain the corresponding impact on human welfare	• Data is often lacking on change in service and consequent impact on production Can not estimate nonuse values	• Utilization of expert scientific knowledge of ecosystem functions • Explicit cause and effect modeling (not just correlation) incorporating possible threshold levels and discontinuities • Modeling of whole market (demand and supply) including dynamic effects • Prices of all inputs and outputs corrected for distortions • Absence of double-counting in studies on multiple use systems
Travel Cost Method (TC)	Survey based technique using information on observed travel and time expenditures (a central assumption is that the benefit an individual receives from a particular site is worth at least as much as he or she is willing to pay to visit it)	• Applicable only in a few contexts • Requires large amount of data • Complex when trips are multipurpose • Can not estimate non-use values	• Reasonable site definition, spatially explicit and coverage of entire area to be affected • Modeling of participation: inclusion of non-visitors as well as visitors • Site selection which reflects actual choice sets • Inclusion of site-specific data on services, lodging options and communication

Technique	Approach	Limitations	Quality check/ Indicators
			• Exclusion of indirect costs from travel cost variables and cost of equipment used one more than one occasion • Appropriate estimation of shadow price for time • Appropriate and relevant selection of environmental quality variable, ideally in quantitative terms. • Consideration of and appropriate adjustment for multipurpose trips • Model explanatory power and confidence intervals for environmental quality attribute and travel cost • More robust results may be achieved in studies which combine TCM and CVM or choice modeling
Hedonic Pricing (HP)	Assumes the good of interest may be implicitly traded via demand for a marketed good; in most cases this will be in the property market, e.g., scenic beauty is often implicitly traded such that its value may be calculated by the price differential between two identical houses where one is located in an area of outstanding natural beauty and the other is not	• Dependent on large amount of data • Very sensitive to specification • Can not estimate non-use values	• Price data based on individual transactions in market rather than assessed values • Consideration of measurement error in price data and appropriate adjustment • Correct specification of HP function and availability of accurate data for all variables • Appropriate and relevant selection of environmental quality variable, ideally in quantitative terms • Appropriate functional form: linear models typically inadequate • Checks for • Multi-collinearity and appropriate action • Correct definition of market extent—under- rather than overestimated Model explanatory power and confidence intervals for environmental quality attribute
Replacement Cost (RC)	Estimates the value of a change in a nonmarket ecosystem service by calculating the cost of	• Tends to overestimate • Few studies verify conditions necessary for validity	• Assessment of extent to which man-made replacement and lost ecosystems are substitutable and any significant differences in quantity

Technique	Approach	Limitations	Quality check/ Indicators
	replacing the lost or reduced service with a manmade substitute or with restoration of the ecosystem	• Can not estimate non-use values	and quality taken into account • Evidence that chosen replacement is least cost way of replacing—otherwise overestimate • Evidence that public are willing to pay for replacement costs (not necessarily a full-blown stated preference (SP))
Defensive Expenditure Method (DE)	This approach considers the costs and expenditures incurred in avoiding damages of reduced environmental functionality	• Issues relating to degree of substitutability • Typically lower bound estimate • Difficulty of disentangling value estimates when joint products provided • Can not estimate nonuse values	• Assessment of degree of substitutability, ideally goods will be prefect substitutes (or very high degree of substitutability) • Examination of perceived versus objective level of protection offered by substitute • Estimation of demand function
Contingent Valuation Method (CV)	A stated preference technique which elicits public preferences by directly asking people how much they would be willing to pay (or accept) for a change in the quantity or quality of a given environmental good or service in a hypothetical market	• Time and cost in designing and implementing surveys • Loss of nontrivial information • Non-compensatory decision strategies, e.g., warm-glow, rights-based • Problem of constructed, theoretically inconsistent preferences • Various sources of bias, e.g., hypothetical bias, strategic bias, insensitivity to scope, framing and elicitation effects	• Evidence of thorough and extensive pretesting of survey instrument: focus groups, cognitive interviews, and pilot testing • Inclusion of reminders of budget constraints and substitutes • Low rates of item nonresponse, protests and outliers (high rates may indicate weaknesses in scenario) • Model explanatory power, rejection of the null hypothesis that all coefficients on explanatory variables are equal to zero; and expected determinants of willingness to pay (WTP) are significant and correctly signed • Reasonable WTP estimates: WTP as proportion of income; consistency with other similar studies; and examination of confidence intervals • Assessment of tests incorporated for bias
Choice Modelling (CM)	A stated preference method which elicits public preferences by asking respondents to	As for CVM, in addition: • Greater cognitive burden may lead to	Similar to CVM, additionally: • All relevant attributes included, and levels are meaningful • For estimates to be welfare

Technique	Approach	Limitations	Quality check/ Indicators
	choose their preferred option from a series of alternatives, each described in terms of its constituent attributes and levels	random errors and difficulty in modeling responses. • Potential bias, e.g., inconsistency, learning and fatigue effects • Missing attributes • Technical complexities in design and data analysis	consistent, a baseline or opt-out option should be included unless in real-life a choice can not be avoided • Attributes (and any interactions with socio- demographic variables) are significant and correctly signed • Where applicable the independence of irrelevant alternatives assumption should be met • Confidence intervals for marginal WTP and overall welfare estimates • Assessment of tests incorporated for bias, e.g., inconsistency; survey satisficing; heuristics; dominant options and results assessed

Source: Adapted from Turner *et al.* (2010).

Stated preference methods: these are techniques that deduce people's preferences by describing hypothetical situations rather than actual scenarios. These methods value non-market goods that do not have surrogate or related markets. Examples include Contingent Valuation Method (CV) and Choice Modelling (CM).

Other techniques such as **benefits transfer methods** use results obtained for one area for a different area. The benefits transfer method has two broad categories of approach; benefit functions and value transfer. Function transfers use estimate equations to predict values for an ongoing study. A unit value has two approaches; unadjusted and adjusted unit value transfer. It uses single point estimates or an average of estimates to transfer values to a policy site (Heal *et al.* 2004).

2.4.1 Choice of valuation methodologies

The main methods that are used in this study include the following; 'market price method', 'travel cost method', 'benefits transfer method', 'replacement cost method' and 'contingent valuation method'. The **market price method** estimates the market prices of the ecosystem goods and services. This was used to estimate mangrove and fish value, recreation and the value of goods sold by curio operators. **Travel cost** and **hedonic pricing methods** estimate the value of ecosystem goods and services according to expenditure or prices of other ecosystem goods and services in the market. The travel cost method uses the amount and time spent by people to visit a place to study their willingness to pay for the ecosystem goods and services benefits. It was used to estimate the recreational value of the Park and Reserve. The **replacement cost method** was used to derive the value of coastal protection. The method measures the cost of replacing an ecosystem to estimate its value.

The only stated preference method used was **contingent valuation method**. This was used to estimate the respondents Willingness To Pay (WTP) for the conservation of mangroves, coral reefs and seagrasses. We used the adjusted unit value of the **benefits transfer method** to estimate the value of indirect use services such as biological control, waste regulation and habitat/refuge. These techniques have advantages and disadvantages discussed in annex 1.

2.5 Stakeholder identification

Reconnaissance meetings held with heads of different NGOs working in the area identified the key stakeholders. The study started with a pre-test in 2 villages, which helped in reviewing the questionnaires as well as getting an idea about the ecosystem goods and services and basic information about the villages. Stakeholders identified include but were not limited to fishermen, fish traders, curio dealers, NGOs and community organizations, hoteliers, tourists, canoe and boat operators. However, the study focused on the fishermen, tourists, curio dealers, community organizations, canoe riders and boat operators.

2.6 Household surveys and survey structure

The study was carried out in nine villages near the Park and Reserve. Key criteria in selection of villages included proximity to the protected area by road (km), community involvement in conservation and livelihood dependence on coastal and marine resources such as coral reefs, mangroves, fishing (Tobey and Elin 2006) and other coastal and marine related activities. A total of 173 household surveys were conducted. Household heads or persons over 18 years old were interviewed between July and December 2010. Most of the fishermen were interviewed at the landing sites immediately after the fishermen came from the sea, though some preferred to answer before going to the sea. This meant that the respondents' answers were influenced by whether interviews were conducted before or after the fishing exercise. For those conducted before, the fishermen may have answered hurriedly while for those conducted after, the respondents may have been tired. The responses given may also have been influenced by the days catch. Stakeholders such as canoe riders and boat operators were interviewed at their places of work. The remainder of interviews were conducted at the homesteads. Since one of our aims was to estimate income distribution among stakeholders, some of our questionnaires were structured to target these stakeholders. Surveys to get basic information were done randomly after every one homestead and incase stakeholders such as fishermen were encountered, we also interviewed them using our target questionnaires.

Table 6: List of respondent classes with numbers interviewed, when interviewed and how respondents were selected.

Respondent class	Number interviewed	Month interviewed	Year	How approached and selected
Fishermen	96	July, November, December	2010	Household surveys and at landing sites
Boat operators, canoe riders and tour guides	61	July, November, December January	2010 2011	Through surveys, at their place of work
Curio operators	50	July, December	2010	At their place of work
Tourists	49	December	2010	At the beach
Household survey	103	November-December	2010	After every one homestead
	70	July, August	2010	After every one homestead

The questionnaires were in English but interviews were conducted in Kiswahili and Giriama. Some preferred that interviews be conducted in English. The primary instruments for data collection included household, focus group surveys as well as key informant interviews (Tobey and Elin 2006). Key informant interviews were conducted with government authorities and project staff. In order to understand the cultural value of the marine resources in Watamu and Mida Creek, the survey had options about the age, gender, education level, income and cultural and ethnic background of the interviewee (Van Beukering 2006). Secondary data were obtained from the Fisheries and Forestry Department and the Kenya Wildlife Service. The fisheries landing data include statistics for the years 2006-2010 and landings at Watamu from the ringnet fishery from October 2008 to December 2009. Data from the Kenya Wildlife Service include visitor and revenue statistics for the Marine Park range for the years 2004-2010, personnel salaries and Park operation cost budget for the financial year 2010-2011.

2.7 Mangrove stand structure and density

A stratified sampling technique was applied in sampling the mangroves of Mida Creek with the location of the transect lines being determined by an initial reconnaissance and examination of medium-scale (1:25,000) panchromatic aerial photographs of the Creek in October 2010. "*Belt transects of 10 m width were established both perpendicular and parallel to the Creek across the entire forest in such a way that they represented as well as possible the general mangrove formation of Mida Creek*" (Kairo *et al.* 2002; Mohamed *et al.* 2009). Vegetation sampling was carried out within 100 m^2 quadrats along transects and included tree height, stem diameter at 130 cm aboveground and their shapes. A total number of 58 quadrats were sampled with 4 in Kadaina, 9 in Kirepwe, 23 in Mida, 5 in Sudi and 17 in Uyombo. The number of samples taken per site depended on the area and heterogeneity in site in terms of mangrove species. More samples were taken in the larger sites. The more homogenous sites were sampled least.

In each of the quadrats, individual trees with butt diameter greater than 2.5 cm were identified and counted. Tree basal area, stand density and frequency were derived from the vegetation measurements while the ecological importance of each species was calculated by summing its relative density, frequency and dominance (Cintrón and Schaeffer-Novelli 1984). The forests' complexity indices (I_c) were obtained as a product of the number of species (sp), basal area (ba) (m^2/ha), maximum tree height (m) and the number of stems ha^{-1} x 10^{-5} (Holdridge *et al.* 1971). Thus,

$$I_c = sp\ (n) \times ba\ (m^2/ha) \times ht\ (m) \times d\ (n/ha) \times 10^{-5}$$

Tree heights were measured in Suunto™ hypsometer while their diameter was measured by use of a forest calliper. "*For Rhizophora, stem diameters were measured 30 cm above the highest prop roots, whereas for Avicennia, when the stem forked below 130 cm, individual 'branches' in a clump were treated as separate stems*" (Kairo *et al.* 2002; Mohamed *et al.* 2009). An assessment of quality of the poles was conducted using a lead stem such that form 1 denote straight stems best for construction (Mohamed *et al.* 2009) while form 3 poles were crooked and therefore the most unsuitable for construction purposes.

2.8 Quantification and monetization

Identified ecosystem goods and services were grouped into the different categories of use and non-use values.

2.8.1 Direct use values

2.8.1.1 Fisheries

The market price method was used to get the value of fish caught by the fishermen. The total number of fishermen interviewed was 96 (30 in Kirepwe, 20 in Uyombo, 7 in Kadaina, 5 in Sita, 10 in Dabaso and 24 in Mida villages). The difference in sample size was due to the difference in size between the villages. Since fishing is artisanal, the selling price per kg of fish to individual and household buyers in local markets around the villages was obtained. The numbers of fishermen in the area were also noted. An individual fisherman's annual fishery value was calculated from average day's catch/price per catch and multiplied by the number of fishing days per annum (Hicks *et al.* 2009).

The average fisherman catch value per year was then multiplied by the total number of fishermen in the area of and the result divided by the total area available for fishing. Hoorweg *et al.* (2008) calculated the total number of fishermen in the area to be 839: Malindi (492) and Mida (347). We however obtained the data for the total number of fishermen from the two beach management units (Malindi/Watamu and Roka) in the area (BMU). Thus the ultimate value derived is the annual fishery value per hectare. Fish catch data and their monetary value were obtained for the Watamu landing site for the year 2009 and total landings for the years 2006 to 2010.

2.8.1.2 Mangrove utilization

We only estimated use for fuelwood and construction, while others such as medicinal value were disregarded. The mangroves sampled were grouped into size classes (fito, pau, boriti, nguzo and vigingi) based on their diameter (Dahdouh-Guebas *et al.* 2000) D_{130} *sensu* Brokaw and Thompson 2000. The total mangrove stand was extrapolated against the prices for the different size classes to get an idea of the value of the forest ecosystem in the Mida Creek. For mangrove use for fuelwood, the quantity and price of fuelwood used by an average family, how and where it is obtained was determined through the questionnaires. This was compared between households that are far away (approximately 1km) from the sea with those that are close to the sea (< 1km).

2.8.1.3 Recreation

The travel cost method, which derives demand for a site, was used to estimate the recreation value. The method applies to surveys of people visiting a non-priced site for recreation and therefore includes the number of visits and travel costs to the park and reserve. Travel cost can be estimated using either the individual travel cost approach, zonal travel cost approach (Cooper and Loomis 1993) or the random utility approach. The individual TCM requires a visitor to visit a site more than once in a year. Incase that is not possible (Gürlük and Rehber 2008), the zonal travel cost method which does not require visitation frequency can be used. The random utility approach on the other hand is used best when there are many alternative sites for the visitor. The recreational service value includes value for services such as food and beverage service, accommodations, entertainment, transport, shopping and other miscellaneous services (Gustavson 1998). The technique requires the user to spend time and money to visit a site. Thus, the cost varies with origin of user. The demand "v_i" to visit a site for each individual "i" is:

$$v_i = f(TC_i; x_{1i}, \ldots, x_{ni}) \qquad (1)$$

Where, $x_1, \ldots, x_n$ denote the other relevant demand predictors including income, education, age, preferences (Gürlük and Rehber 2008), entry fee, distance and time among others.

$$COST = f[\text{income; education; age; time; distance; entry fee}] \qquad (2)$$

For the zonal travel cost model, the trip generating function is

$$V_j/P_j = f(TC_j, INCOME_j) \qquad (3)$$

Where Vj is the total number of entry by individual visitors from zone *j* to Watamu Marine Park per year; Pj is the population of the zone *j*; TCj is the travel cost from zone *j* to Watamu Marine Park; INCOMEj is the average income of zone *j*.

The linear demand curve (Figure 4) indicates that each point along the curve represents the WTP to visit the site (frequency of visits) and travel costs involved. If an individual visits a site f_1 trips, the benefit he derives from the visit is the area 'odef$_1$'. The more the trips, the more the benefits that individuals derive from the site. Thus, the benefit for f_1 trips includes the actual expenditure '$ocef_1$' plus what they are WTP 'cde'. For f_3 trips, the consumer surplus will be 'adg' and for 'h' trips 'odh'.

The area under the demand curve (theoretical) and above the price is the consumer surplus. We used the individual travel cost approach, where we calculated the total expenditure including accommodation, and transport costs to the park and compared them with the visitation rate/frequency. Thus,

$$\text{TRIPS} = f(\text{travel cost, accommodation, other expenses}) \qquad (4)$$

Total travel cost is derived from the willingness to pay and ability to pay by people to visit their sites of interest and the number of trips made. The demand curve indicates the number of trips made by a visitor to the site and the overall costs involved.

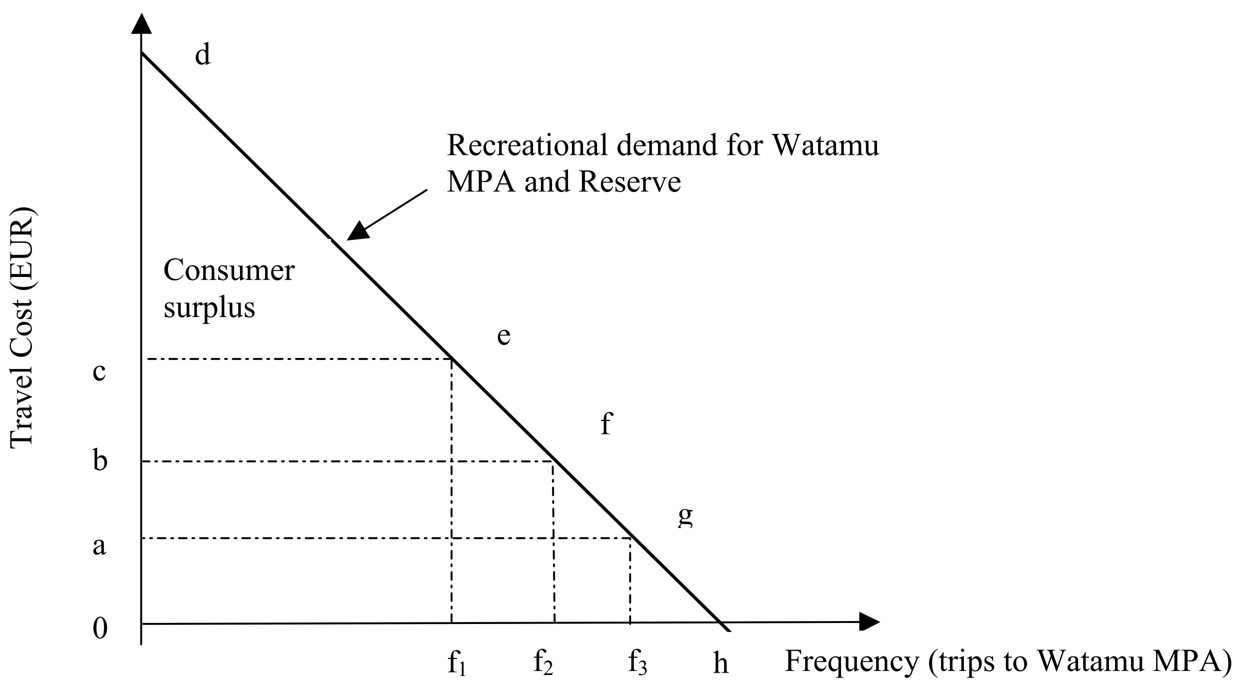

Figure 4: Recreational demand curve for the Watamu MPA and Reserve. Source: adapted from Navarro *et al.* (2010)

It is assumed that the higher the travel cost, the fewer the number of trips that visitors will make and *vice versa*. The value of the site to every individual is defined as "*the individual's compensated demand curve for that site*" (Freeman 2003). An ordinary least square regression was performed to determine the demand function (Navarro *et al.* 2010), from which the consumer surplus (the area under the curve) is derived.

The design consisted of questions about the travel costs to and from a tourist's place of residence, cost of accommodation and other costs incurred during the period of stay, reasons for visiting, intended activities while at the park, number of countries visited apart from Kenya. Boat operators and canoe riders were also questioned to understand the amount it costs to take visitors to different locations in the Park and Reserve. The fuel costs they incur in the case of boat operators were also noted, though other costs they incurred such as boat purchase, maintenance and costs to middlemen were not taken into consideration.

2.8.1.4 Research and education

A number of institutions including KWS, Watamu Turtle Watch, CORDIO EA, KMFRI and AROCHA Kenya have conducted largely ecological studies in the Park and reserve. A number of students and researchers from Kenya and other countries have also conducted research on different aspects. Despite this fact, a compilation of this work has not been done (KWS 2011). This acts as an impediment in assessment of the research and education value. However, we collected information on budgets for research work from Wildlife Clubs of Kenya, KWS, Forestry Department and National Museums of Kenya. This included research expenditure, donor funds and costs of hosting interns in Wildlife Clubs of Kenya and National Museums of Kenya. From a bibliography on research work done on MPAs in Kenya, we estimated a total of 73 studies done between 2000 - 2010 within the Watamu Marine Park and Reserve. From this number, we estimated an average number of 6.6 per year. We used an average cost of EUR 12,500 (the cost of a publication) per research to estimate the cost of research in the Park and Reserve per year. The total amount of money used by these institutions and individuals for research and awareness was divided by the area covered by the Park and Reserve to derive the research and education value.

2.8.2 Indirect use value

2.8.2.1 Coastal protection value

Both biotic and abiotic (such as bathymetry) characteristics of the coastal zone provide wave attenuation. Mangroves, seagrasses and coral reefs are all important for coastal protection by wave attenuation. Coral reefs for example protect both directly and indirectly the coast by creating sheltered conditions that are suitable for mangrove and seagrass growth (Koch *et al.* 2009). Overall, coastal protection should be highest when the tide is low and the biomass of biotic structures is at its maximum. We determined the cost of protection through the replacement cost method by estimating the cost of constructing a 10m long wall, 0.2 m thick, 1m deep foundation into the sand and 1.5m high. The value determined was extrapolated to cover the area covered by coral reefs and mangroves in the area.

2.8.2.2 Carbon sequestration

Three main methods have been described for estimation of mangrove forest biomass: allometric, harvest and mean-tree methods (Komiyama *et al.* 2008). The mean-tree method is used to estimate the biomass of forests with homogenous tree size distributions such as plantations while in the harvest method all trees are harvested (Komiyama *et al.* 2008). We used the non-destructive allometric method, which relates size (diameter) to weight of a tree (Chave *et al.* 2005; Komiyama *et al.* 2005; Komiyama *et al.* 2008; Kairo *et al.* 2009a) to estimate the mangrove forest above ground biomass. Above ground measurements of mangrove forests take into account tree height and diameter at 1.3m stem height referred to diameter at breast height and abbreviated as DBH or D_{130} (Kairo *et al.* 2009a). The following equations for above ground biomass were used.

$0.168\rho DBH^{2.47}$ (Chave *et al.* 2005)

$0.251\rho D^{2.46}$ (Komiyama *et al.* 2005)

Where, ρ represents wood density, D stands for $D_{R0.3}$ for *Rhizophora* species and *dbh* in case of other species. The biomass was calculated per species per site. Thus, we used the following equation to estimate the vegetative carbon from the above ground biomass.

Vegetative Carbon (tC) = Above ground biomass (t ha^{-1}) x 0.5 (Kairo *et al.* 2009b).

Using a market value of carbon of USD 15 (Approximately EUR 11.20 in December 2010) used by Swetnam *et al.* (2011) in ARC mountains in Tanzania we estimated the carbon sequestration value. This was determined from the vegetative carbon based on the values estimated from the two equations for the above ground biomass determination. Uncertainties in the tree density estimations using plotless sampling methods may cause an underestimation or overestimation in the final value (Hijbeek *et al.* unpublished manuscript). Other uncertainties that may cause an underestimation or overestimation of the carbon sequestration value include allometry and wood density estimations.

2.8.2.3 Other indirect use values

The monetary costs of some indirect use values such as waste regulation function, biological control, nutrient cycling and habitat/refuge could not be established because of time and budgetary constraints. Therefore, we determined them using the benefits transfer method. The valuation approach transfers a value from other sites (study sites) to the current study (policy site).

Table 7: Average annual global value of ecosystem services estimated by Costanza *et al.* (1997) in USD ha^{-1} $year^{-1.}$ The blank values were not estimated in their study.

Ecosystem service	Coral reef	Mangrove	Seagrass beds	Total
Waste regulation	58	6,696	_	6,754
Biological control	5	_	_	5
Habitat/refuge	7	169	_	176
Nutrient cycling	_	_	19,002	19,002

Costanza *et al.* (1997) further defined the ecosystem services above as follows:

Waste regulation: recovery of mobile nutrients and removal or breakdown of excess or xenic nutrients and compounds. Example: waste treatment, pollution control, detoxification.

Biological control: trophic-dynamic regulation of populations. Examples: Keystone predator control of prey species, reduction of herbivory by top predators.

Habitat/refuge: Habitat for resident and transient populations. Examples: nurseries, habitat for migrating species

Nutrient cycling: Storage, internal cycling, processing and acquisition of nutrients. Examples: Nitrogen fixation, N, P and other elemental or nutrient cycles.

We used the values in Costanza *et al.* (1997) to determine the value for our site. The values from their study were adjusted for inflation (CPI) at a fixed rate for 2010. Thus,

$$WTP_{PS} = WTP_{SS} (CPI_{SS\text{-}2010}/CPI_{SS\text{-}1994})$$

Where, WTP_{PS} is the WTP in the policy site, WTP_{SS} is the WTP in the study site when the study was done (1994), $CPI_{SS\text{-}2010}$ and $CPI_{SS\text{-}1994}$ are consumer price indices in the study site in 2010 and 1994 respectively.

This method has also been used by Hicks *et al.* (2009) and Alves *et al.* (2009). Since Costanza *et al.* (1997) determined their values in value per hectare (Hicks *et al.* 2009) the values used in their study can more appropriately be transferred to ours, though we are aware of validity and accuracy issues (Ready *et al.* 2004; Brander et al. 2007) as a result of transfer errors that might occur (Holme-Mueller and Muthke 2004; Ready *et al.* 2004).

2.8.3 Non-use value

The non-use value is difficult to measure, but the contingent valuation method (CV) is normally used. There are three variants to the CV: iterative bidding, dichotomous choice models and open-ended methods. In the open-ended method, respondents state their maximum WTP. In iterative bidding the respondent is given a series of amounts until they reveal their maximum WTP. The dichotomous choice model results in less bias and requires "Yes" or "No" answers to predetermined bid amounts. To get the option and bequest value, a hypothetical question was also asked to tourists about their willingness-to-pay (WTP) *per annum* for the conservation of seagrasses, coral reefs and mangroves. Also, domestic tourists were asked to name their preferred ecosystem for conservation purposes.

2.9 Data analysis

Data analysis was performed using the Statistical Package for Social Scientists (SPSS 13). One way Analysis of Variance (ANOVA) was performed for fuelwood use and visitors to the Park. ANOVA was done to compare fuelwood use between households that were close to (<1km) and those that were far from (>1km) the sea by road. ANOVA for visitors to the Park was done for the different years (2004-2010). Prior to ANOVA the data were tested for the assumptions for parametric tests. Descriptive statistics were also done to determine the difference between sites in terms of average counts. Graphical analyses and representation were done on Excel 2007.

Spearman correlation tests were performed to determine the degree of association between revenue earned by the Park and visitor groups. Similar tests were performed for variables derived from visitor WTP and travel cost such as ‘years snorkeling’, ‘visits to Kenya’ and ‘frequency of visits to the Park’. To test if the relation between variables was significant, linear regression analyses were performed. This was done for variables that showed a significant correlation.

CHAPTER 3

3.0 Results

3.1 Respondents socio-economic characteristics

A total of 173 respondents were interviewed during the survey with different income generating activities. Out of the respondents, 69% were between 20-39 years old (Figure 5a).

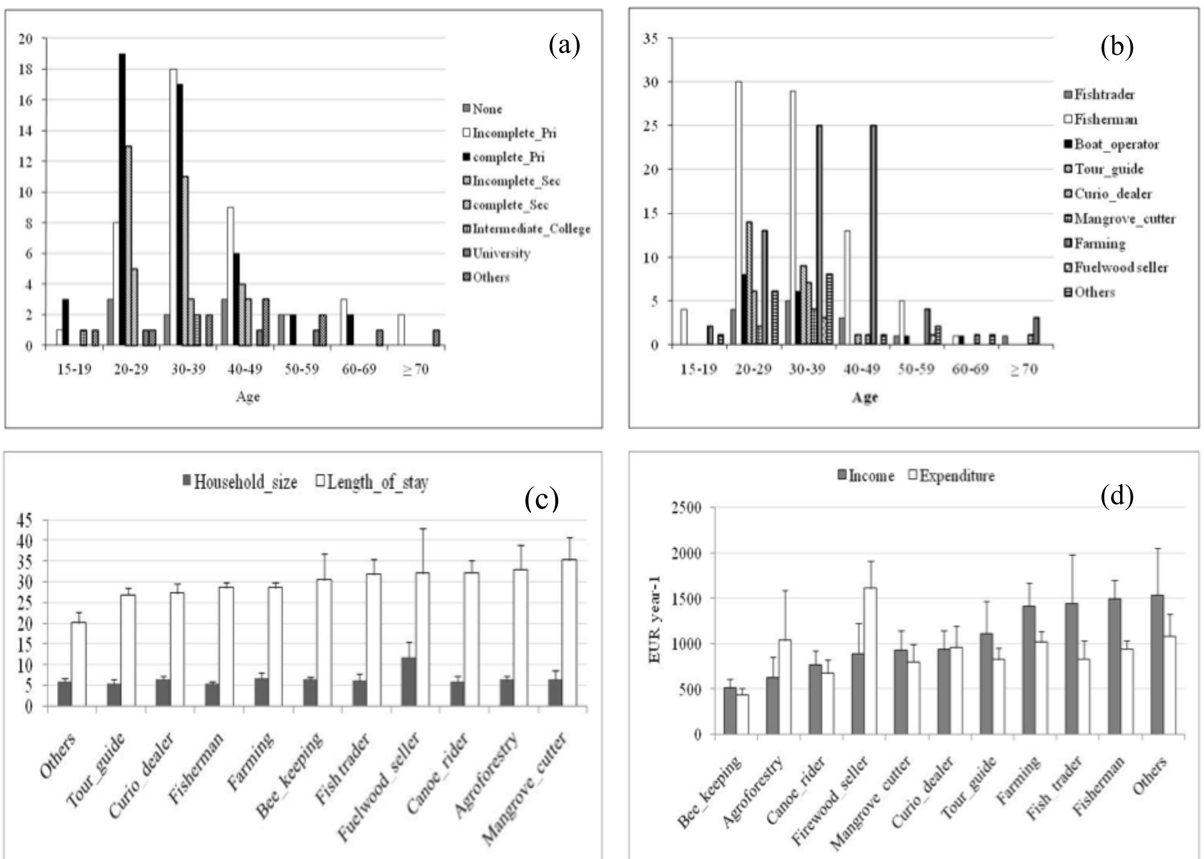

Figure 5: Respondents' socioeconomic characteristics: a) Age distribution by level of education; b) Age distribution by household sources of income; c) Average income (ascending order) and expenditure per household occupation and d) Occupation by household size and length of residency in Mida Creek in ascending order. EUR1 = KES 107.63 (31st December 2010). Source: Exchange rate adapted from the Central Bank of Kenya.

Most of the respondents were associated with fishing and with up to primary school level (73%) of education and aged 20 - 39. On average, annual income and expenditure per household were

EUR 1,257.86 and EUR 903.96 respectively, though households with fishermen had the highest average income (Figure 5d). The mean household size in all the villages sampled was 6.1 while the mean duration of stay of the respondents was 27.9 years (Figure 5d). Length of stay determined the ownership of the resource.

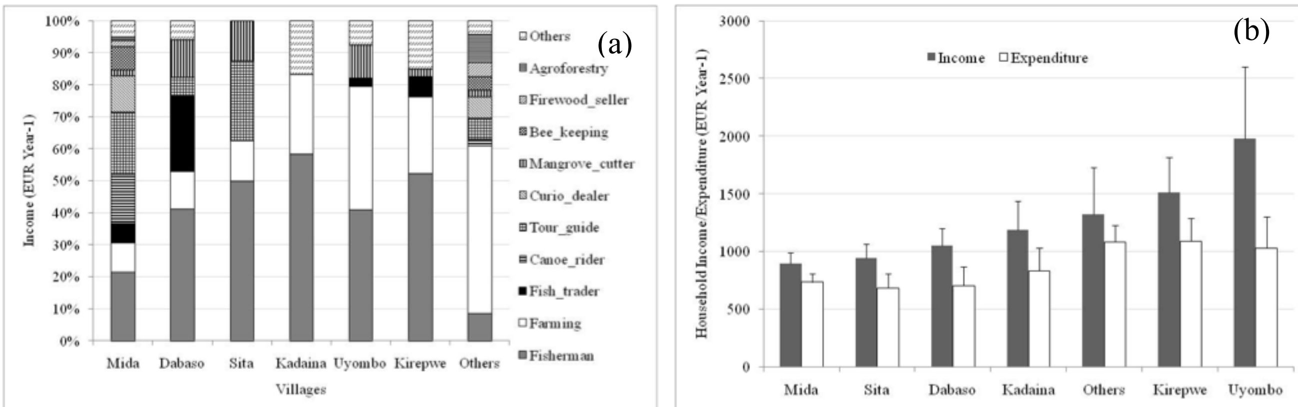

Figure 6: Income per household in villages sampled a) In percentage in relation to occupation of household members b) In relation to household expenditure per annum.

In the villages sampled, most of the respondents were associated with fishing and farming (Figure 6a). Individuals and households were associated with one or more income activities. Household expenditure was on average, less than income in all the villages (figure 6b).

3.2 The value of Goods and Services within the Park and Reserve (TEV)

3.2.1 Direct use values

3.2.1.1 Fisheries value

Fishing is one of the major economic activities in the area. In total there were 76 registered and an approximate 122 unregistered members in the Malindi/Watamu and 177 registered members in Roka BMUs. All fishermen sampled were artisanal, using multispecies gear types: Gill nets, seine nets, long line (zulmati), set net (jarife), traditional fishing traps (malema).

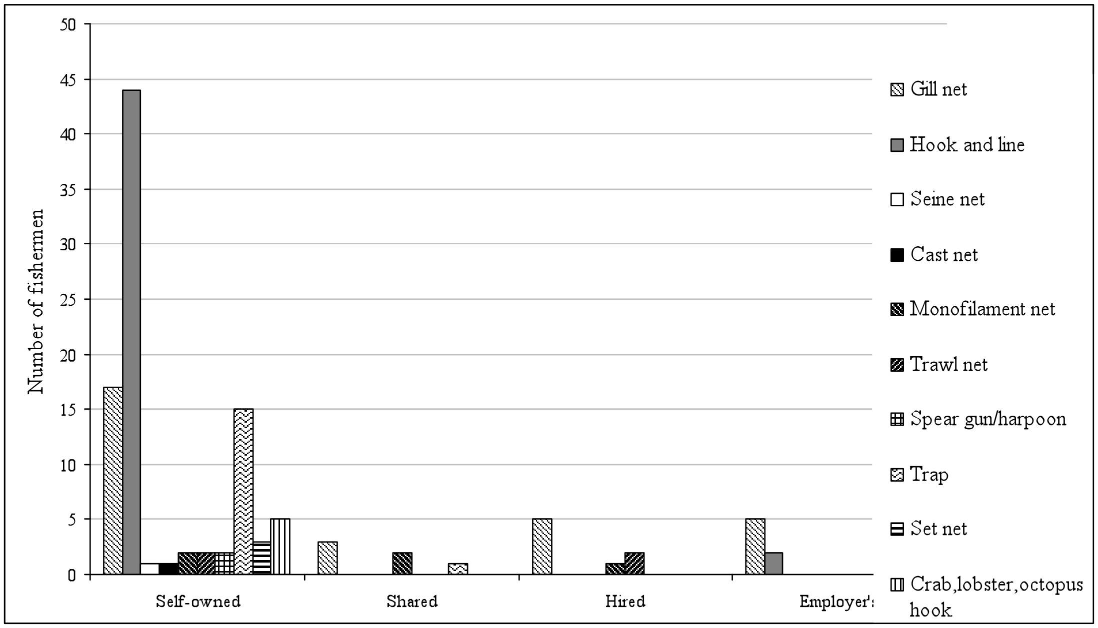

Figure 7: Types of gears used by fishermen in the area and their ownership status. Obtained from a sample of 88 fishermen from Kirepwe, Kadaina, Sita, Dabaso, Uyombo and Mida villages.

Most of the gears were self-owned (81%), with the rest being shared, hired or owned by the employer (Figure 7). Fishermen used more than one gear type. Most of the fishermen used gill net and line fishing. Gill net was the only gear that was self-owned, shared, hired or owned by an employer. A small number of fishermen in the villages used seine and cast nets.

Most of the catch is sold at the shore and in the villages around. Fishermen on average sell 90% of their catch and feed the family with the rest of the catch. The fish include among others; rabbit fish (*Siganidae*), groupers (*Serranidae*), parrot fish (*Scaridae*), surgeon fish (*Acanthuridae*) and goat fish (*Mullidae*) with varying prices.

Table 8: Local fish, crustacean and mollusk prices at landing sites as at June 2011.

	Reef fishes	**Sail & cuttle fish**	**King fish**	**Tuna**	**Shark**	**Squids**	**Lobsters**	**Giant prawns**	**Octopus**
Price KES/kg	100	120	170	130	100	600	500	500	120

Fish species caught on or in the vicinity of coral reefs and mangroves are considered to be a direct benefit. Most of the fish at landing sites are caught within the Mida Creek. Some fishermen go beyond the Mida Creek to fish. The prices of most fish species ranged from KES

100 – 130 per kg (Table 8). The average number of days fishing per week was 5 in SEM and 6 in NEM locally referred to as *kusi* and *kaskazi* respectively.

Table 9: Annual fishery value for Watamu Marine Park and Reserve (EUR ha^{-1} yr^{-1}).

	Catch $fisher^{-1}$ day^{-1}	Fishing days yr^{-1}	Individual annual fishery value (EUR yr^{-1})	Fishers per site (numbers ha^{-1})	Area available for fishing (ha)	Annual fishery value (EUR) ha^{-1} yr^{-1}
Mida N=24 (NEM)	6.33	140	1,071.64	299	3200	**138.35**
Mida N=24 (SEM)	3.06	120				
Kirepwe, Dabaso, kadaina (n=72)	7.7	261	409.02	299	3200	**209.52**

Source: Fishermen numbers adapted from the Fisheries department, Kenya. 1EUR approximately equal to USD 1.34 and KES 107.63 (31st December 2010). Source: Central Bank of Kenya.

On an average fishing area of 3,200 ha and with a total of 299 fishermen, Mida Creek has a potential fishery value of EUR 173.94 ha^{-1} yr^{-1} (233 USD ha^{-1} yr^{-1}). The annual fishery value varies with season (Table 9) but is higher in NEM. On average, a fisherman gets 7.7kg day^{-1} of fish without considering seasons.

3.2.1.1.1 Fish landings

Fish catch data from the Kenya Fisheries Department established that a total of 244,807 kg of fish with a market value of EUR 273,585.63 landed at the Watamu landing site (Figure 8a). The landings have been increasing since 2006-2010 (Figure 8b).

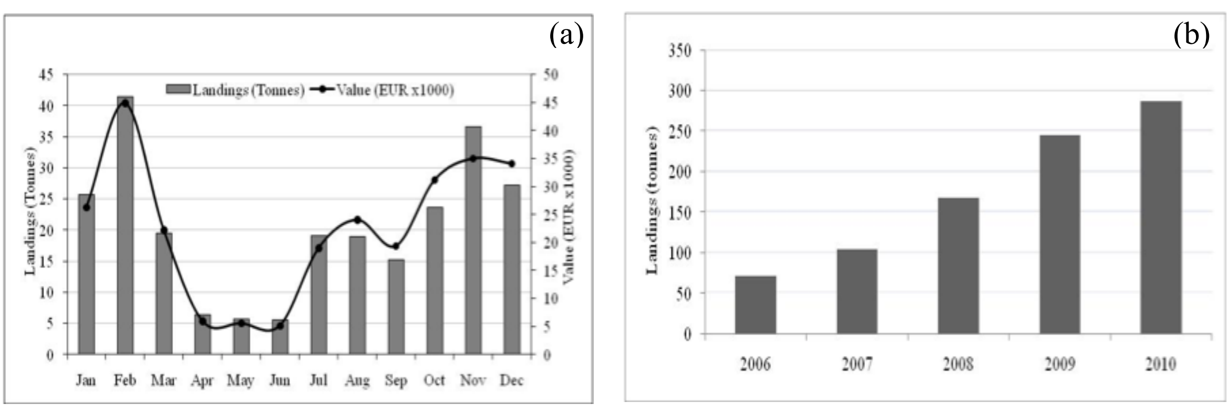

Figure 8: a) Watamu-Mida fish landings and their value in 2009. Bars represent fish landings at the Watamu site per month with their monetary value in EUR represented as a line. b) Watamu-Mida fish landings in tones per year 2006 – 2010. Source: Fisheries Department of Kenya.

In terms of seasons, a total of 150.417 tonnes of fish was landed in NEM (November-March) and 94.39 tonnes in SEM (April-October) costing EUR 163,008 and EUR 110,577 respectively (Figure 3a). The highest quantity of fish landed was in November and February months, which occur during the NEM season. The difference in landings is because of the unfavorable conditions during the SEM such as strong winds that makes many fishermen to shun fishing. Assuming that all the fish was caught in the reserve area (approximate area 3,200ha), the potential value of the fish in the reserve area is EUR 85.49 ha^{-1} $year^{-1}$ (USD 114.56 ha^{-1} $year^{-1}$). This value is less than what was obtained by interviewing fishermen (Table 9).

3.2.1.2.2 Ring net fishery

Ring net fishery accounts for a large percentage of fish landings at the Watamu landing site. Demersal fish landed for instance in 2009, included unicorn fish (*Acanthuridae*), surgeons (*Acanthuridae*), grunter (*Teraponidae*), parrot (*Scaridae*) and snappers (*Lutjanidae*). Pelagic fish include mackerel (*Scombridae*), barracuda (*Sphyraenidae*), milkfish (*Chanidae*), bonito (*Scombridae*), king fish (*Scombridae*) and cavilla jacks (*carangidae*).

Table 10: Ring net fishery statistics at the Watamu Landing site (The total value of fish landed per unit time in EUR in parenthesis).

	Oct-Dec 2008	*2009*	*Jan-Apr 2010*
Snapper (*Lutjanidae*)	3,132	1,814	
Grunter (*Teraponidae*)	795	3,856	3,580
Unicorn fish (*Acanthuridae*)	570	14,255	4,344
Mackrel (*Scombridae*)	4,335	11,054	3,345
King fish (*Scombridae*)	1,040		
Sail fish (*Istiophoridae*)	100		
Tuna (*Scombridae*)	285		
Marlin (*Istiophoridae*)	1,000		
Mixed pelagic species	335		
Surgeon (*Acanthuridae*)		11,248	2,287
Parrot (*Scaridae*)		1,300	250
Barracuda (*Sphyraenidae*)		5,920	2,700
Milk fish (*Chanidae*)		1,610	6,859
Bonito (*Scombridae*)		2,343	3,433
Gar fish (*Belonidae*)			2,015
Cavilla jack (*carangidae*)			2,442
Rainbow runner (*Carangidae*)			2,574
Moon fish (*Labridae*)			560
Others - SEM			1,077
Total	**11,592 kg (EUR 10,394.40)**	**53,400 kg (EUR 56,663.15)**	**35,466 kg (EUR 27,986.44)**

Source: Adapted from the Fisheries Department of Kenya

Thus, a total of 53,400 kg of fish from ring net fishery with an estimated value of approximately EUR 56,663 was landed at Watamu in 2009 (Table 10). Ring net fishery impacts on fish prices since they bring in large quantities of fish compared with artisanal fishermen therefore lowering prices. This type of fishery is considered an off-site fishery as only artisanal fishermen are allowed within the reserve.

3.2.1.2 Timber for construction

The stand quality (Table 11) of the locations was dominated by species of form 2 and 3 (46% and 28%) respectively. Straight stems (form 1) suitable for construction purposes were fewest.

Table 11: Tree form distributions in Mida Creek showing the densities per ha for the villages sampled. (*Numbers in parenthesis are in percentage of column totals*).

	Form 1		Form 2		Form 3	
Kadaina	650	(32.10)	975	(48.15)	400	(19.75)
Kirepwe	1,155	(36.84)	1397	(44.56)	583	(18.60)
Mida	114	(5.08)	569	(25.41)	1,556	(69.51)
Sudi	920	(21.00)	2620	(59.82)	840	(19.18)
Uyombo	670	(35.96)	729	(39.12)	465	(24.92)
Total	**3,509**	**(26.00)**	**6,290**	**(46.00)**	**3,844**	**(28.00)**

Stocking densities for the mangrove vegetation in the Mida Creek (Table 12). On average, most of the stems were <6.0 cm (for instance in 59% in Kadaina and 75% in Sudi). Density of stems ha^{-1} was highest in Sudi and lowest in Uyombo. Apart from Mida village (8%) where it covered small percentages, *Ceriops tagal* cover was highest in the other villages.

Table 12: Stand table for the mangrove forest of Mida Creek. Fito, pau, mazio and boriti indicate size classes in cm (Numbers in parenthesis represent percentages of each size class).

Site	Species	≤ 4.0 (Fito)	4.1 – 6.0 (Pau)	6.1 - 9.0 (Mazio)	9.1 – 13 (Boriti)	13.1 - 20	20.1 - 35	>35	Density (Stems ha^{-1})
Kadaina	*A. marina*	_	_	_	_	25 (50)	25 (50)	_	50 (2.47)
	B. gymnorrhiza	25 (7.14)	25 (7.14)	_	50 (14.29)	50 (14.29)	125(35.71)	75 (21.43)	350 (17.28)
	C. tagal	400 (48.48)	150 (18.18)	125 (15.15)	50 (6.06)	25 (3.03)	75 (9.09)	_	825 (40.74)
	R. mucronata	175 (23.33)	400 (53.33)	125 (16.67)	50 (6.67)	_	_	_	750 (37.04)
	X. granatum	_	25 (50.00)	_	25 (50.00)	_	_	_	50 (2.47)
	Total	**600 (29.63)**	**600 (29.63)**	**250 (12.35)**	**175 (8.64)**	**100 (4.94)**	**225 (11.11)**	**75 (3.70)**	**2025**
Kirepwe	*A. marina*	44 (25.00)	55 (31.25)	77 (43.75)	_	_	_	_	176 (5.61)
	B. gymnorrhiza	33 (17.65)	66 (35.29)	11 (5.88)	_	44 (23.53)	11 (5.88)	22 (11.76)	187 (5.96)
	C. tagal	682 (35.43)	836 (43.43)	242 (12.57)	99 (5.14)	55 (2.86)	11 (0.57)	_	1925 (61.40)
	R. mucronata	231 (36.21)	220 (34.48)	44 (6.90)	22 (3.45)	44 (6.90)	77 (12.07)	_	638 (20.35)
	X. granatum	_	22 (10.53)	88 (42.11)	33 (15.79)	66 (31.58)	_	_	209 (6.67)
	Total	**990 (31.58)**	**1199 (38.25)**	**462 (14.74)**	**154 (4.91)**	**209 (6.67)**	**99 (3.16)**	**22 (0.70)**	**3135**
Mida	*A. marina*	44 (4.92)	88 (9.84)	92 (10.25)	154 (17.21)	220 (24.59)	242 (27.05)	55 (6.15)	895 (40.00)
	B. gymnorrhiza	7 (6.45)	18 (16.13)	7 (6.45)	22 (19.35)	15 (12.90)	44 (38.71)	_	114 (5.08)
	C. tagal	48 (26.53)	62 (34.69)	37 (20.41)	4 (2.04)	22 (12.24)	7 (4.08)	_	180 (8.03)
	L. racemosa	4 (7.69)	29 (61.54)	15 (30.77)	_	_	_	_	48 (2.13)
	R. mucronata	121 (12.74)	334 (35.14)	202 (21.24)	195 (20.46)	84 (8.88)	15 (1.54)	_	951 (42.46)
	S. alba	7 (50.00)	_	7 (50.00)	_	_	_	_	15 (0.66)
	X. granatum	11 (30.00)	4 (10.00)	11 (30.00)	4 (10.00)	7 (20.00)	_	_	37 (1.64)
	Total	**242 (10.82)**	**536 (23.93)**	**371 (16.56)**	**378 (16.89)**	**349 (15.57)**	**308 (13.77)**	**55 (2.46)**	**2239**

Site	Species	≤ 4.0 (Fito)	4.1 – 6.0 (Pau)	6.1 - 9.0 (Mazio)	9.1 – 13 (Boriti)	13.1 - 20	20.1 - 35	>35	Density (Stems ha^{-1})
Sudi	*A. marina*	_	20 (50.00)	_	20 (50.00)	_	_	_	40 (0.91)
	B. gymnorrhiza	80 (22.22)	80 (22.22)	100 (27.78)	20 (5.56)	20 (5.56)	60 (16.67)	_	360 (8.22)
	C. tagal	1400 (44.03)	1460 (45.91)	280 (8.81)	20 (0.63)	20 (0.63)	_	_	3180 (72.60)
	R. mucronata	60 (7.50)	180 (22.50)	200 (25.00)	160 (20.00)	140 (17.50)	60 (7.50)	_	800 (18.26)
	Total	**1540 (35.16)**	**1740 (39.73)**	**580 (13.24)**	**220 (5.02)**	**180 (4.11)**	**120 (2.74)**	_	**4380**
Uyombo	*A. marina*	6 (3.70)	24 (14.81)	47 (29.63)	6 (3.70)	12 (7.41)	41 (25.93)	24 (14.81)	159 (8.52)
	B. gymnorrhiza	65 (25.00)	82 (31.82)	29 (11.36)	24 (9.09)	12 (4.55)	24 (9.09)	24 (9.09)	259 (13.88)
	C. tagal	459 (45.09)	235 (23.12)	171 (16.76)	71 (6.94)	59 (5.78)	24 (2.31)	_	1017 (54.57)
	R. mucronata	47 (13.33)	47 (13.33)	18 (5.00)	29 (8.33)	59 (16.67)	141 (40.00)	12 (3.33)	353 (18.93)
	X. granatum	_	29 (38.46)	18 (23.08)	24 (30.77)	6 (7.69)	_	_	76 (4.10)
	Total	**576 (30.91)**	**417 (22.40)**	**282 (15.14)**	**153 (8.20)**	**147 (7.89)**	**229 (12.30)**	**59 (3.15)**	**1864**

The poles for construction are sold at different prices depending on their size classes. In Mida for instance, the Kenya Forestry Service at lower prices than the usual market prices sells poles acquired from illegal cutters (Table 13).

Table 13: Prices of mangrove poles per score in KES

	Mida from KFS	Hardware in Mida	Hardware in Lamu
Fito	100	150	400
Pau	600	1,000	800
Mazio	1,200	3,000	4,000
Boriti	1,600	4,000	
Nguzo			4,000

Source: per's comm.

Thus, using the prices of the poles according to size classes, extrapolated price for the forest assuming that the prices of the rest of the size classes after *Boriti* (9.1 – 13cm) are EUR 37 per score will be as follows.

Table 14: Market analysis of extractable wood products from mangrove forest in the Mida Creek

Site	≤ 4.0cm (Fito) EUR	4.1 – 6.0cm (Pau) EUR	6.1-9.0cm (Mazio) EUR	9.1 – 13cm (Boriti) EUR	13.1 – 20cm EUR	20.1 – 35cm EUR	>35cm EUR	Total Mangrove pole value (EUR ha^{-1})
Kadaina	41.98	279.85	349.81	326.49	186.57	419.78	139.93	1744.41
Kirepwe	69.26	559.24	646.46	287.31	389.93	184.70	41.04	2177.94
Mida	16.93	250.00	519.13	705.22	651.12	574.63	102.61	2819.64
Sudi	107.75	811.57	811.57	410.45	335.82	223.88	_	2701.04
Uyombo	40.30	194.50	394.59	285.45	274.25	427.24	110.07	1726.40

1 score = 20 poles in the market; 1EUR =Approx. KES 107.63 (December 2010).

Despite having a lower density of stems ha^{-1} than Sudi and Kirepwe (Table 11), Mida had the highest value of mangrove poles (Table 14) at EUR 2,819.64 ha^{-1}. However, apart from Kadaina, all the other sites had a value of greater than EUR 2000 ha^{-1}.

3.2.1.3 Fuelwood for household use

Branches of mangrove trees are normally harvested for fuelwood (Kairo *et al.* 2009). There was no significant difference in fuelwood use ($F\ (1,89)=0.18$, $p<0.001$) for households close to the sea and those far away (323.6 and 304 head loads per annum respectively). There were on average 8.2 members per household in villages close to the sea (n=75) and 6.1 (n=29) in villages far away (approximately 1km). At KES 30-50 (approximately EUR 0.28 - 0.46) per score, the total value of fuelwood used per household per annum is EUR 90.56-150.93 in households close to the sea and EUR 85.07 -141.79 in households approximately 1km from the sea by road.

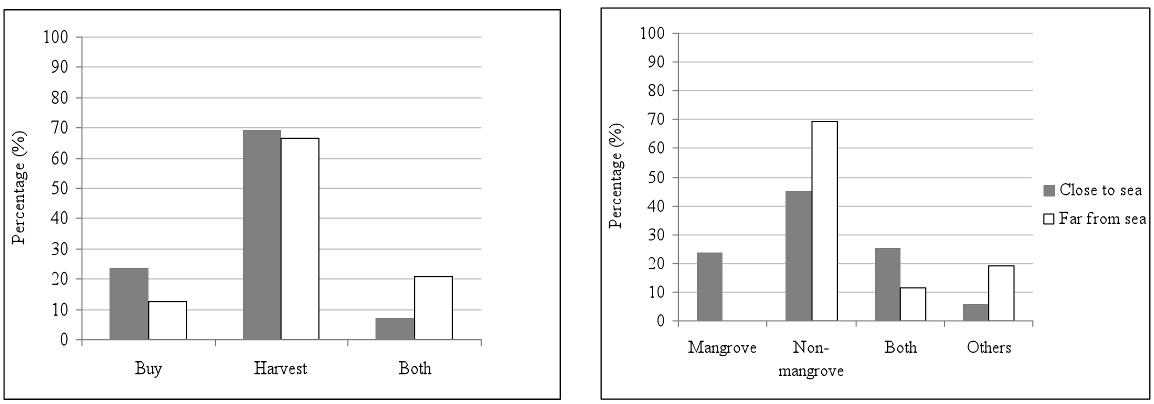

Figure 9: Percentage of respondents in relation to a) how they obtain fuelwood for household use b) source of domestic fuelwood as at December 2010. Respondents came from villages close (n=75) and those that are more than approximately 1km or more away from the sea (n=29).

Despite the distance from the sea, most households harvest fuelwood for household use (Figure 9a). We established that 69.4% of households that were considered close to the sea and 66.7% of those that are far from the sea harvest fuelwood for use. Other households, though a small percentage both harvest and buy (6.9% and 20.8 of those close to and far from the sea respectively). Most of these households obtained their domestic fuelwood from non-mangrove tree species (Figure 9b). Whilst none of households that are away from the sea exclusively used mangrove as fuelwood source, 24% of households that are close to the sea obtained fuelwood from mangrove trees. Others used charcoal in combination with mangrove and non-mangrove tree species, though most of residents (19.2%) were in villages far from the sea.

3.2.1.4 Recreation service value

The tourists to the Park and Reserve are classified into three categories; Kenyan citizens, Kenyan resident and non-residents. On arrival at the Park or Reserve, tourists are taken round by registered canoe riders or boat operators, though cases of tourist harassment by local boat and tour operators and fraud by boat operators have been reported (KWS 2011). A recreational demand curve determined that tourists visited the site between once and four times per year (Figure 10). Those that came more frequently were mostly Kenyan residents.

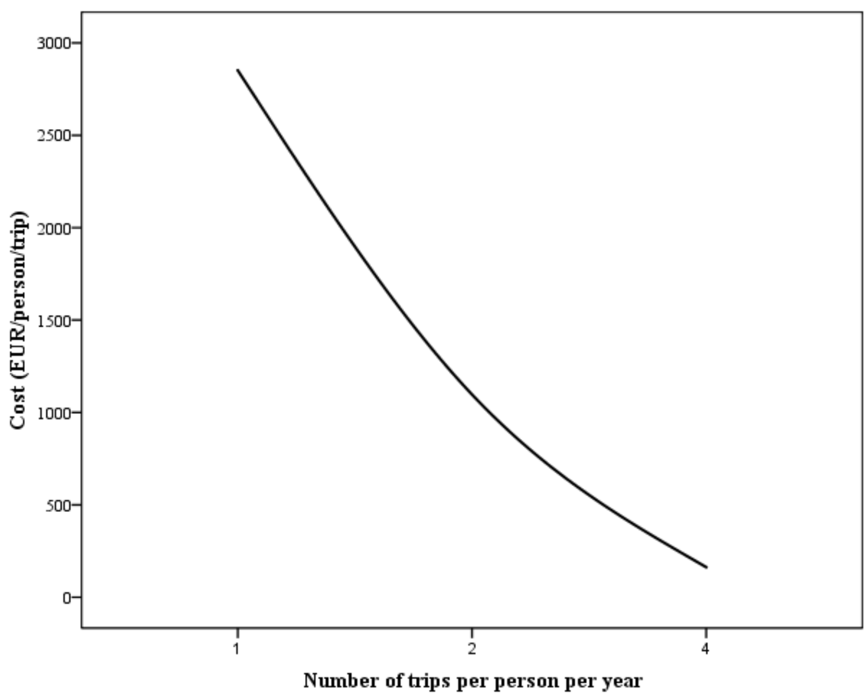

Figure 10: Recreational demand curve for Watamu Marine Park; cost (EUR) by number of trips per person year^{-1}.

Years snorkeling and the number of times that the tourist has visited the park were significantly correlated with the travel costs while number of visits to Kenya was not (Table 15). Thus, visits to Kenya and years snorkeling were removed from the final analysis since we aimed at determining the relationship between the number of trips and travel cost (Heal *et al*. 2004).

Table 15: Estimation results for the model determining the demand function

Variable	Coefficient	Std. Err	p-value
(Constant)	-1108.499	452.857	.022
Visits to kenya	306.535	184.925	.111
Frequency to Park	2494.082	302.986	.000
Years_snorkeling	66.472	32.265	.051

Dependent variable: Exp*trps

Therefore a linear regression analysis of the cost of travel against number of trips to the site per year was done (Table 14) to establish the demand function.

$$demand_{MPA} = 2220t - 440.9 \quad (1)$$

$$CS = (2220t - 440.9)dt \quad (2)$$

Thus

$$CS = \sum_{i=1}^{22,154} \left[(2,220t - 440.9)dt \right]_1^4 \quad (3)$$

Where; **CS** is the consumer surplus from recreation, **n** is the total number of tourists that visited the Park in 2010 and **t** is the frequency of visit by an individual tourist to the Park and Reserve.

A consumer surplus of EUR 14,217 was determined. This figure was derived only from the non-resident visitors. Since tourism takes place both in the Park and Reserve (total area of 4200ha), we estimated a recreational value of EUR 74,991 ha^{-1} yr^{-1} for 2010. This is given the fact that there were in total, 22,154 visitors that year. On average however, the number we used is less than that of tourists that have visited the Park per year in the last 7 years of 27,146 (Figure 12). When the average number of visitors for the 7 years is used, the recreational value increases to EUR 91,889 ha^{-1} yr^{-1}.

3.2.1.4.1 Canoe riders and boat operators

Canoe riders in the Mida Creek Conservation and Awareness (MCCA) group usually take the tourists to different sites in the Creek, mostly carrying 1-2 tourists per trip. At the same time there are tour guides who guide the tourists in groups of 1-4 or 5-20 within the Creek (Table 16) including among others for bird watching.

Table 16: Entry and guiding fees by the Mida Creek Conservation and Awareness group in KES. Source: Mida Creek Conservation and Awareness group 2010. Non-resident tourists return to their countries of origin after the tourism activities. Resident tourists are not Kenyan citizens but stay in Kenya.

Guiding fees	Fees paid	Time
1-4 people	300	Per hour
5 – 20 people	1,000	Per hour
Canoe 1 – 2 persons	700	1 – 3 hours
Entry fees	**Adult**	**Children**
Non-resident	250	150
Resident	150	100
Citizen	80	30
Student (university/college)	50	

In order to be allowed entry, visitors are charged differently depending on their origin and age (Table 17). Boat operators take tourists to both the Marine Park and Reserve parts. They charge a fee much higher than canoe riders since they also incur fuel costs. Each tourist pays KES 2,000 to visit the corals and approximately KES 3,000 to visit other sites (mangrove, bird watching in the Creek, Sudi and Green islands). During high season, the boat operators carry up to 30 tourists per trip and go on average 2 trips in a day compared to low seasons where some may go for a week without getting any visitors.

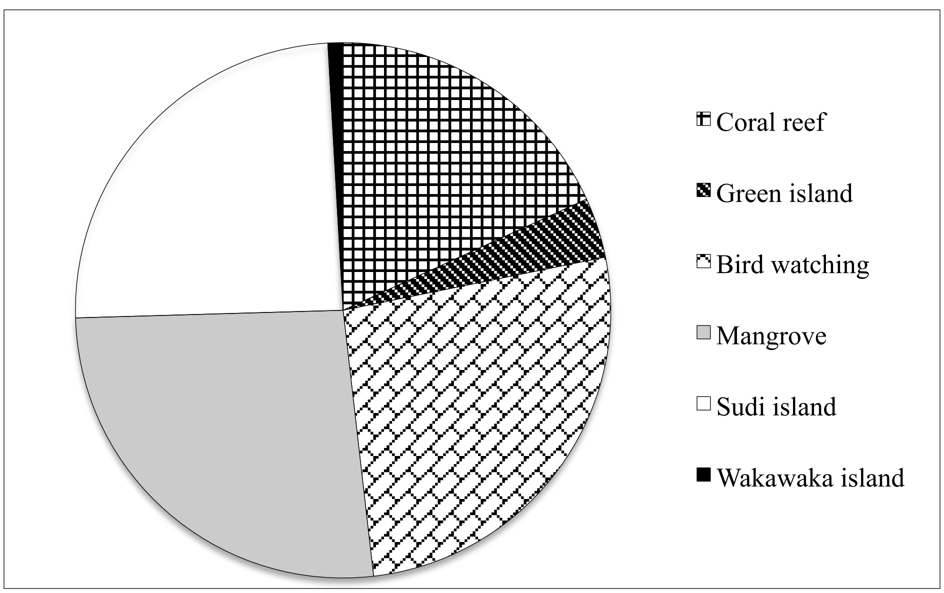

Figure 11: Specific sites where tourists are taken for recreation activities (n= 49).

The fuel cost to the different destinations also varies. It costs an average of 8.5 litres to travel to the coral site and 28.45 litres to transport tourists to the other sites. Boat operators also reported tourists preferring to visit certain areas to others (Figure 11). Thus, bird watching sites, Sudi island and mangrove areas (26%, 26% and 24.5% respectively) were preferred sites according to tourists. From the KES 2,000 the Park fees amounts to KES 1,200. The remaining revenue of KES 800 per visitor is shared between the boat owner and the crew on an average ratio of 2:1, but when the boat owner is part of the crew the ratio becomes 3:1. Thus, assuming that the boat operator transports 2 tourists per trip at 2 trips per day, the boat owner gets approximately KES 2,160 and the crew KES 1,040 per day. In a good year therefore, we estimate that boat owner and the crew get EUR 7,354 and EUR 3541 respectively.

3.2.1.4.2 Temporal trends of tourists visiting the park

Although visitor numbers have been fluctuating over the years due to political unrest, the trend shows an increase in revenue over the years except in 2007-2008 where there was a drop (Figure 12). The revenue is in form of park entry fees that depends on visitor origin and age (Table 16).

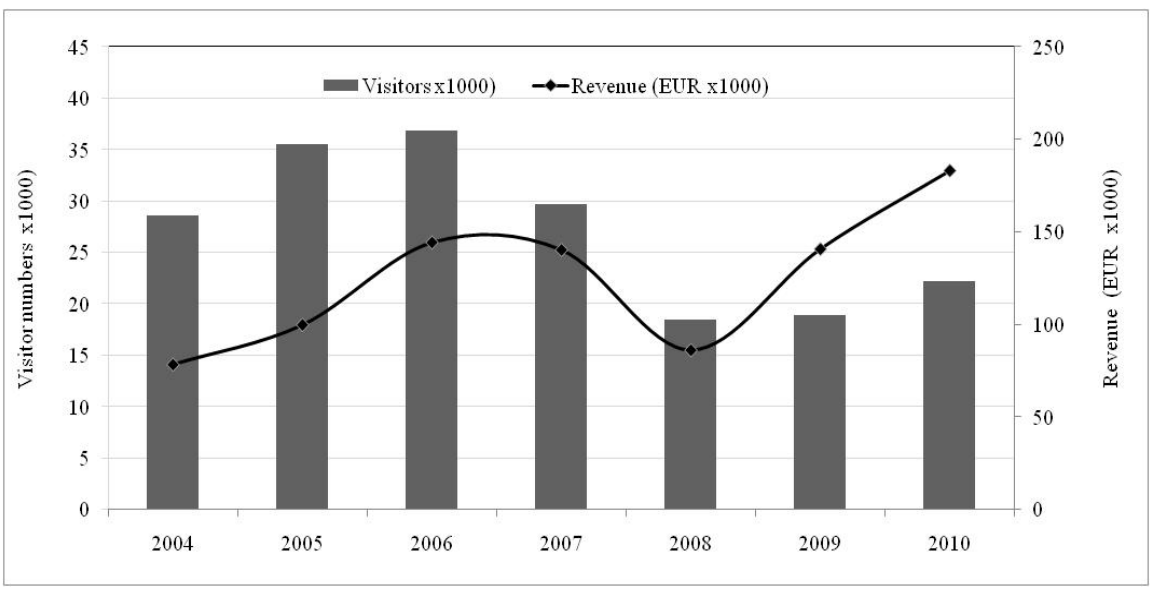

Figure 12: Annual visitor numbers and revenue to the Watamu Marine Park.

The highest revenue was witnessed in 2006 (EUR 144,045), while the lowest was in 2004 (EUR 78,073). Non-residents pay more than the residents (Table 17), high numbers of non-residents were witnessed between 2004 and 2006 (Figure 13).

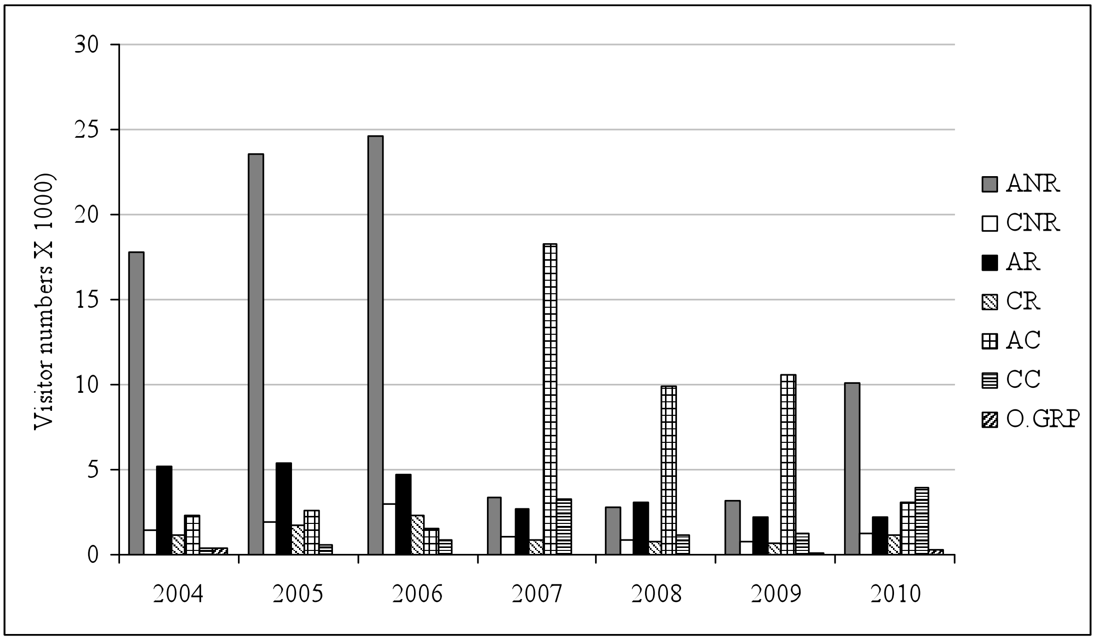

Figure 13: Number of visitors according to residency status. Where, ANR represents adult non-residents, CNR – children non-residents, AR – adult residents, CR, children residents, AC – adult citizens, CC – children residents and O.GRP-organized groups. Adult citizen numbers were high in 2007, 2008 and 2009.

A Spearman Rank correlation analysis determined that organized groups were not significantly affecting the revenue of the Park.

Table 17: Watamu Marine Park entry fees (conservation fees) for the year 2011.

Variable	East African citizens (KES)	East African residents (KES)	Non-residents (Euros)
Adults	100	300	11.20
Children	100	150	7.50

Source: Adapted from KWS tarrifs for Parks 2011.

Thus, a multiple regression analysis of variables CC, AR, CNR, AC, CR, ANR was significant (Table 18), though CNR and CR differed significantly from the others in Park revenue contribution.

Table 18: Regression analysis of the contribution of different visitor groups to the Park revenue 2004-2010. ANR represents adult non-residents, CNR – children non-residents, AR – adult residents, CR - children residents, AC – adult citizens and CC – children residents. Source: Adapted from KWS.

Variable	Coefficient	Std. Err	p-value
(Constant)	181464.261	89236.892	.046
ANR	424.135	72.653	.000
CNR	427.572	390.584	.277
AR	-1105.795	324.516	.001
CR	772.554	632.094	.226
AC	1944.235	322.054	.000
CC	692.586	189.005	.000

N=81. Significant at $p<0.05$

The average expenditure by a tourist not on a return trip to the Park was estimated at EUR 1,876.79. This included airfare, accommodation and other costs incurred such as purchase of curios but does not include their family who accompany them during the trip. This cost was limited only to the non-resident visitors. The study did not take into account other costs such as the cost of time spent. The figure is subject to corrections based on the fact that most respondents gave a package value they paid to the tour operator. Others did not state the amount of money they used for other activities.

3.2.1.5 Research and education

Based on the data we obtained from the four institutions and from other studies (2000-2010) including 45 publications, 1 book and 6 theses (Table 19), we estimated a research and education value of EUR 30.29 ha^{-1} $year^{-1}$. We also assumed that this value is an underestimate since much research has been conducted in the Park and Reserve.

Table 19: Funds for research and education conducted at the Watamu Marine Park and Reserve from four institutions.

Institution	Expenditure category	Research funds (EUR)
Forestry Department	Mangrove, birds, socio-economics	9,291
KWS	Education and awareness	3,270
	Ecological monitoring	4,200
Wildlife Clubs of Kenya	Donor funds	9,291
	Expenditure on research and internship costs	7,386
National Museums of Kenya	Donor funds	4,646
	Internship costs	6,634
Universities and Individuals	Publications, reports, theses and books	82,500
Total		**127,218**

Source: Adapted from Wildlife Clubs of Kenya, KWS, Forestry Department and National Museums of Kenya.

3.2.2 Indirect use value

3.2.2.1 Coastal protection

In July 2011, the cost of building a 10m long wall with concrete columns (pillars) 5.0m apart and 200mm thick welling was estimated at EUR 714 (EUR 1 = KES 127 = USD 90; 19th July 2011; Source: Central Bank of Kenya). This was complete with a 1m deep foundation and 1.5m in height. Thus, the total cost of building a protective wall in replacement for the mangrove and coral reef along the coastline was estimated as EUR 71,406 km^{-1}. The Malindi Watamu Marine National Parks and Reserve covers an area of 229 km^{-2} with an approximate coastline of 30 km (Zanre 2005). Assuming that our study area which covers only 42 km^2 has a coastline of 5.5 km, we estimate the replacement cost for mangroves and coral reefs to be EUR 392,733 (approximately USD 549,826). This value does not include the cost of maintenance of the sea wall and labour costs involved.

3.2.2.2 Carbon sequestration

The Mida creek mangrove forest biomass was 206.95 tha^{-1} and 299.39 tha^{-1} (equivalent to 103.48 and 149.7 tC ha^{-1} respectively) when we compared equations by Chave *et al.* (2005) and Komiyama *et al.* (2005).

Table 20: Above ground biomass in tones ha^{-1} of mangrove species tree in the Mida Creek. Fieldwork was conducted in 5 sites; Uyombo, Mida, Sudi, Kadaina and Kirepwe in October-November 2010. AM represents *Avicennia marina*, BG – *Bruguiera gymnorrhiza*, CT – *Ceriops tagal*, LR – *Lumnitzera racemosa*, *Rhizophora mucronata*, SA – *Sonneratia alba* and XG – *Xylocarpus granatum*.

	AM	BG	CT	LR	RM	SA	XG	Biomass (t ha^{-1})
Komiyama et al. 2005 (t ha^{-1})	135.39	64.81	26.75	0.31	68.48	0.05	3.61	299.39
Chave et al. 2005 (t ha^{-1})	93.75	44.92	18.37	0.21	47.18	0.03	2.48	206.95
Wood density (g cm^3)	0.63	0.74	0.75	0.69	0.77	0.46	0.57	

Source: Wood density data adapted from Nele Schmitz (2011) unpublished data.

Avicennia marina and *Bruguiera gymnorrhiza* had the highest biomass compared to the other species in the forest (Table 20**.** Above ground biomass was higher when Komiyama *et al.* (2005) equation was used. This value is influenced by the tree and wood density estimation method used (Hijbeek *et al.* unpublished manuscript). Using a market value of USD 15 (EUR 11.20) used by Swetnam *et al.* (2011) in ARC mountains in Tanzania we estimated carbon sequestration values of EUR 1,159 and 1,677 t C ha^{-1} using the equations from Chave *et al.* (2005) and Komiyama *et al.* (2005) respectively.

3.2.3 Other Indirect use values

Compared to all the other indirect use values, the value of nutrient cycling by seagrass beds was the highest (Table 21).

Table 21: Indirect use values for coral reef, mangrove and seagrass beds (EUR ha^{-1} $year^{-1}$) using the benefits transfer method. The values were derived from Costanza *et al.* 1997.

Variable	Coral reef	Mangrove	Seagrass beds	Total
Waste regulation	63.69	7,352.42	_	7,416.11
Biological control	5.49	_	_	5.49
Habitat/refuge	7.69	185.57	_	193.26
Nutrient cycling	_	_	20,864.81	20,864.81

Source: CPI data adapted from U.S. Department Of Labor, Bureau of Labor Statistics. USA CPI for 1994 = 148.2 and 2010 = 218.056

We did not take into account error correction, which may mean that the values may be overstated. However, compared to other methods, the error is slightly reduced by adjusting the transferred value though they all perform equally well (Ready *et al.* 2004).

3.2.4 Non-use Value

Contingent valuation method was used to elicit willingness to pay for conservation of coastal and marine resources (mangroves, coral reefs and seagrasses). Thus, the average amount of money that resident and non-resident visitors (n=62) to the Park would be willing to pay as charge fee for the conservation of the coastal and marine resources was EUR 14 ± 11. For every trip they make, resident tourists (n=13) would be therefore willing to contribute EUR 9 ± 5 if the Park were in good condition while non-residents (n=48) would pay EUR 16 ± 12. Thus, assuming that all visitors to the Park (22,154 in 2010) were non-residents, the total revenue to the park using EUR 16 as the new entry fees would be EUR 354,464 ± 265848. The total revenue to the Park in that year was approximately EUR 182,835. This would lead to a consumer surplus of EUR 147,260. From the total contributed, the existence value of the Park and Reserve would therefore be EUR 84.40 ± 63.30 ha^{-1} $year^{-1}$.

Table 22: A regression analysis to determine the relation of household income to WTP by tourists in Watamu MPA

Variable	Coefficient	Std. Err	p-value
Constant	-2.946	14.782	.845
Income	-8.601	4.516	.081
Adjusted R^2	.168		

In a spearman's correlation test, we noted that there was no correlation between the values with many variables (days to the Park, hours travelled, household members, gender, education) except income (n=15). A regression analysis (Table 22) showed that a strong negative influence of income on individual's WTP. This might be due to the fact that those who responded to these questions were few. However, 16.8% of the model is explained by income. CV data usually yield of between 10% and 40%, though less than 15% is considered unreliable (O'Garra 2006).

3.3 The costs of conservation

3.3.1 Park operating costs

There are six major categories in the KWS budgetary allocation of the Park and Reserve. These include biodiversity, tourism, partnership, technical, security, salaries and management services (Figure 14). The total operating budget for the park for the financial year 2010/2011 excluding salaries was EUR 68,630.56. The budget for the species biodiversity category which includes ecological monitoring, species surveillance and management costs (e.g. boat and vehicle running and maintenance) was EUR 4216 (KWS budget 2011/2012).

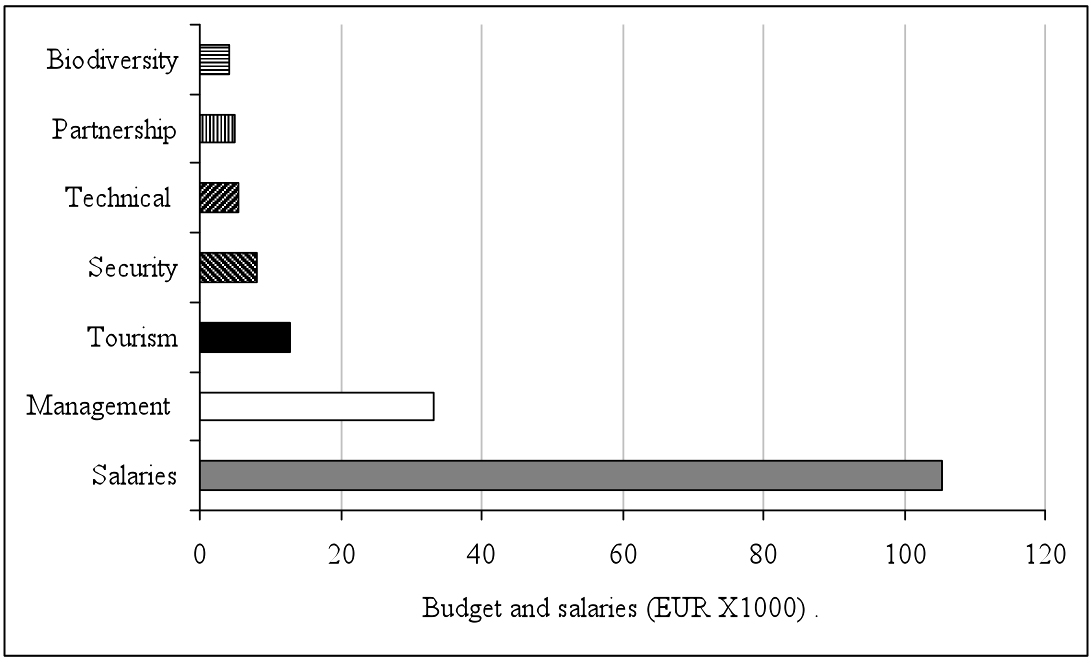

Figure 14: KWS budget and salaries for the financial year 2010/2011. (Source: adapted from KWS)

The tourism section includes tourism administration and management and gate revenue collection and management services, incur approximately EUR 12,826.49. This section includes among others advertising, beach maintenance, local travel and accommodation and boat and vehicle running and maintenance. The management services category caters for 48% (EUR 33,080.19) of the total budget (salaries excluded) and consists of administration and management costs of the park (Table 23).

Table 23: Categories of KWS budgetary allocation

Category	Sub-category	Expenses incurred
Biodiversity	Ecological monitoring	Boat running, professional services and boat maintenance
	Species surveillance and management	Boat running and maintenance, local travel and accommodation, vehicle maintenance and running
Tourism	Tourism administration and management	Banda and campsites, advertising and publicity, purchase of stationary, beach maintenance, office and janitorial, signage and display, local Travel and accommodation, vehicle running and maintenance, boat running and maintenance.
	Gate revenue collection and management	Local travel and accommodation, vehicle maintenance and running expenses
Management services	Administration and management	Electricity, water and conservancy, telephone, postage, e-mail and faxes, maintenance of residential and non-residential buildings, bank charges, leave and passage, entertainment, vehicle maintenance and running expenses, special events/public affairs, boat running and maintenance, office and janitorial, maintenance of office equipment
Partnership	Education and awareness	Seminars and conferences, vehicle maintenance and running, plant and machinery maintenance and running, printing and publicity, local travel and accommodation and special events.
	Partnership admin and management	Vehicle running and maintenance, local travel and accommodation and purchase of stationary
Security	Routine security patrols	Boat running and maintenance expenses, vehicle running and maintenance and local travel and accommodation
Technical services		Maintenance of roads and bridges

Source: adapted from KWS 2011

The partnership category encompasses education and awareness programmes such as conferences, seminars and other special events. Technical services comprise maintenance of roads and bridges while security category includes boat and vehicle running and maintenance. Given that the total area of the Park and Reserve (1,000 and 3,200 ha respectively) is 4200ha, the cost of protecting the Park and Reserve by KWS will be EUR 41.42 ha^{-1} $year^{-1}$. If the budget had been limited to the Park alone, then its operating cost would have been EUR 173.88 ha^{-1} $year^{-1}$.

Community organizations and NGO'S

Due to the poverty levels and unemployment, destructive and illegal fishing methods and overexploitation of mangroves, low education levels limited resources and conflicts existing between user groups among others (Muthiga 2009; KWS 2011), community organizations and NGOs have been established around the area. Most of the organizations are donor-funded and conduct a range of projects aimed at conservation of the limited resources as well as enhancement of livelihoods of the local community. The main projects of community organizations that aim at alternative livelihood provision include bee keeping and handicrafts.

Canoe riding and community scouts tour guiding are in the tourism sector. Membership of community organizations includes an average of 30 (n=16) individuals who contribute an average of EUR 1.31 membership fees and monthly fees that depends on the group's objectives. NGOs strive mostly towards conservation of threatened habitats and species such as birds, turtles and dolphins in order to boost tourism. They are also involved in environmental education of the local community and scientific research.

Curio dealers

A total of 42 curio sellers were interviewed who benefit from the tourism at the Park. They sell a variety of items ranging from terrestrial to marine related items (Figure 15). Some of these items or their raw materials are bought from other dealers in Malindi, Kilifi, Nairobi, Watamu and Mombasa towns, Tanzania and as far as the Rift valley.

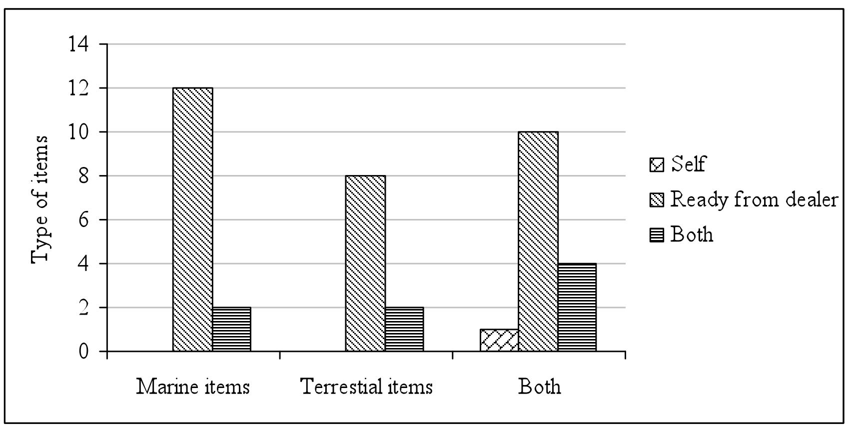

Figure 15: Type of items sold by curio dealers and depending on whether they are self-made or purchased.

The most targeted customers are non-resident tourists, though in some cases Kenyan residents and citizens also purchase curios. We determined that foreign tourists buy approximately 12% of the curio sold while the dealers sell 80% of curios to both domestic and foreign tourists. The income per dealer varies with season and between dealers themselves. During tourist high season, income per month ranges from EUR 18.7-634 (Table 24), though on average curio dealers earn approximately EUR 168 per month and EUR 2001.49 per year. This is dependent upon the costs incurred such as transportation and cost of purchasing ready-made items.

Table 24: Summary statistics of net income per month by curio dealers with sales and costs incurred (EUR)

Monthly	Make	Mean	Min	Max	StdDev
Sales	Self-made	182.7	9.3	746	279.6
Sales	Ready-made	395.1	46.6	746	245.5
Cost	Self-made	31.5	3.54	149	57.9
Transport cost	Both	130.6	3.54	419.8	110.1
Purchase	Both	202.6	28	513	143.1
Net income (EUR)	Both	166.8	18.7	634.3	146.0

Some dealers apart from the ready-made curios buy raw materials and make curio items from them. The most preferred tree species include *Azidirachta indica* A. Juss (Neem), *Cocos nucifera* L. (Coconut palm), *Mangifera indica* L. (Mango), *Brachylaena huillensis* O.Hoffm and *Afzelia quanzensis* Welw (Mahohany).

CHAPTER 4

4.0 Discussion

This study presents the first ever economic valuation done by the management of the Watamu Marine National Park and Reserve. The study has attempted to assess all resources associated with the MPA. It takes into consideration both use and non-use values. The study assessed the monetary value of ecosystem goods and services in the Watamu Marine Park and Reserve, the income accrued by the different stakeholders and the overall cost of conservation of the available goods and services for sustainability. Despite the shortcomings of the economic valuation process, the information generated highlights the importance of biodiversity conservation and hence the essence of establishing and managing MPAs. It further guides the management in crucial management decision making, touching on critical environmental issues such as development, landuse planning and/or urbanization.

However, poverty levels, limited resources and low education levels have limited benefits for local communities. This has consequently generated conflicts amongst stakeholders. Whereas benefits were sought by all stakeholders, there was little appreciation on the costs of managing the protected area or the resources. Our overall estimate indicates that maintaining the protected area is more economically beneficial in the long-term. Further, in line with the Secretariat of the Convention on Biological Diversity (CBD), this study forms a step towards integrating protected areas into wider landscapes, seascapes and sectoral plans and strategies while demonstrating that MPAs are of important national economic benefit.

4.1 Income distribution among stakeholders

4.1.1 Socio-economic characteristics of respondents

Stakeholders in the Park and Reserve include *inter alia* Non-Governmental Organizations (NGOs), community based organizations (CBOs), Fisheries Department, Kenya Marine and Fisheries Research Institute (KMFRI), Kenya Forestry Service (KFS), Community Based Organizations (CBOs), beach management units (BMUs), Boat operators, Curio sellers, Divers, Hoteliers and beach operators (KWS 2011). The government in this case is considered a stakeholder such that state corporations such as KMFRI are categorized as stakeholders. The study established that majority of households were associated with fisheries and farming (Figure 6a). Apart from tourism, fishing has been a major economic activity in the area. Income varies with season for the fishermen (Northeast monsoon and Southeast monsoon abbreviated as NEM and SEM respectively) and for boat operators, canoe riders and curio operators (high and low tourist seasons). The two seasons (NEM and SEM) are created by the migration of the Inter-Tropical Convergence Zone (ITCZ). The SEM is characterized by high cloud cover, rain, wind energy, and decreased temperature and light (McClanahan 1988).

In general, we observed marked seasonality in economic activities, including earnings and resource exploitation patterns. Fishermen earned their highest income during NEM that occurs between November to March, when wind strength is low and much gentler. Lowest fisheries yields were observed during the SEM, which is characterized by violent winds, frequent rains and rougher seas, which makes fishing difficult. These fishermen utilize mostly artisanal or traditional techniques and are characterized by low catch. Additionally, the catch is largely sold at landing sites and in local markets, where income of customers is modestly low. The operating or running costs for the fishermen is high. Such costs include purchase of fishing gear and transportation costs (Cinner *et al.* 2010). Transportation cost to trading centers is often high, with no preservation facilities, necessitating sell of the catches at low prices. Availability of markets is also not assured as a result of competition from ring-net fishermen. The ringnet fishermen often have larger vessels that can go far, net larger fish catches and have access to storage facilities with access to better marketing. Generally, fishermen close to the Park are considered wealthier than non-Park fishermen because of improved catches and tourism opportunities (Cinner *et al.* 2010).

During the SEM, many fishermen abandon fishing and venture into other income generating activities. The ability of households to improve income depends on their levels of education and other investments. In our study area, households had diversified their sources of income and many individuals had more than one source of income. However, Cinner *et al.* (2010) argued that livelihood diversification reflects impoverishment as it is seen as a way of taking advantage of uncertain environment such as seasonality in fisheries to accumulate assets. Household expenditure was generally related to the income of the household. High income was associated with high expenditure and *vice versa.*

Amongst the stakeholders studied, curio dealers earned the least income *per annum* (EUR 2,001) while boat operators and owners earned the highest income (EUR 3,541 and EUR 7,354 per year respectively). This is similar with what Munga *et al.* (2010) established in the Mombasa Marine Park and Reserve to the south of Watamu. They explained that it is due to the ability of non-resident tourists to pay due to their high income. Residents may be considered to spend less, which does not mean that they have a lower income.

4.1 The value of Goods and Services within the Park and Reserve (TEV)

4.2.1 Direct use value

4.2.1.1 Recreational value

Since we only focused on non-residents in our calculations, the recreation value (EUR 74,991 ha year-1) was high. The recreation value was the highest of all services estimated (Table 25). This could be because we only studied non-resident visitors while there are many residents and citizens that visit the Park and Reserve. In their study, Hicks *et al.* (2009) established that on average, in government-managed and co-managed areas, the value of recreation was over 99% of the sites TEV. In community-initiated areas however, aesthetic and research values contributed the largest percentages. The travel by tourists to a site can also be determined for the cultural and heritage value. We assume that the high value combines recreational experience and the cultural and heritage values (Bedate *et al.* 2004) keeping in mind that UNESCO gazetted the Park and Reserve as Man and Biosphere Reserves. Watamu and Malindi areas are also some of the most sought after touristic sites by most high profile visitors in Kenya including 'world celebrities'. For coral reef recreation values, the variation in values is due to the number of dive sites, number of visitors and the different valuation methods (Brander *et al.* 2007). Thus, demand for biologically rich sites more often increases their value, but a decline in biodiversity reduces the demand for the site and therefore its value.

The trends of tourists to the Park and Reserve were also associated with the political status of the country. A sharp decrease in number of tourists and consequently revenue is generally common during election years indicating the vulnerability of this sector. Watamu MPA however was noted to contribute significantly to the revenue from tourism in all the MPAs. Coastal tourism depends to an extent on the quality of reefs (Brander *et al.* 2007). Previously, coral colonies were reported as damaged in the Watamu and Malindi Marine Parks due to visiting by tourists (McClanahan and Obura 1995). The aim of the Park should therefore not be to increase revenue at the expense of biodiversity conservation. However, if tourism is left unchecked, it might lead to detrimental effects such as destruction of the protected corals and hence it would reduce the biodiversity we aim to conserve.

4.2.1.2 Timber for construction

The mangrove stand density (Table 12) is comparable to the one established by Kairo *et al.* (2002) in Uyombo (1585 trees ha^{-1}), but higher than their findings in Kirepwe (1197 trees ha^{-1}). This may be attributed to the fact that there has been a ban imposed on mangrove cutting in 1999 (KWS 2011) and intensified efforts to conserve and protect the mangrove forests by communities and NGOs. Some of these community groups have been known to be planting mangroves in the forest. This may explain the high densities as it is documented that restored forests have a higher stem densities than natural forests (Bosire *et al.* 2008), at least in earlier stages of development.

Mangroves can either be restored by natural or more advantageous artificial regeneration methods though an understanding of mangrove zonation pattern and the level of cooperation of local communities and their leaders usually determine the success of a restoration project (Kairo *et al.* 2001). However, there is no need to replant a degraded forest if the objective is only to have a dense forest cover and not economically superior *Rhizophora,* since the mangrove forest can be expected to regenerate by itself (Kairo *et al.* 2002). In Mida Creek, apart from the natural regeneration, there have also been restoration campaigns in areas where mangroves have been degraded (KWS 2011). Restored mangroves will return mangrove ecosystem goods and services (Kairo *et al.* 2001; Bosire *et al.* 2008).

Previously, these mangrove forests have been described as being overharvested (Dahdouh-Guebas *et al.* 2000; Kairo *et al.* 2002; Omodei-Zorini *et al.* 2004) and therefore leading to a reduction of their capacity to provide ecosystem services. An example is Uyombo, which has been under heavier anthropogenic influence, as compared to Kirepwe, such that the young tree population is *Ceriops*-dominated. Natural regeneration first favours *Ceriops* over *Rhizophora* (Kairo *et al.* 2002). In fact, *Ceriops* dominated in 4 out of 5 sites in our study: Uyombo, Sudi, Kirepwe and Kadaina (Table 12). Moreover, the KWS (2011) draft management plan for Malindi and Watamu conservation areas singles out overharvesting of mangrove trees for poles, timber, firewood and oyster as very high in terms of severity, scope and ranking. It also indicates that mangrove cover has declined in Mida Creek due to illegal logging and dieback of the old forests.

Kenya Forestry Service (KFS) allow for extraction in areas that they manage by giving permits. They sometimes conflict with KWS who protect the forests from extraction (KWS 2011). Since there is currently no (legal) extraction of the forest for timber, the mangrove forests in Mida Creek can therefore be reported as having an averagely high potential timber extraction value of extraction of EUR 2234 ha^{-1}. If poles were to be sold, they would be graded based on butt diameter, height and number of nodes (Kairo *et al.* 2009). Readiness for market for the quality classes diminishes from quality class 1 to 3 which depends on straightness of the poles (Kairo *et al.* 2009; Mohamed *et al.* 2008). Plantations were however described to have more suitable poles for construction than natural forests (Kairo *et al.* 2009). Approximately 72% of the trees in our study were in quality classes 1 and 2 (Table 11) and therefore suitable for construction.

4.2.1.3 Fuelwood

Fuelwood collection is known to cause damage to mangrove forests (Naylor and Drew 1998) though it is still considered to be of value to local coastal communities apart from other mangrove ecosystem services. We determined that 24% of households exclusively use mangrove as fuelwood or indirectly as charcoal compared with Naylor and Drew (1998) who established that out of the 90% of their respondents who used mangrove wood for cooking a third relied on it as a primary fuelwood source. Our results might be lower because of respondents fearing to be prosecuted. We confirmed our expectations that those who live farther from the forest use non-mangrove trees for fuelwood.

Total direct use value of fuelwood is usually determined from the quantity of wood collected, the price of the wood minus the cost incurred. When products are used for subsistence purposes, gross income is estimated from "*market prices of the closest substitute of that product or opportunity cost of the time spent collecting the product*" (Sathirathai 1995). From the central-place foraging theory, individuals who walk greater distances go for resources of highest quality while those who travel shorter distances opt for resources that are easier to find (Holmes 2006). In this study, we did not take into account the cost of time incurred during extraction. This is because some individuals travel greater distances and therefore use more time not because they have to but because they choose to (Holmes 2006). We also aimed at establishing the price of fuelwood used by households *per annum* with or without collection, which would allow for inclusion of households that buy fuelwood without searching for it.

The total value of fuelwood used per household per annum was EUR 90.56-150.93 in households close to the sea and EUR 87-141.8 in households approximately 1km from the sea by road. The gross value for mangrove fuelwood obtained by Naylor and Drew (1998) of USD 278,500 $year^{-1}$ (EUR 207,836 $year^{-1}$) for Kosrae in Micronesia was extremely high compared with what we derived in our study. The cause could be due to the overreliance of Kosrae households on mangrove for fuelwood and difference in market prices and income levels.

Sathirathai (1995) estimated a mean annual household value of mangrove use per household of USD 1,479.38 (Approximately EUR 1,104). Though this value comprised the value of fuelwood, honey and tree trunks for fishing gear repair, it was higher than the average household income in their site of study. The value determined in this study was also much lower than the average household income of approximately USD 1,692.3 (Approximately EUR 1,263). Only 10% of the households in their study collected fuelwood, as compared to what we determined in this study (Figure 9). We found out that 69.4% of households that were considered close to the sea and 66.7% of those that are far from the sea collected fuelwood for household use while the remainder either relied on buying or both buying and fuelwood collection.

For 43.09 m^3 ha^{-1} of non-merchantable wood with each cubic meter of firewood costing KES 500 (Approximately EUR 4.65), Kairo *et al*. (2009) estimated the fuelwood value of a

Rhizophora plantation to be USD 18.5 (Approximately EUR 14) ha^{-1} $year^{-1}$ with a net income of USD 222.07 ha^{-1} (Approximately EUR 166 ha^{-1}). Households usually collect fuelwood for use and very few buy. Households that are close to the sea partly get their household fuelwood from mangrove branches. Those that are far, rely on non-mangrove wood while those that are in or close to shopping centers use charcoal. Wood from mangrove trees burns for long (Walters 2005). Charcoal is also used but it is but more expensive (Dahdouh-Guebas *et al.* 2000) costing approximately KSH 40 per kg.

4.2.1.4 Fisheries value

The fisheries value we determined falls within the range (USD 159-507 /EUR 119-308 ha^{-1} $year^{-1}$) determined by Hicks *et al.* (2009) in Kenya. It was however lower than some protected and community managed sites, including the government-protected Marina and Mtwapa (Approximately EUR 280 and 245 ha^{-1} $year^{-1}$ respectively) and community-managed Chale and co-managed Mwanamia (Approximately EUR 378 and 230 ha^{-1} $year^{-1}$ respectively) areas (Hicks *et al.* 2009). Different options exist in explanation of the above phenomena. According to Daw *et al.* (2011), human population and closure design not coral cover have an influence on fish biomass and not coral cover. Mangi and Roberts (2007) suggest that the number of fishermen and live coral cover determines the total fishery catch while Olendo *et al.* (2011) suggest that interactions between fishing pressure and gear have an effect on substratum and fish fauna. We postulate that a combination of both habitat status or health and the anthropogenic elements may be interacting and eventually influencing the catch. The value obtained in our study does not mean that all the fish landed was from the Reserve. The assumption made was however that most of the fish were caught within the Reserve. Approximately 75% of fish landed is caught in the shallow waters since most local fishermen are artisanal using gears such as traps, spear guns and gill nets.

Fish landings have increased steadily since 2006 in the Watamu-Mida landing site (Figure 8b). This may be due to an increase in catch-per-unit-effort due to spillover of fish into fishing grounds close to the MPA (McClanahan and Mangi 2000; Mangi and Roberts 2007). MPAs have more fish numbers than adjacent fished areas (McClanahan and Obura 1995; McClanahan and Mangi 2000) and therefore replenish them with larvae, recruits and exploitable adults (McClanahan and Mangi 2000). Moderately vagile and fast growing fish families such as Rabbit fishes (*Scaridae*) and surgeon fishes (*Acanthuridae*) display the highest spillover and therefore characterize a mature coral reef fishery (McClanahan and Mangi 2000) while small-bodied fishes indicate intense fishing pressure (Mangi and Roberts 2007).

The values determined are not normally the exact landings since there are undocumented landings. In this sense our estimates are conservative. On the other hand, the estimate takes into account both seasons and therefore may be considered as non-conservative. There are also cases of overfishing and destructive fishing reported in Kenyan reefs (Mangi and Roberts 2007) such as use of ring-nets and beach seine nets (Cinner 2010). Destructive gear users in Kenya are usually poor (Cinner 2010) and less likely to exit a declining fishery (Cinner 2009). The KWS (2011) management plan ranks the use of destructive fishing practices (such as spear guns and seine nets) and overfishing and in terms of severity and scope in a scale of "high" and "very high respectively". Therefore, it would be necessary to empower beach management units (BMU) by training and capacity building so that fisheries resources will be exploited sustainably (KWS 2011).

The costs involved in fishing have been explained in terms of time spent searching for fish (Sanchirico *et al.* 2002). Thus, a reduction in searching cost means that the fishermen will use less time, and the catches will increase. The study did not, however, estimate the costs associated with fishing.

4.2.1.5 Research and education

The Park and Reserve have attracted a number of studies by researchers from both local and foreign institutions focusing on different aspects. Others include a number of NGOs and CBOs that apart from conservation aspects focus on research. Research studies focus on *inter alia* coral reef, fisheries, mangrove ecology, seagrass ecology and socio-economics. The studies have produced books, publications, theses and reports. These studies have also led to awareness and education campaigns for the local communities and stakeholders that are geared towards sustainable utilization of marine ecosystems.

We estimated a research and education value of EUR 30.29 ha^{-1} $year^{-1}$ (Table 25). This value is rather low compared to what Kairo *et al.* (2009) estimated in Gazi, Kenya (USD 770.23 ha^{-1}

year^{-1}). Hicks *et al.* (2009) using an annual research budget from NGOs working in the region estimated much higher values in their study. They estimated for instance a research value of USD 17,921 ha^{-1} year^{-1} each for Marina and Mtwapa areas. We expect that much more undocumented research has been done in the area. This low value may also imply that Watamu Marine Park and Reserve has a high potential for research. On the contrary, it may imply that despite having the potential for research, researchers prefer to do their studies elsewhere in the coastal parts of Kenya where accessibility is easy. Also, not many people may have developed the interest to do their research in the area.

4.2.2 Indirect use value

4.2.2.1 Coastal protection

Mangroves have been known to attenuate waves, trapping mud and preventing soil erosion (Othman 1994). Coral reefs and seagrasses also play a role in wave attenuation. The shoreline protection function of mangroves and coral reefs are valuable during extreme weather events (Chong 2005). Though Van Beukering *et al.* (2007) argue that these structures have often negative effects such as increased beach erosion, walls have been built to protect the coastline from waves including Kadaina Island in our study area and Vanga on the Kenyan south coast. Other sea walls have been built in Ngomeni and Siyu on the Kenyan north coast (Kairo *et al.* 2009).

Hence, studies have used the replacement cost method to determine the coastal protection function of mangroves by estimating the cost of replacing them with these constructed structures (Chong 2005). The method uses cost as a measure of economic benefit since costs and benefits are equal in economics (Barbier 2007). Bann (1997) and Barbier (2007) cautioned that the replacement cost method may overestimate the coastal protection value. Other methods have also been used to estimate the cost of protection of coral reefs and mangroves such as benefits transfer and avoided damages (Chong 2005).

The value of coastal protection varies with site (Chong 2005). We used the cost of constructing a wall to estimate a value of EUR 71,405 km^{-1} (USD 99,968 km^{-1}). Using benefits transfer method, Hicks *et al.* (2009) estimated the coastal protection value of coral reefs to be USD 3,866 ha^{-1}

year^{-1} (Approximately EUR 2761 ha^{-1} year^{-1}) while Kairo *et al.* (2009) estimated mangrove shoreline protection value of USD 333,333 (Approximately EUR 238,095). The value we determined does not include the cost of maintenance (Kairo *et al.* 2009) and labour which we assume would be costly. In this sense our estimates are conservative. Thus, it was not possible for us to estimate the annual cost of coastal protection per hectare.

4.2.2.2 Carbon sequestration

Mangrove trees are carbon sinks since they are able to sequester carbon dioxide into their biomass and therefore reduce the effect of global warming. They are considered among the most carbon dense forests in the tropics (Donato *et al.* 2011). Constraints for tropical forests including mangroves, to sequester carbon are not biophysical but sociopolitical relating to the livelihood of users (Pfaff *et al.* 2007; Unruh 2010; Donato *et al.* 2011). Efforts that ensure that forests are not degraded by supporting reforestation programmes and allowing regeneration increase carbon sequestration benefits (Niles *et al.* 2002; Pfaff *et al.* 2007). An averagely growing tropical forest is estimated to uptake 2.5 t C ha^{-1} year^{-1} (Pimentel *et al.* 1997) and stock 121 t C ha^{-1} (Dixon *et al.* 1994; Malhi *et al.* 1999). We estimated that mangroves in Mida Creek are able to sequester between 103.48 and 149.7 t C ha^{-1} using equations in Chave *et al.* (2005) and Komiyama *et al.* (2005) respectively.

Thus, the carbon sequestration value determined is EUR 1,159 and 1,677 t C ha^{-1} using equations in Chave *et al.* (2005) and Komiyama *et al.* (2005) respectively. Although Kairo *et al.* (2009) used USD 10 set by Niles *et al.* (2002) as the carbon mitigation price for developing countries, Niles *et al.* (2002) estimated the price of carbon per tonne to increase due to the unpredictable nature of the carbon management market. Thus, we chose to use the higher market value of USD 15 (EUR 11.20) used by Swetnam *et al.* (2011), which gives a non-conservative estimate. Also, we could only estimate the carbon sequestration per year if the forest were a plantation.

The above ground biomass of a tree includes stem, branch and leaf biomass, while on the other hand, the below ground biomass comprises prop root and below ground root biomass (Komiyama *et al.* 2008). We however did not estimate the below ground biomass which could have given us the true value of carbon sequestration of the forest. In this respect our estimates are conservative. Bann (1997) warns that measurement of forest biomass should include below ground biomass. Above ground biomass of mangrove tree species varies. It tends to increase in stands inland because of succession on newly deposited sediments by pioneer species, soil properties and nutrient status (Komiyama *et al.* 2008) of the soil. Since the dominant species display no obvious zonation in Mida (Kairo *et al.* 2002) we could not discern that pattern. However, *Avicennia marina* that occurs on both landward and seaward displayed the highest biomass and *Sonneratia alba* on the seaward margin the least (Table 20).

4.2.3 Other indirect use values

Values obtained for other indirect use values were derived using the benefits transfer method from Costanza *et al.* (1997). They did not however estimate the value of all the ecosystems and therefore our values totals may be an underestimate. We determined that biological control by coral reefs had the least value of EUR 5.49 ha^{-1} $year^{-1}$. Coral reefs also have a function as habitat/refuge for fish and other marine organisms but the value is lower than that of mangroves. Seagrass nutrient cycling function had a value of EUR 20,864 ha^{-1} $year^{-1}$ that may be considered high compared with other indirect use values estimated. In their study, Holme-Mueller and Muthke (2004) estimated their values by taking into account PPP between their study site and policy site. Our study did not take into account the income differences between the two study sites. In this case our estimates are conservative. The transfer error from a benefit transfer method we used is less than 50% (Ready *et al.* 2004) but accuracy is higher when a large number of samples are transferred and when benefit functions are used over transferring unit values (Turner *et al*. 2010).

4.2.4 Non-use value

Non-use value has been described as the most difficult to determine accurately (Beaumont *et al.* 2008). Hein *et al.* (2006) and Beaumont *et al.* (2008) suggest that since it is difficult to separate existence value from bequest, the values are often combined. Thus, our value (EUR 84.40 ± 63.30 ha^{-1} $year^{-1}$) combines both existence and bequest values. The relationship between income and tourist WTP was not significant (Table 22). Income determines respondents valuing a resource (Ebert 2003; Ransom and Mangi 2010). Ransom and Mangi (2010) determined a value of USD 346,733 yr^{-1} (Approximately EUR 247,666) and a positive association between WTP and income, recycling of household goods and participation in visits to the Mombasa MPA but a negative association with age of their respondents. In both studies however, visitors to the Park were willing to pay more for conservation. However, the proposed increase in MPA entry fees (conservation fees) for 2012 may reduce the number of domestic tourists to the Park. Many of them would not afford to pay more (Ransom and Mangi 2010) for improved conservation and management.

The World Conservation Union (IUCN) defines ecotourism as “environmentally responsible travel and visitation to relatively undisturbed natural areas, in order to enjoy and appreciate nature (and any accompanying cultural features – both past and present) that promotes conservation, has low visitor impact and provides for beneficially active socio-economic involvement of local populations” (Ceballos-Làscurin 1996). Ecotourism is a major and potential source of revenue to both the government and to the local communities around the Park and Reserve. However, support for conservation is often diminished when people do not trust the institution that collects the donation (van Beukering *et al.* 2003).

4.3 Cost of protection and management

Most of the costs that the MPA incurs are geared towards management and KWS spends more on personnel salaries. MPAs reduce overfishing, habitat degradation and promote the development of alternative livelihoods (Christie and White 2007). If coral reef and mangroves ecosystems are not protected, van Beukering *et al.* (2003) and Nam *et al.* (2005) predicted that there would be a decline in their functions, fisheries and an ultimate diminished ecotourism. The creation of the Mombasa MPA in a heavily fished reef increased fish species and tourism (McClanahan and Obura 1995)

Balmford *et al.* (2004) found out that MPAs cost more to run per unit area when small in size, when close to inhabited areas and when cost structures are high. They also estimated that MPAs in developed countries cost much more for their running than those in developing countries (USD 8,976 vs. USD 1,584 km^2 $year^{-1}$). The difference in running costs between MPAs in developing and developed countries was due to difference in personnel wages and salaries, regular operational costs, cost of replacement of worn out equipment, cost of investment in new facilities and cost of other activities such as protection, research and visitor facilities (Balmford *et al.* 2004). For an MPA like Watamu that has existed for over 40 years Ban *et al.* (2009) estimated that their management costs are much lower. Nevertheless, the park needs additional funding supplemented by funding agencies apart from what it gets from the headquarters pool and allocation since its effective management depends on funding (KWS 2011). This is because the Park has in the past received low funding which scuttles implementation of its activities. Sustainable financing has been recommended which encourages MPAs to have diverse sources of funding (Gallegos *et al.* 2005).

It is important to ensure that there is protection of ecosystems that we have and that conservation professionals are trained (Pimm *et al.* 2001) so that ecosystems will continue providing the goods and services that we derive from them. Conservation efforts are often expensive but are expected to bear more fruit in the long run. Studies have shown that the Park is progressing well in attaining its objectives in biodiversity conservation. In contrary, the Reserve has not yet met its objectives of sustaining community livelihoods as a result of inadequacy in fishery management in the Reserve (Muthiga 2009).

4.3.1 Cost of biodiversity conservation

The services provided by ecosystems categorized by the MA (2005) into provisioning, regulating, supporting and cultural services are all linked to biodiversity (TEEB 2010). Biodiversity loss is due to habitat disturbance, overexploitation, pollution from nutrient load and conversion of land to other uses due to the growing human population. Natural ecosystems are vulnerable to the effects of climate change and overexploitation (Hicks 2011). Destruction and loss of marine ecosystems is expected to lead to a loss of biodiversity hence affecting the livelihood of the local communities that highly depend on these ecosystems for their survival and security, the society in general and future generations (Polidoro *et al.* 2010; TEEB 2010; Hicks 2011; Martín-López *et al.* 2011). This loss is irreversible (Devall 2006).

Incase biodiversity is lost, the cost of the loss may not be realized if its value was not known. The poor are the most affected by biodiversity loss because of their overdependence on natural resources (Hicks 2011). Habitat/refuge (Table 25) and biodiversity are among the least valued ecosystems, though they offer crucial supporting services for the continued provision of other services (Hicks 2011). Thus, even if the costs of biodiversity conservation are higher than the value of biodiversity estimated, the benefits of protection outweigh the costs in the long run. MPAs should therefore be seen as part of a wider landscape that promotes economic activities such as agriculture, tourism and fisheries (Martín-López *et al.* 2011). The costs of conservation are usually claimed to be high when in fact they are not (James *et al.* 2001). Moreover, total costs of conservation are superseded by environment harmful payments (subsidies) (de Groot 2006) such as support for agricultural production and commercial fisheries. These economic subsidies cause destruction of ecosystem goods and services. Therefore, their reduction will reduce conservation costs assisted by developed countries (James et al. 2001) in terms of financial support.

Protected areas such as Watamu MPA should be complemented with a tiered approach of recognizing, demonstrating and capturing value (TEEB 2010; Eigenbrod 2011) though its not known how effective tiered approaches are in comparison to single strategies (Eigenbrod 2011). For instance, the greatest use of a forest is for agriculture while ecosystem services generated by them are 'public goods' especially for the poor rural communities. In demonstrating the value of this ecosystem, regulating services account for two thirds of the total economic value of ecosystems (Table 25). The costs may also be captured through payment for ecosystem services e.g. Reduced Emmisions from Deforestation and Forest Degredation (REDD) that generate revenue for conservation and sustainable use of forests (TEEB 2010).

Table 25: Summary of the value of ecosystem goods and services estimated in this study

	Value	Methodology used	Conservative or not	Evaluation summary
Use Values				
Direct use value				
Fishery goods	EUR 233 ha^{-1} yr^{-1}	Market price	Not conservative	Trustworthy result. Catered for both seasons.
Fuelwood (villages close to sea)	EUR 90.56-150.93	Market price	Not conservative	Trustworthy result. Catered for distance from the resource
Fuelwood (villages away 1km from sea by road)	EUR 85.07 -141.79	Market price	Not conservative	Trustworthy result. Catered for distance from the resource
Timber	2,233.89 EUR ha^{-1}	Market price	Not conservative	Trustworthy result.
Research and education	EUR 30.29 ha^{-1} $year^{-1}$	Market price	Conservative	Not trustworthy. More assessment of research needed including researchers travel cost
Recreation	EUR 74,991 ha^{-1} yr^{-1}	Travel cost method	Conservative	Not trustworthy. Need to take into account other visitors and not only international.
Indirect use value				
Carbon sequestration	EUR 1,159 and 1,677 t C ha^{-1}	Market price	Conservative and non-conservative	More research need to be done to assess the value of below ground biomass
Coastal protection	EUR 392,733	Replacement cost	Conservative	Need for a study to assess the replacement cost of each of the ecosystems (coral reefs and mangroves)
Waste regulation	7,416.11 ha^{-1} yr^{-1}	Benefits transfer	Conservative and non-conservative	Results not trustworthy. Need for inclusion of purchasing power parity in calculation to address income disparities between study sites. Other methods such as benefits function transfer or meta-analysis can also be used. Benefits transfer method is not recommended unless it is necessary to use it.
Biological control	5.49 ha^{-1} yr^{-1}	Benefits transfer	Conservative and non-conservative	
Habitat/refuge	193.26 ha^{-1} yr^{-1}	Benefits transfer	Conservative and non-conservative	
Nutrient cycling	20,864.81 ha^{-1} yr^{-1}	Benefits transfer	Conservative and non-conservative	
Non-use value				
Existence and bequest value	EUR 84.40 ± 63.30 ha^{-1} $year^{-1}$	Contingent valuation	Conservative	An assessment of the WTP by user groups in relation to their socioeconomic characteristics needs to be done
Total Economic Value	EUR 103, 818.36 ± 63.30 ha^{-1} $year^{-1}$		Conservative	Not inclusive of all the goods and services studied since the value is in (ha^{-1} $year^{-1}$)

CHAPTER 5

5.0 Conclusion and recommendations

5.1 Conclusion

Watamu MPA and Reserve possesses a wide range of ecosystem goods and services that are beneficial to the local community and to Kenya in general. These include *inter alia* recreational value, coastal protection, habitat/refugia and carbon sequestration. The study established that income distribution varies among stakeholders and with seasons. Income is therefore not shared equally among resource users. Boat operators and owners earn more than other stakeholders interviewed. A number of techniques were used to assess the monetary value these ecosystem goods and services. These include market price method, replacement cost method, benefits transfer method, travel cost method and contingent valuation method.

The study may not have exhausted all the ecosystem goods and services, but from the values derived (Table 25) we have noted that these ecosystems have a high value. This has been noted especially for those ecosystem services that cannot be traded in the market including indirect use values and non-use values. Indirect use values, account for two thirds of the total economic value (Table 25) (TEEB 2010).

The local communities highly depend on these ecosystems for their livelihood and food security. Majority of households derive their income from fisheries related activities (Figure 5b). The cost of protecting them is also high (Figure 14) and is expected to increase with increased funding. The ecosystem services functions may be diminished due to conflicts between user groups and due to the concept of the 'Tragedy of the Commons' (Hardin 1968) and 'Tragedy of the unmanaged Commons' (Hardin 1994). Valuation is therefore essential to enable the value of ecosystem services not to be overlooked and subsequently overexploited and degraded (Beaumont et al. 2008). Conservationists have argued that modification of management and public awareness are key for conservation of marine ecosystems (Agardy 2000). Moreover, economic valuation should be used as a bargaining tool to press for protection and conservation of ecosystems since scientists, policy makers, politicians and economists easily understand it.

Jameson *et al.* (2002) recommended that in order for a marine protected area to attain its objective, it should follow a business planning approach where it should be able to provide in the long run ecosystem goods and services to its users. The approach reduces the cost of protection and enforcement by encouraging partnerships. The move by the Park to divide the resource use area into zones in order to abate conflicts will enable sustainable utilization and management. The zones include core protection, limited use, multiple use and livelihood intervention zones (KWS 2011).

5.2 Recommendations

The results obtained provide estimates of the value of goods and services in the Park and Reserve. Since they show that Watamu Marine Park and Reserve is endowed with valuable resources and services, we recommend that the Park management should enhance its protection and conservation efforts. They should do so assisted by the various stakeholders who derive benefits either directly or indirectly from the resource. Efforts against destructive fishing practices, logging and overexploitation of mangrove and fisheries resources should be accompanied by ongoing awareness and education campaigns. Policy makers need to be made aware of the value of biodiversity. More funding to the Park is required to sustain conservation efforts and reduce biodiversity loss whilst supporting economic activities such as fisheries and tourism.

Since we did not derive the value of all the ecosystem goods and services identified, we recommend more research in the future to establish their value. The benefit transfer method was used to get an estimate of the value of indirect use values such as waste regulation, biological control, habitat/refuge and nutrient cycling. There is need for more research to estimate the value of these services since our values relied on the value estimated by Constanza *et al.* (2007). Therefore, those services that were not estimated in their study were not assessed. If its necessary to use the benefits transfer method, which is not often recommended in estimation of the value of ecosystem services, extreme care should be taken to address differences between study sites to reduce the transfer error. For instance, income may be the main difference affecting WTP between sites. If income is not the only difference affecting the WTP of the two sites, the benefits function transfer should be used such that other differences such as age are taken into consideration. A meta-analysis that combines research from more than one study can also be applied.

The travel cost valuation methodology used did not adequately cover the recreational value of all the visitors to the Park (non-residents, residents and citizens). Future studies should isolate the three types of visitors since they differ in expenditure. Also, zonal travel cost method that does not require visitation frequency should be used since not many tourists visit the Park more than once in a year. Since the replacement method uses the cost of replacing a lost good or service to determine its value, caution should be taken not to overestimate the value of the intended service. Also, the cost of maintenance of sea walls should be taken into consideration in calculation of the shoreline protection value.

A more comprehensive compilation of all the research work that has been done in the Park and Reserve will give a better estimate of the research value. Also, budgets that these studies have used need to be taken into consideration. The whole aspect of the value of services per unit area needs to be handled with caution since most of the activities do not take place in the whole of the study area. An example is the recreational value where tourists to the Parks are taken to specific places and not the whole area.

Future valuation studies should also assess the loss of biodiversity as a result of human economic activities and climate change. This should be done over time. A set of guidelines should be established within the Western Indian Ocean region for valuation of ecosystem goods and services. These guidelines should outline the methodologies to be used to value the various ecosystem goods and services.

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7.0 Annexes

Annex 1

The ‘pros’ and ‘cons’

The methodologies selected for valuation have a number of advantages and disadvantages.

Source: Adapted from Barbier *et al.* (1997); Bann (1997); Birol *et al.* (2008) and http://www.ecosystemvaluation.org/dollar_based.htm (April 2011)

Market Price Method

Advantages

- The technique reflects the willingness to pay by an individual, the costs and benefits for ecosystem goods traded in the market such as fuelwood, recreation, fish and timber. This enables the values obtained to be well defined.
- The price, quantity and cost of goods data are easy to obtain.
- The observed consumer preferences data is used in this technique.

Disadvantages

- The economic value of the goods and services may not be reflected as a result of market imperfections and/policy failures.
- Seasonal variations need to be considered, as well as other effects when using this technique.
- The market data may not reflect the value of all productive uses of a resource. This is because it may only be limited for a number of goods and services provided by an ecological resource.
- Benefits may be overstated since the technique does not deduct the value of resources used to bring the ecosystem products to the market.
- Can also not be used to measure the value of larger scale changes which are likely to affect the supply of or demand for a good or service.

Travel cost method

Advantages

- This is the most widely used technique to estimate the value of recreational sites (Parks and Reserves) in developing countries. Can also be applied in estimation of willingness to pay for ecotourism purposes to wetlands in developing countries.
- It is relatively inexpensive to apply and results easy to interpret and explain
- The method is based on people's actual behavior rather than WTP in a hypothetical set up.
- Visitors are interested in participating in on-the-site surveys and therefore easy to acquire large sample sizes.
- The technique mimics the more conventional empirical techniques used by economists to estimate economic values based on market prices.

Disadvantages

- Data intensive; restrictive assumptions about consumer behaviour (e.g., multi- functional trips), thus difficult to divide the costs among the various purposes; results highly sensitive to statistical methods used to specify the demand relationship.
- Assumes that people perceive and respond to changes in travel costs in the same way as to changes in admission price.
- It may be difficult to define and measure the opportunity cost of time, or the value of time spent travelling. The value of the site would be underestimated unless the opportunity cost of time is added to the travel cost. On the other hand, if people enjoy the travel itself, then travel time becomes a benefit and not a cost, thus the value of the site will be overestimated.
- The availability of substitute sites will affect values. Two people travelling the same distance have same value, but if one travels to a preferred site his value is higher. Some of the more complicated models account for the availability of substitutes.
- Interviewing visitors on-site may introduce sampling biases to the analysis.
- Those valuing sites may choose to live nearby, thus low costs of travel.
- Measuring and relating recreational to environmental quality can be difficult.

- The standard travel cost approaches provide information about current but not about gains or losses from anticipated changes in resource conditions.
- In order to estimate the demand function, there needs to be enough difference between distances travelled to affect travel costs and for differences in travel costs to affect the number of trips made. Thus, it is not well suited for sites near major population centers where many visitations may be from "origin zones" that are quite close to one another.
- The travel cost method is limited in its scope of application because it requires user participation. It cannot be used to assign values to on-site environmental features and functions that users of the site do not find valuable. It cannot be used to value off-site values supported by the site. Most importantly, it cannot be used to measure nonuse values. Thus, sites that have unique qualities that are valued by non-users will be undervalued.

Contingent Valuation Method (CVM)

Advantages

- Widely used and considered as the only method that can measure option and existence values and provide a true measure of total economic value.
- Though the technique requires competent survey analysts to achieve defensible estimates, the nature of CV studies and the results of CV studies are not difficult to analyze and describe. Dollar values can be presented in terms of a mean or median value per capita or per household, or as an aggregate value for the affected population.

Disadvantages

- Results are sensitive to numerous sources of bias in survey design and implementation.
- Rather than expressing value for the good, the respondent might actually be expressing their feelings about the scenario or the valuation exercise itself.
- There is a difference in the way that people make hypothetical decisions relative to the way they make actual decisions. For example, respondents may fail to take questions seriously because they will not actually be required to pay the stated amount. Responses may be unrealistically high if respondents believe they will not have to pay for the good or service and that their answer may influence the resulting supply of the good.

Conversely, responses may be unrealistically low if respondents believe they will have to pay.

- WTA results exceed WTP showing responses to be expressions of what individuals would like to have happen rather than true valuations.
- The embedding effect (amount given to a small part of the system may equal that of the whole system) and ordering problem (people's expressed willingness to pay for something has been found to depend on where it is placed on a list of things being valued) may also occur.
- In case of bidding, the choice of starting bid affects respondents' final willingness to pay response.
- Respondents may give different willingness to pay amounts rather than expressing their actual value for the good, depending on the specific payment vehicle chosen e.g. taxes lead to protest responses.
- Strategic bias arises when the respondent provides a biased answer in order to influence a particular outcome. Information bias may arise whenever respondents are forced to value attributes with which they have little or no experience. In such cases, the amount and type of information presented to respondents may affect their answers. Non-response bias occurs when individuals who do not respond are likely to have, on average, different values than individuals who do respond.
- Estimates of non-use values are difficult to validate externally.
- Many people, including jurists, policy-makers, economists, and others, do not believe the results of CV.

Replacement cost method

Advantages

- Can be used to estimate indirect use values incase ecological data are not available for the other methods of estimation.
- Based on observable data derived from actual behavior and choices.
- The method is cheap.
- Provides a lower bound WTP if certain conditions are met.

Disadvantages

- May overstate WTP when only indicators of benefits are available.
- Costs are usually not an accurate measure of benefit as the method assumes.
- Does not consider individuals behavior in the absence of ecosystem services. Should therefore be used as a last resort.
- Estimates do not include fully losses from environmental degradation.
- Does not measure non-use values.
- Limited to current situation assessments.

Benefits transfer method

Advantages

- Its less costly and easier compared to conducting an original survey
- Can be used to assess if an original study is worth undertaking.

Disadvantages

- The transfers are only as accurate as the value of the study site.
- It may be difficult to get adequate studies from which to transfer.
- Benefit transfer estimates may not be accurate when the sites differ in characteristics.
- Up to date studies may be difficult to get since they may not be published.

Annex 2: Questionnaires

Occupation: **Interview ID Number:**

Objective: The main goal for the Marine Park and Reserve is to conserve biodiversity for sustainability. The questionnaire values the ecosystem goods and services within the Watamu Marine Park and Reserve to assist in the effective management of the Park and Reserve.

Name of interviewer: Date:

1. Name of respondent: ....

2. Name of Village:..

3. For how long have you lived in this area? ....

4. Stakeholder identification

   Sex (tick one) [ ] Male [ ] Female

   Age 15-19 20-29 30-39 40-49 50-59 60-69 70+

5. Household size………(# Adults) (# Children)

6. Level of education (tick one)

   [ ] None [ ] Incomplete primary school [ ] Complete primary school [ ] Incomplete secondary [ ] Complete secondary [ ] Intermediate college [ ] Graduate studies

7. Average monthly household income

Source	Main occupation	Other:	Wife/partner	Other Household Members
Income				

8. Average monthly expenses. Indicate your typical monthly expenses where relevant

Item	Fuel	Food	Transport	School Fees	Health Care	Rent
Expenses (KES)						

9. What is your source of domestic fuel wood?

   Mangrove trees [ ]   Forest trees [ ]   Both [ ]

10. Please indicate how you obtain your fuel wood.

    Buy [ ]   Harvest fuel wood [ ]   Both [ ]

11. How much fuel wood do you use per week?

    Quantity per week [ ]   Cost [ ]

Occupation: Mangrove cutter **Interview ID Number:**

1. How much money do you pay for the following?
   1.1 License
   1.2 Royalties (per m^3)
   1.3 Transport permit

2. Do you pay people to cut trees for you? [ ] Yes [ ] No

3. If yes, what are the costs involved?

Number of people	Average quantity harvested per visit	Amount per person (KES)	Cost of transporting per visit? (KES)	Distance transported

4. Which species of mangrove trees do you exploit?

Mangrove species	Location cut	Frequency/month	Quantity harvested per visit	Price per quantity	Cost incurred	Where sold and Buyers

5. Is there any seasonality to cutting? [ ] Yes [ ] No

6. If yes, indicate the seasons, quantity harvested per visit and price

Season	When (e.g. month)	Quantity harvested per visit	Price

Occupation: Mangrove trader **Interview ID Number:**

1. Details of trade : Please indicate;

Mangrove species	Volume traded	Product	Origin	Buying price	Cost incurred	Selling price

2. Is there any seasonality in this business? [ ] Yes [ ] No

3. If yes, indicate the season and price you sell your products

Season	When (e.g. month)	Quantity harvested per visit	Price

4. Indicate the taxes you pay, and the amount per annum in KES.
   Transport permit Licence

Occupation: Fisherman **Interview ID Number:**

1. Indicate the type of fisheries you specialize in (you can tick more than 1)
   [ ] Deep-sea fishery [ ] Sport fishery [ ] Crab fishery [ ] Lobster fishery [ ] Prawn fishery
   [ ] Octopus fishery [ ] Finfish fishery [ ] Other (specify)

2. Type of gear(s) used
   Gill net [ ] Long-line hook [ ] Beach seine [ ] Prawn seine [ ] Reef seine [ ] Cast net [ ] Hand-line [ ]
   Monofilament net [ ] Trawl net [ ] Scoop net [ ] Ring net [ ] Trammel net [ ] Spear guns/harpoon [ ] Trap/basket [ ]

3. Indicate fishing gear ownership
   Self: - ________ b. Shared: - ________ c. Hired:-_______d. Employer's _______

4. Average days spent fishing per week during
   Kusi (SEM) Kaskazi (NEM)

5. Which species of fish do you catch (kg per day)?

Fish species	Average Catch per day (kaskazi)	Average Catch per day (kusi)	Target market	Selling price (Kusi)	Selling price (Kaskazi)

6. What is the intended use of the fish you catch?
   Feeding my family……….%
   For Sale…………………...%
7. Do you own a boat? [ ] Yes [ ] No
8. If yes how many? ……………………………………………………………..
9. What type(s) of boat do you own?
   Ngalawa [ ] Mtumbwi [ ] Mashua [ ] Foot-Fishers [ ] Dau (Mtanyingi) [ ] Hori [ ]
10. Indicate which describes your current situation:
    [ ] Employed as crew
    [ ] Employed as a Skipper
11. Do you hire the boat yourself? [ ] Yes [ ] No
12. Are you part of a cooperative/association that own a boat? [ ] Yes [ ] No

13. If you are employed as crew or as a skipper are you paid a set 'wage' per trip or are you paid with a share of the day's catch? [ ] Wage per trip [ ] Paid with a share of the day's catch

14. How much are you paid in KES/trip?

15. How much share do you receive % share of the catch/trip?

16. If boat is hired, indicate how much you pay per one fishing day or the proportion of the catch that you receive

Amount in KES/day…………………..

Catch proportion/day ……………………

17. If boat is shared indicate number of share holders and proportions of catch distribution per one fishing day

Number of shareholders……………….

Catch proportions………………………….

18. Do you rent out your fishing gear(s) to other fishers? [ ] Yes [ ] No

Number of gears……………

Cost/day/gear KESs…………………..

Number of days/week ……………………………

19. If fishing gear is not self owned, indicate how you pay for it:

Share of the fish catch (%)………………..Cash (KES)…………………..

20. Indicate how much you earn from the employer or proportion of catch obtained in one fishing day

Amount in KES/day …………………..Catch proportion/day………………

21. If fishing gear is hired, indicate how much you pay per one fishing day or proportion of catch obtained

Amount in KES/day ………………….. Catch proportion/day………….

22. If fishing gear is shared indicate number of share holders and proportions of catch distribution per one fishing day

Number of share holders ………………. Catch proportions ……………….

Occupation: Boat operator, tour operator, canoe rider **Interview Number:**

1. Who is your employer?
2. What type of boat do you use?
   [ ] Outboard fibre glass [ ] Ngalawa
3. Indicate ownership of the boat (tick one)
   [ ] Individual owned [ ] Group/association owned [ ] Employer
4. What role do you play in the tourism industry?
   [ ] Diver [ ] Tour guide [ ] Boat operator [ ] Tour boat owner [ ] Coxswain
5. How many trips do you make in a day during;
   High season; Average number Period (month)
   Low season; Average number Period (month)
6. Indicate the average number of tourists you carry/guide per trip during;
   High season; Average number Low season; Average number
   If possible, indicate the amount of revenue per person per tour/trip…………………………………
7. If boat is not self owned, indicate how proceeds are shared (KES/month)
   Owner……………………Boat operator……………Association……………………
8. If boat is group/association owned, indicate how proceeds are shared per month among members
   KES/month/individual ……………………………………………
9. Which are the target places you take the visitors?
   [ ] Within the Marine Park
   [ ] To the reserve
   [ ] Both
10. Which specific areas in the MPA and reserve do you go to (tick more than 1)?

    [ ] Coral reef [ ] Green Island [ ] Bird watching in the creek [ ] Mangrove

    [ ] Dive point [ ] Sudi Island [ ] Whale island
11. How much does it cost to take the visitors to the destinations including fuel costs?

	Corals	Mangrove in the creek	Sudi Island	Green Island	Bird watching in the creek	Dive point	Whale island
Charges per tourist							
Litres of fuel							

Occupation: Curio vendor **Interview ID Number:**

1. What type of curio items do you sell? (tick one or more)

☐ Marine items ☐ Terrestrial items ☐ Both marine and terrestrial items

2. Who makes your curio items?

   Self [ ] Ready made from dealer [ ] Both [ ]

3. If self, indicate the type of tree species you use to make your curio items?

Tree Species (swahili name)	Quantity purchased/ month	Cost per Unit

4. If not self, indicate the tree species you prefer/that is used to make your curio items and how much you pay for it.

Curio item	Tree Species (swahili name)	Where purchased	Quantity purchased per month	Cost per Unit (KES)

5. For the marine items, indicate where purchased and the amount sold during low and high season.

Marine item	Where purchased	Average number sold during high season	Price (KES.)	Average sold during low season	Price (KES.)

6. If self made, indicate the:
7. Sale value per month during;

   High season KES. Low season KES.

8. If ready-made curios are obtained from a dealer, indicate:

   Total costs per month KES ……………………………

   Sale value per month KES ………………………………..

9. Who are your target customers? (tick one or more)

   Foreign tourists [ ] Local tourists [ ] Foreign and local [ ]

Tourists **Interview ID Number:**

1. Sex (tick one) [ ] Male [ ] Female
2. Level of education (tick one)
   [ ] None [ ] Incomplete primary school [ ] Complete primary school
   [ ] Incomplete secondary [ ] Complete secondary [ ] Intermediate college
   [ ] Graduate studies
1. Indicate your:
   Nationality Country of residence
2. How many days is your visit to the MPA?

3. Indicate the costs, number of times done and mode of payment of the activities that you have so far undertaken

Activity	Cost (per person)	Frequency (number of times done during visit)	Paid how (cash/to hotel/to tour operator)
Glass-bottom boat			
Diving			
Snorkelling			

4. How much is your hotel room per person
5. Is your hotel half-board/full-board?
6. How much do you spend daily outside the hotel on meals/drinks/shopping/curios in KES.?
   Meals………………………………Transport……………………
   Drinks……………………………..Shopping…………………………
   Curios……………………………..

7. How many are in your party/family?

8. Which Hotel/Guesthouse are you staying in?

9. How did you pay for your hotel?
   [ ] To a tour operator in your home country
   [ ] Directly to the Hotel here in Kenya

10. How much did it cost you to travel here?
    International Flights Taxi

Domestic Flights Vehicle Hire

11. Which among the following best fits the reason why you travelled to Watamu Marine National Park and Reserve?

    [ ] Beautiful beaches [ ] Varieties of fish species [ ] Bird watching

    [ ] Other (please specify)

12. Which among the following fits your net annual income?

    [ ] < $ 25000 [ ] $ 25000-50000 [ ] $ 50000-75000 [ ] $ 75000-100000

    [ ] > $ 100000

13. What are your views about conservation of marine resources?

    [ ] Strongly agree [ ] Agree [ ] Not sure [ ] Disagree [ ] Strongly disagree

14. Which among the following ecosystems would you be willing to conserve?

    [ ] Corals

    [ ] Mangrove

    [ ] Seagrasses

15. In case there is an oil spill and that the named marine resources are destroyed. You are requested to contribute monthly towards the restoration of the resource of your choice. Which one would you be willing to pay for?

    [ ] Coral reefs

    [ ] Mangrove

    [ ] Seagrasses

16. How much money would you be willing to give monthly for;

    Coral reef conservation…………………………..

    Mangrove restoration……………………………..

    Seagrass………………………………………………

17. How much more will you be willing to part with for the restoration and conservation of the destroyed marine resources as entry fees to the Marine Park?

    [ ] $ 1 [ ] $ 2 [ ] $ 5 [ ] $ 10 [ ] $ 15 [ ] $ 20 [ ] $ 25 [ ] $ 50 [ ] $ 75 [ ] $ 100 [ ] $ 200

If a Community/conservation group member

1. Name of your group:
2. Number of members:
3. Indicate how much each member pays as
   Membership fees………… Annual contribution…………….
4. Are there sources of revenue that support your programmes related to the MPA and Reserve?
   Mangrove protection and conservation [ ] Yes [ ] No
   If yes, specify the approximate value KES……………..programme name…………..
   Coral reef conservation [ ] Yes [ ] No
   If yes, specify the approximate value KES……………..programme name…………..
   Birds conservation [ ] Yes[ ] No
   If yes, specify the approximate value KES……………..programme name…………..
   Fish and turtle conservation [ ] Yes [ ] No
   If yes, specify the approximate value KES……………..programme name…………..
   Seagrass restoration and conservation [ ] Yes [ ] No
   If yes, specify the approximate value KES……………..programme name…………..
   Tourism [ ] Yes [ ] No
   If yes, specify the average number of visitors of and entry fees in KES during;
   High season: Number of visitors………… Entry fees………
   Low season; Number of visitors………… Entry fees………
5. How do you share amongst members the proceeds from your income?

………………………………………………………………………………..

Annex 3:

Table 26: Market information on selected wholesale commodity prices for 15th August 2011 in Malindi and Mombasa

	Commodity	Unit	Kg	Malindi (KES)	Mombasa (KES)
Cereal	Dry maize	Bag	90	4,400	2,950
	Green maize	Ext Bag	115	3,600	4,000
	Finger Millet	Bag	90	6,300	4,680
	Sorghum	Bag	90	4,500	3,600
	Wheat	Bag	90	4,500	
Others	Eggs	Tray		285	280

Source: Ministry of Agriculture. Accessed on 15th August 2011. http://www.kilimo.go.ke/index.php?option=com_content&view=article&id=94:market-information&catid=169:market-information&Itemid=110