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Full Length Research Paper

Development strategies for a coastal resort in Southern Mozambique

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As part of a long-term monitoring project studying coastal development, a number of rapid scan field surveys and project interventions were conducted in Ponta do Ouro, at the southern border of Mozambique. Here we report on four issues in support of sustainable development: 1. Tourism, 2. Water supplies, 3. Biodiversity and 4. Governance. In our tourism study, we interviewed tourists and managers, and placed a researcher as an intern in a beach camp to assess management and interactions. Tourism brings in about $3 Million in revenue annually. The seasonal variability in demand requires managers to adjust staffing levels to ensure viability. Local staff is insensitive to profit margins – so tend to resist. Tourists come for the beach and scuba-diving, and do not want development. In our water study; quality, supply and demand were quantified at source and community level. It was found that the local lake will meet the needs of the entire population including tourists in peak season, if a small pay-for-service can be developed. Currently, most of the community hand-carry water from open wells. In the biodiversity study: botanical and zoological species richness was assessed in three different habitats: dune forest, grassland, and wetland; all within close proximity of the resort. In addition fish species on the coral reefs were identified during a scuba dive. It is suggested that zoological richness at order level of classification is the most useful indicator of bio-diversity and the need for conservation. In the governance study, a plan for the development of a town services department was presented to key stakeholders, and reactions were gauged. Leasehold taxes are diverted to the district and national level, leaving little for infrastructure improvements and services. It was found that the rural community members strongly support a local services department, and indicated a willingness to pay. However, most business managers have water and other services; and believe that 'development' would disturb the tranquillity and lead to an influx of migrant workers. Hence there is little consensus on the need for governance to be localised. Inevitably, mass tourism projects will provide in-direct benefits and services, as this coastal resort develops.

Key words: Mozambique, botanical and zoological species, tranquillity tourism, water supplies, biodiversity and governance, Ponta do Ouro, development, community.

INTRODUCTION

Ponta do Ouro is a small coastal resort in southern Mozambique, situated next to the border of South Africa. The Portuguese name means 'point of gold', for the iron-rich sands. According to historical accounts, the Portuguese traded gold and slaves in this southern coast with entrepreneurs from South Africa. During the civil war from 1975 - 1990, the town became deserted. Gradually tourism recovered and with it, the town. People flock to the beaches for relaxation, to dive the coral reefs (approximately 100 000 times / year) and experience the local culture (Bjerner and Johansson, 2001). The tourism activity brings economic benefits yet contributes to degradation of the coastal environment (Motta, 2004). There is a need to preserve the coral reef ecosystem because its regeneration time is very long (Perry, 2001).

Our main objective is to study appropriate paths to

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sustainable development in the coastal town of Ponta do Ouro, Mozambique, as part of a long-term UNESCO-initiated monitoring project. The project also has components in South Africa (Mabibi) and Swaziland, so we can compare cross-border differences in the environment and its management. In Ponta five field surveys were conducted in the period 2003 - 2006. Environmental assessments and interviews with community leaders were carried out. We investigate the current status, identify environmental problems and propose solutions for four inter-related issues: tourism, water, biodiversity, governance.

Environmental characteristics

Ponta do Ouro is located at 26° 51' S 32° 58' E, atop low sand dunes with a view of the Indian Ocean (Figure 1a). The area of the town is 10 km^2, situated 117 km south of Maputo (Bjerner and Johansson, 2001). Southern Mozambique is characterised by a warm sub-tropical climate. The Agulhas current that flows southward just offshore, maintains a warm temperature, salty composition and blue appearance. The region is covered with sandy fluvial soils with high drainage rates, low organic content (< 1%) a salinity < 2% with low traces of sodium. The coastal dunes are steep in the south with topographic gradients up to 35%. Around the town, gradients are < 10% (WFP, 1998). The vegetation is of sub-humid savannah type and comprised of dry coastal forests and prairie grasslands, with a sharp transition about 500 m inland. There is a limited environmental carrying capacity caused by low soil nutrients and high evaporation. Hence agriculture yields are low and most food is imported from Manguzi, South Africa. Custom duties make this route expensive, so food is also brought from Maputo over 100 km on a sandy road. This originates from the Lubombo district about 40 km inland, which has considerably better soils. Fruit trees are the most important ones for the local family farms: banana, coconut, mango, etc. Crops like sweet potatoes, manioc, beans, and others are grown at the homestead scale (Bjnerer and Johansson, 2001). Other consumption crops include maize, peanuts, millet, rice and watermelon, grown with the help of traditional fertilisers, manure and bush fires.

Most of the natural landscape is intact, that is there is little change or substitution of native vegetation, except around the wetlands, which are used for cropping. There is deforestation caused by fuel-wood collection (Faria and Sitoi, 1996). Some wild game animals are caught for food. There are neither rivers nor estuaries in Ponta do Ouro, but a few small lakes are located a short distance inland. The most important Lake is Zilonto, the traditional water supply for the town, whose distribution system is largely derelict. In the dry season, from May to September, the town feels a scarcity of water (ACNUR/PNUD, 1997). Most water is drawn from open wells and is of reasonable quality. Near the more urbanised well points such as the community market (baraccas), the water is polluted by lechate from about 50 m^3 of garbage (Figure 5d). Two deaths (of children) were reported in May 2005, and attributed to drinking the contaminated well water (Figure 2e). Clearly water supplies are vulnerable to weak environmental management.

In a 1960 ecological survey there were 5, 500 species of animals recorded in southern Mozambique, of which 216 were mammals, elephants, lions, impalas, zebras, buffaloes, hippopotamus, crocodiles, antelopes, leopards, hyenas and wolves. Marine animals are becoming less abundant, especially fish, crayfish, crocodiles and lobsters (Faria and Sitoi, 1996). Since 1980 the biodiversity was reduced by civil war, the grazing of cattle, financial insecurity and the limited carrying capacity of the land (interview: Ponta do Ouro Town Secretary, 2004).

Socio-economic conditions

In southern Mozambique there are five districts for public administration, namely: Catembe, Catuane, Machangulo, Zitundo and Bela Vista, the capital. There are twelve villages with clustered development. The district directorates of agriculture and fisheries, industry and trade, tourism, education, housing and public works, health, and culture represent a governmental attempt to co-ordinate social action. There are other district services such as the Mail, Civil Notary, Judicial Tribunal, Public Politic and Security services, public companies, i.e. the railway company Caminhos de Ferro (ACNUR/PNUD, 1997). However most of these services are located far from Ponta do Ouro and necessitate lengthy trips for even the simplest of municipal authorisations.

Ponta do Ouro had 1600 inhabitants in 2005, of which 90% live in simple reed shelters (interview: Town Secretary, 2004). Most residents come from Maputo and other parts of southern Mozambique. The local population emigrated during the armed conflict and about 600 have returned. The community displays a multi-ethnic reality with the Shangaan culture / language dominant over Zulu. Close to 90% of the population work in part-time or informal periodic jobs. These comprise tourism services; including sea boating, tour guiding, maintenance, catering, etc. Without a local bank, not much is saved or invested by workers. Yet, many have upgraded their homes from thatch to concrete. Unfortunately the informal sector of the town has no layout plan, and with the construction of roads and water pipelines in future, this could present significant problems. In June 2005 for example, a major arterial road on the north side of town was cut off by fencing for an unauthorised development.

Although tourism is the mainstay of the local economy and generates an estimated $ 3 Million (R 20 Million) turnover, unemployment makes migration to South Africa attractive. These workers become an important source of

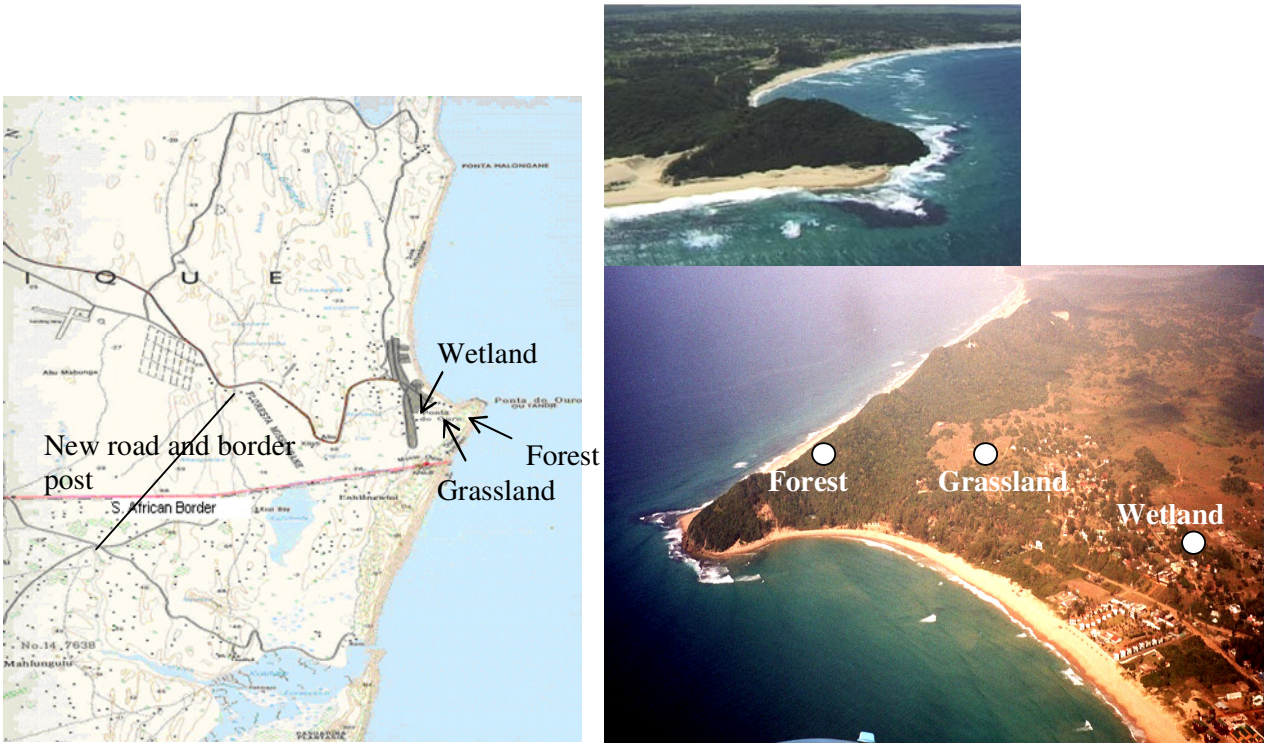

Figure 1. Location map and ecological sites, b: aerial views (from the south and north) of the study sites.

income for households. Apart from tourism income, a few people sell traditional alcoholic drinks (ACNUR/PNUD, 1997). The informal retail sector is growing, but market concessions are not formally granted, and thus little investment is generated. The turn-over at the local community market is estimated at $30 000 / yr (in 2005), less than one percent of the total. This marketplace in the centre of town needs an acceptable image to increase the flux of visitors.

In April 2004 it was observed that most of the food items were very expensive. For instance, three tomatoes cost 50 cents (US) and an equal number of onions cost 30 cents; a cup of rice cost 25 cents; same for a loaf of bread. Apples imported from South Africa were 50 cents each. Most costs were about double that found in South Africa, where salaries are much higher. All this suggests hardship for people earning the equivalent of $100 a month. It is unlikely that food production or salaries could be increased. Thus border duties should be abolished for basic food items. There is only one primary school in Ponta do Ouro. A secondary school that existed was destroyed during the 16-year civil war (ACNUR/PNUD, 1997). The existing school has five classrooms and students come in three shifts daily. There were 506 students in 2004, being 235 females. In 2005 the number increased to 600. Nine teachers (12 in 2005) cater for the lot. The dean of the school was concerned with the lack of classrooms and a lack of books for upper grades. In February 2004 the school was connected to electricity.

Water supply is through a borehole (dug in 2004) with a manual pump. Plastic containers are used for distribution (Figure 5b). There is a small clinic in town where there is a full time nurse and servant. The doctor posted to the district stays in Bela Vista, the administrative head-quarters, 40 km away. The doctor visits Ponta once a month unless transport problems occur (interview: Town Secretary, 2004). The health centre functions in a partially rehabilitated building. Its equipment is obsolete. There is no laboratory for simple analysis. The health centre receives an average of 30 patients a day, the majority being residents of the town. Few national or foreigner tourists use the centre.

In case of a serious illness, the patient is transferred to the neighbouring hospital of Manguze (South Africa) for it is much closer than Bela Vista. Such action is made easy due to the good will and relations that exist between the two countries. Visa restrictions were removed in 2004. The health centre does not have transport. Patients are carried in vehicles belonging to local residents or other people. Subsistence fishing is a declining activity due to wave action, overfishing and scuba diving activities. Conventional boats with engines are needed and few traditional (paddled) vessels are launched to sea. The fishing activity is largely recreational and limited to tourist sport fishing (interview: Town secretary, 2004). There are five main boreholes in town; the school, Baptist church, the wetland, the baraccas, and the health centre (dry in 2005). The people travel long distances to fetch water.

Figure 2a. Dive boat being launched.

Electricidade de Moçambique (EDM), the energy supplier is one of the few services operating in the town. There were more than 500 clients in 2005 (375 in 2004), both domestic and commercial consumers. In April 2004 there was an ongoing programme to stimulate the rational use of power (Rebeca, Eng/EDM, 2004).

Southern Mozambique has a high potential for the development of tourism activities, which in their implementation, will result in a growing level of prosperity for the local community, but with potential spin-off of unplanned (and improper) land use and degradation. Although tourists are usually environmentally aware, the services they require should be underpinned by locally contracted agencies for garbage collection, water supply and recycling, road and landscape maintenance, etc (Motta, 2004). There is a variety of ecosystems in Ponta do Ouro, a high level of bio-diversity and a scenic landscape, whose conservation would retain the chance for eco-tourism. The beaches have warm clear waters, and the diversity of fish that occur in the offshore coral reefs attracts divers (Figure 2a) and tourists (MICOA, 1996), although this is declining. The peak months for tourist activity are from December to April.

Ponta do Ouro has functioned as a coastal resort since 1968, with major interruptions in 1975 when Portuguese persons were ejected, and in 1986 when armed conflict flared. The avalanche of tourists resumed in 1995 after the Peace Accord of 1992 and the arrival of democracy to South Africa in 1994 (Bjerner and Johansson, 2001). Tourism resorts have proliferated leeward of the headlands: Malongane, Tanguele, Mimoli; although only marginally legalised. Hence there is a need for a land use management service within the local government authority, to control growth and blend it with ecological requirements. Most visitors are South Africans; during peak SA holiday periods up to 98% according to Bjerner and Johansson (2001).

Some domestic tourists visit the town during Mozambican holidays and on weekends and generally spend longer periods of time there (at Christmas). Tourism development such as a golf course or large hotel, could promote a water supply and recycling system, and also help to preserve the wetlands. Apart from bringing economic benefits to the community, it may also bring about negative impacts such as incremental polution. Most of the upmarket houses near the beach belong to salaried workers who visit from Maputo. They use them for relaxation and pleasure, and often rent them out during summer holidays to nationals and South Africans. There are some houses in ruin, some being rehabilitated and others newly completed. Local residents of the town live in small concrete houses and precarious thatch dwellings across the inland periphery of the town (Figure 10).

According to the town secretary, 80% of residents are migrant workers. There is one main access to town that splits into two further inland, leading to Maputo (north) and Manguzi (south). The road is in very poor condition and the use of 4 × 4 vehicles is essential (Bjerner and Johansson, 2001). Occasionally the road is graded in a few places by earth-moving equipment provided by local building contractors. There is a small landing field for light aircraft that is seldom used. Given this background and with the support of UNESCO, rapid scan field surveys were conducted twice a year over the period 2001 - 2005.

Each field survey had a specific mission. Initially a landscape analysis and opinion polls were conducted on issues of conservation, recreation and development. Then more intensive botanical, zoological, marine and beach-profile surveys were done by experts at selected 10 × 10 m quadrants to represent the diverse ecosystems and gradients of impact. These rapid scan surveys used methodologies established by UNESCO Coasts and Small Islands: case study assessments on tourism, water supply, biodiversity and governance; and species richness analysis as outlined in: www.unesco.org/csi/act/maputaland/maputa.htm, (Govender and Jury, 2005).

Figure 2b. View of beach camp.

Figure 2c. View of beach camp.

COASTAL TOURISM MANAGEMENT

Coastal tourism is on the upturn following years of stagnation. In the period July – September 2004 we analyzed the micro-economics of coastal tourism in this small border town. In any business there is a triangular relationship between supply, demand and cost. Supply we take to be fixed assets (eg. buildings and amenities), demand is according to tourists visitations and preferences, determined by their 'willingness to pay' and perceived 'value', and costs are generated in the production of services provided by staff (eg. retail, accommodation, catering, maintenance, etc). In our case, we consider the beach camp at Ponta do Ouro (Figures 2b and 2c). Market demand is based on tourist preferences, from a survey conducted at the campsite in April 2004. The following information is pertinent:

i. Tourists origin: 55% Johannesburg, 18% Durban, 5% Cape Town, < 5% each for other SA cities, only 5% from overseas.

ii. Number of visits: about 50% visited once, 25% visited 4 - 6 times.

iii. Size of group: 75% come in groups of 3-7 people.

iv. Activity preferences: 117 questionnaires are summarised in Figure 3.

When asked the question; why do you come here? Ocean-based water sports ranked as the most frequent response (Figures 3a and 3b). The sand by-pass around a headland that shelters the bay (Figure 1) is a key element, providing for boat launching and swimming. Thus climatic elements can be expected to have a critical influence on the seasonal cycle of tourism demand. Considering this, we estimate the level of demand through a statistical model based on local weather data:

$$D = (sh) - (ws) + (1/3 \times mt).$$

Where D= demand, sh= sunshine hours, ws= wind speed, and mt= minimum temperature; with all data in standard SI units.

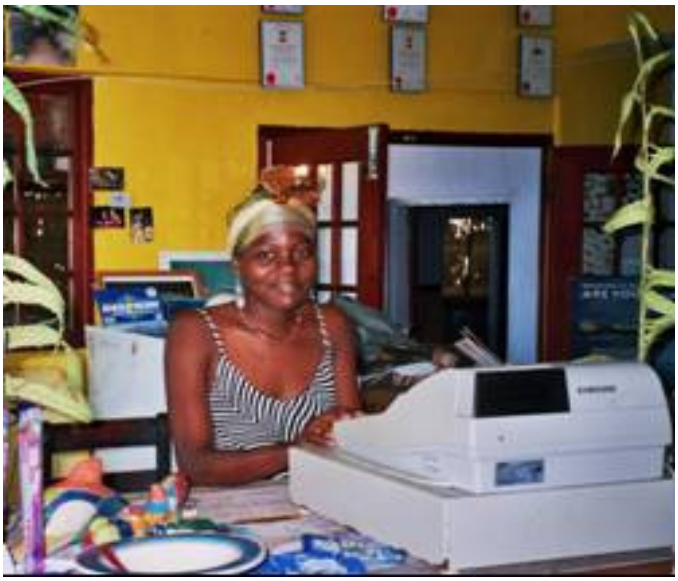

Figure 2d. Researcher on internship.

Figure 2e. Tap water in camp ablutions.

Our climatic model indicates that tourism demand is suppressed from August to November (Figure 3d). For a small tourism business to remain profitable, two different staffing levels would be needed: a higher one for the December to July period and another for the 'low' season. However, it is not easy for owners to adjust costs when it involves people's livelihoods. Management techniques that could be used to improve the situation:

i. Involve key local staff in financial accounting, and regularly update staff members on profit margins and anticipated tourism demand.

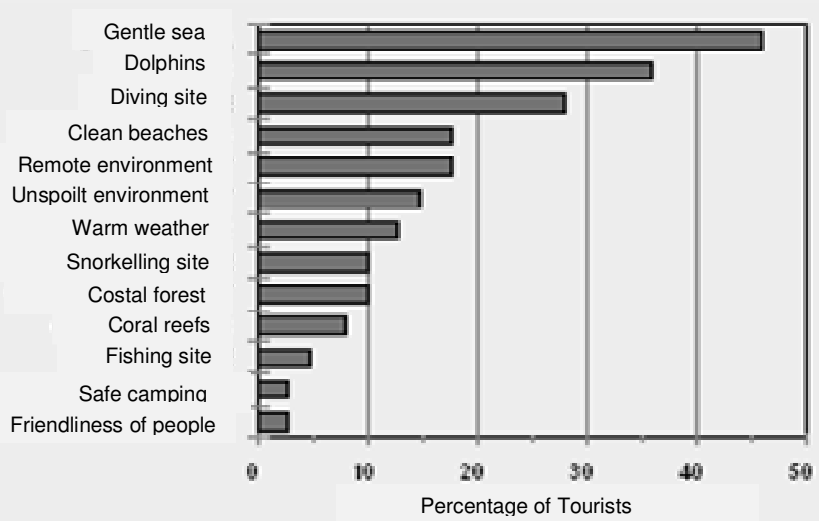

Figure 3a. Tourist's reasons for visit.

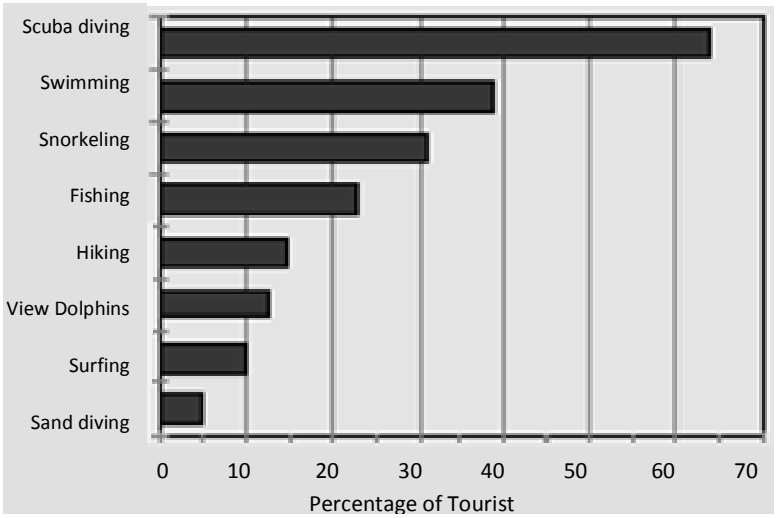

Figure 3b. Dominant activities.

ii. Empower staff to adjust costs themselves by instituting a democratic system of rotation to reduce staff during the low season.
iii. Involve staff in asset renovation during quiet periods.

These methods of communication tend to put (mainly white South African) managers and (local) staff on an equal footing. Although relatively liberal, the managers tend to underestimate the social maturity and management abilities of their Mozambican staff, who have had many generations of cultural interaction with the former Portuguese colonizers that uplifted their business and service skills.
On the other hand, the socialist national government and its worker's unions do not recognize variability in market demand. They expect (staff) costs to be fixed throughout the year – a situation that is not viable. Hence there is a need for greater communication between business and government planners to account for these factors, particularly as approximately a quarter of the Mozambican economy ($1 billion per annum) is driven by revenue from South African tourists. The owners of tourism businesses at our study site have a 'one-year-at-a-time lease' which inhibits investment in fixed assets, such as the replacement of reed huts. So conditions remain primitive. The beach camps consist of temporary reed shelters where sand floors are overlain with reed mats, a light bulb and mosquito net hang from the ceiling, sandy walkways connect rooms to toilets and kitchen, rats scurry around the premises. The beach vegetation is quite dense and helps block the wind. The rooms are totally open to the elements, however crime is still rare.

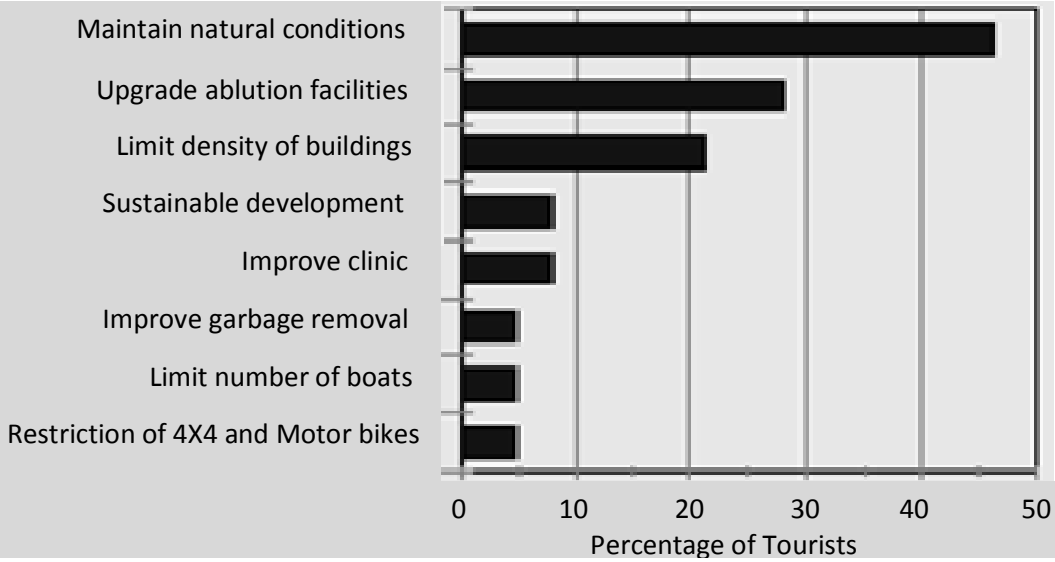

Figure 3c. Tourists views on possible improvements.

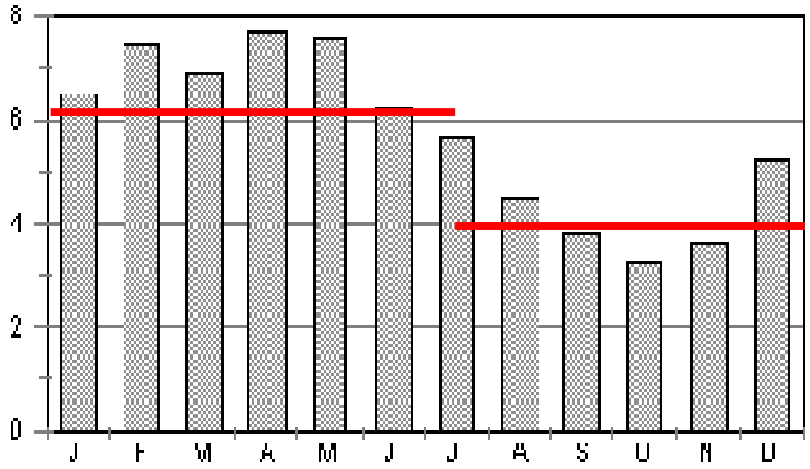

Figure 3d. Outcome of model on tourism demand.

Most Mozambican people respect another persons' private space. So it is possible to have a restful time without worrying about crime (unlike South Africa). Most tourists do not want a proliferation of development (Figure 3c), but most would be happier with improved water supplies and basic services.

Amenities in the border town of Ponta do Ouro are lacking with regard to road access, water supply and garbage removal, despite a population that reaches 10 000 and an estimated tourism revenue of $ 3 Million (R 20 Million) per annum. Municipal infrastructure in much of rural Africa is limited by overly-centralized government structures and no land tenure. There is a need for local government empowerment to provide support to eco-tourism development: in municipal planning (road network), the zoning of land for (residential, informal and commercial) development and conservation (coastal dune forests, wetlands), and in providing much-needed water supplies, as outlined below.

A WATER SUPPLY FOR PONTA DO OURO

Lack of access to water is one of the major causes behind the cycle of poverty. This section brings together data on the water quality and supply in Ponta do Ouro, a small but prosperous border town with a recessed bay and low dunes. In this section we investigate water quality, supply and demand. Numerous water samples were taken from community wells, boreholes, wetland, lake and hotel taps and other sources of water in the study area.

Table 1. Questionaires' result.

Sources	Frequency	Percentage
Borehole	12	35.3
School borehole	11	32.4
Community Well	6	17.6
Church borehole	4	11.8
Deep well	1	2.9
Total	34	100

In estimating supply and demand, we obtained population, climatic and hydrological data; we studied the current level of service, and water use through interviews with the hotel and camp managers and questionnaires administered to the community. Water quality was analysed in our laboratories in the departments of Chemistry, Agriculture and Microbiology for: pH, Electrical Conductivity (EC), Calcium (Ca), Sodium (Na), Potassium (K), Total Dissolved Solids (TDS), Turbidity and Total Coliforms. Of globally available fresh water, crop irrigation typically consumes 60 - 70%, industry uses about 20%, and the municipal sector about 10%. In Ponta do Ouro there is no crop irrigation or industry, only tourism services and residential consumption. The provision of safe drinking water (Brooks et al., 1997) requires the active engagement of local governments in managing supply and demand (UN Economic and Social Council, 2004). In Ponta do Ouro, local government barely exists. The supply of safe water of adequate quality is important to the development of any country because it supports public health and therefore ensures economic growth. The provision of water and sanitation services is vital for the protection and development of human resources (Devadas, 1984). Drinking water is regulated by guidelines which establish the maximum contamination levels. Most of these levels allow a sufficient margin of safety; however, one must remember that acceptable contaminant levels vary widely (DWAF, 1996). Thresholds are typically set, for example at a coliform level < 5 CFU/100 ml, bacterial infection is unlikely (Chapman, 1996; Rawlins, 2001). Household water demand is the product of population and per capita consumption. Since accessibility is one of the main factors affecting rural water consumption, the use of water is likely to be at a minimum where supplies are taken from wells or hand pumps where distances which water must be carried are excessive, or where long queues result from an excessive number of users (Hartmann, 2001). In establishing a water supply system, communities should consider quantity, quality, reliability, access / distance, cost of operation / maintenance, and ability to pay for the service (DWAF, 2001).

In Mozambique, public utilities were hamstrung by years of civil war, neglect and poor administration, which translated into destruction of assets, revenue losses, and dwindling resources. Recently, the Mozambique government has shown a commitment to water reform. For public health reasons, as well as economic ones, the government wants to establish a system for delivering better water services. Only about 25% of Mozambique's 18 million people have direct access to safe water. In rural areas, women and children spend hours collecting water–energy and time that could otherwise be spent productively in school or at work (National Directorate for Water, 1999).

RESULTS OF PERCEPTION QUESTIONNAIRES

Thirty-four community members in different households and also eight commercial managers were interviewed. There are 3 - 5 people per household. The community uses water for cooking, washing, bathing, etc. The researcher found that 88% of the community is getting their supply from a common (shared) source and 12% have individual sources. The researcher found that community members travel long distances to get water (Table 1). Most of the community members are not working, and cannot afford their own supply system, so they go to the school borehole, church borehole, community well, etc. During the interview with Thomas M., he complained about the water supply system of the area, saying he had to travel more than 1.5 km to reach the community well (Figure 6b). He felt that the water was unsafe for drinking purposes. The first manager interviewed was Dino S., the Camp site manager who commented about the water situation within the camp site. He said that the camp site has up to 400 visitors during peak season and long weekends. The camp site is presently getting water supply from its borehole while previously it was from the well. The camp site uses more than 6000 litres per day during peak times. Dino said that the water that they are using appears unsafe and visitors complain. Many visitors bring their own drinking water. Dino stated that the government wants to build a hotel in the camp site. The Hotel manager, Jerenras W. said that the hotel has about 100 visitors during peak season and long weekends. The hotel gets its water from Lake Zilonto (Figure 6a), averaging around 3 200 litres per day. He said that they are using pumps and underground pipes to abstract water from the lake and the water supply is adequate.

This supply exhibited the highest quality of all samples. Sara M., a dive camp manager expressed concerns: "it is very important that the quality of water in the camp (Figure 2e) is improved to be able to satisfy the tourists visiting here". Sara's dive camp gets its supply from the Camp site borehole and they are using more than 1000 litres per day. The water is brown in colour but usually safe except during peak season when septic tanks overflow.

Water quality

From the water quality analysis done in the laboratory

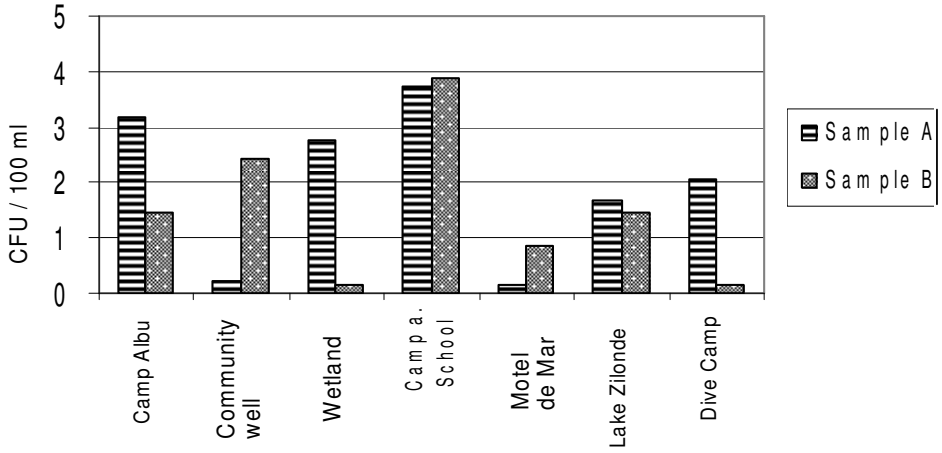

Figure 4a. Bacteria counts.

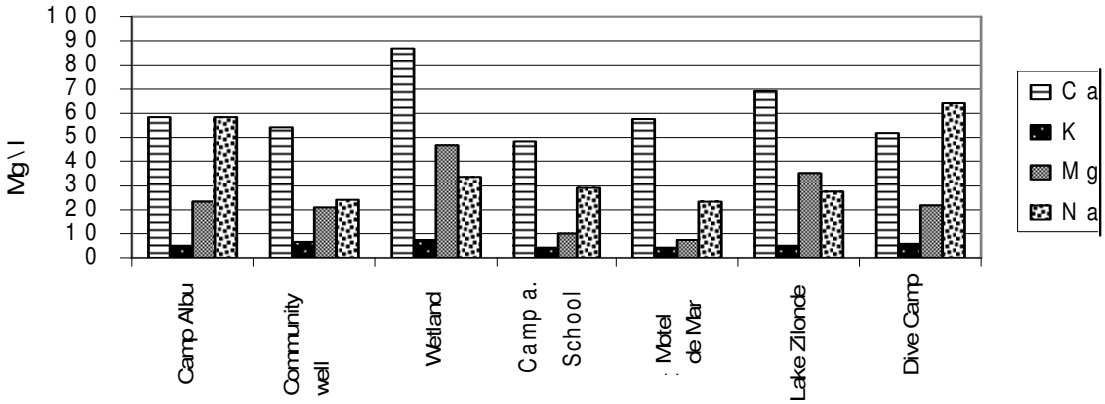

Figure 4b. Metals for various sources (mg/l).

from samples taken in September 2004 (Figure 5c), there is minor contamination in many sources that could lead to stomach ache, headache, skin rash, etc (Figures 4a and 4b). Bacteria levels are within accepted health limits, however only Motel do Mar had levels consistently below 1 CFU. Highest levels were found at the new lodge above the school, and at the beachfront camp ablution block. There was high calcium concentrations > 16 mg/l that would contribute to corrosive effects and 'scaling'. The amount of magnesium is 46.8 mg/l in the wetland and 34.6 mg/l in the Lake, exceeding the standard, whilst other points have low values. People using water directly from the wetland or Lake could expect diarrhoea. Sodium concentrations are below the standard, with 63.8 mg/l in Dive Camp and 23.7 mg/l in Motel de Mar. The amount of Potassium in all sample sources is within or slightly above the expected level, with 5.6 mg/l in the Dive Camp for example.

The Electrical Conductivity (salinity) for the wetland is 100 mS/m, and is above the standard (70 mS/m), whilst the Camp Ablution point has 64 mS/m and therefore a slightly salty taste. Similarly, the Total Dissolved Solids (TDS) in the wetland is 600 mg/l, above the standard (450 mg/l). TDS in the camp ablutions is also high, 416 mg/l. TDS in Lake Zilonto is low at 162 mg/l. Environmental lectures were provided to the primary school focussing on the connection between water quality and landscape cover around the wells (Figures 9b and 9c). During questions, it was determined that most students felt that clean water piped into the home was a luxury that only tourists could afford. They did not claim the right.

Estimate of water supply

Population, evaporation, rainfall and groundwater flow are important environmental factors in assessing the potential supply and demand for water in Ponta do Ouro. Average data for Kosi Bay indicate around 200 (100) mm/

Figure 5a. Lake Zilonto.

Figure 5b. Local teachers carrying water.

month of evaporation (rainfall) in summer, declining to 100 (10) in winter. The annual evaporation volume is 2 x 10^6 m^3, whilst the rainfall volume is 10^6 m^3 or half as much. The average groundwater flow toward the lake is estimated at 0.3 litres / second from borehole measurements made during hydrological surveys in 2003. Groundwater is the main component of inflow to the lake with an estimated 10^7 m^3 annually. The volume of Lake Zilonto (storage, Figure 5a) is 2 x 10^6 m^3. The annual volume of water currently abstracted from the lake is 2 x 10^3 m^3. Calculating the total water budget we estimate a yield of 9 x 10^6 m^3. The population of the area peaks at about 10 000 people at Christmas. The estimated demand, based on a minimum of 25 litres / person / day or 10 m^3 / person / year, is 10^5 m^3. Hence the lake yield exceeds demand by a hundred-fold.

Synthesis on water provision

Numerous boreholes serve the interests of the business community and tourists, however most of the rural community are without access to clean water, contributing to health problems. Without local government, a water supply system can not be organised. Community members travel long distances to get water. Most community members collect water daily and carry > 40 litres. The hotel extracts water from Lake Zilonto through considerable investment in pumps and pipelines. It already supplies a few neighbouring businesses with water. The Motel do Mar seems to have been able to monopolize the municipal water system that is intended to serve the whole community. This could be turned into a pay-for-service, via establishment of a private company within the

Figure 5c. Water analysis in the university laboratory.

Figure 5d. Garbage near the market causing groundwater contamination.

next few years, before the quality of water in Ponta do Ouro deteriorates further.

BIODIVERSITY AS AN ECOLOGICAL INDICATOR

Biodiversity studies in Mozambique have revealed areas that can be classified as being important (Mabjaia et al., 1997). Southern Mozambique has a high endemism of plant species which would imply endemism for fauna as well. Of the known species, 38% are threatened with extinction. The study reported here considers species richness for abundant families (such as insects) as an indicator of diversity, because of their 'representivity' in snapshot surveys. Insects are highly sensitive to environmental instability (Bevis, 1964; Hoffman and Frodsham, 1993).

The slopes of the 100 m sea-side dunes have a coastal forest as its climax plant community (Bayer and Tinley, 1966; Weisser, 1978). West of the higher dunes (< 1 km

Figure 6a. Biodiversity monitoring site: Grassland.

Figure 6b. Wetland with crops in foreground.

inland), are grassland communities, interspersed with a high ground water table in which swamps and sedgelands are common (Conlong and van Wyk, 1991). The vegetation in the dune forest ecotone is relatively undisturbed, as the dunes are very steep and there is no easy path to the area. The grassland ecotone is a mixture of various species of 10 - 30 cm high grasses and herbs. The topsoil is thinly layered and residential development is occurring in the area. The fringe of the wetland ecotone is of reed and marsh. Our sampling followed a 3-year drought so water starts 8 m into the wetland, marked by *Phragmites*. The water has a brown colour, indicating a high iron content, high dissolved organic matter and possibly anoxic conditions (Figure 2e). The wetlands are

Figure 6c. Dune forest canopy.

Figure 6d. Beach access to Dune Forest.

being used for cropping, resulting in habitat reduction (Naidu, 2003). With plans to promote tourism development, there is a need for information on the state of the ecosystem and the potential impacts that development will have on the biodiversity in the coastal area (Govender, 2001). This work on biodiversity will form a baseline and contribute towards the ongoing study of habitat reduction through (mostly unplanned) development in Ponta do Ouro. New species inventories will be collected every few years to track 'change' in species as a result of habitat encroachment in the process of urbanisation.

The diversity of species found in each ecotone (Figures 6a, 6b and 6c) was compared, according to overall species richness at family and order level classifications, eg alpha- and beta- diversity, and the similarity between the

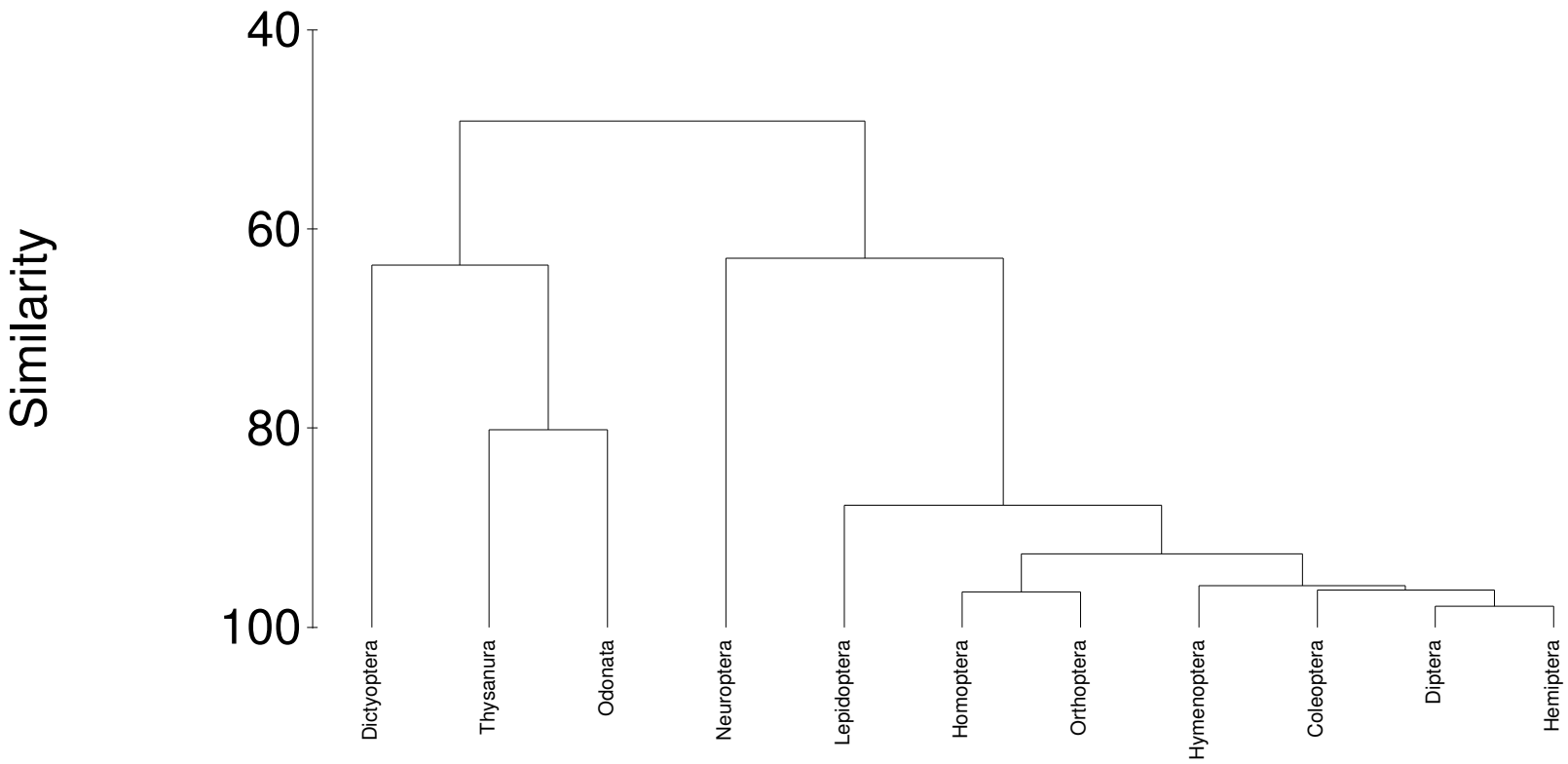

Figure 7. Cluster analysis of the insect orders sampled at Ponta do Ouro.

the sites (Whittaker, 1975; Ellenbroek, 1987). Species richness is calculated with the equation:

$$d = [S - 1] / \log (N)$$

where S = total number of species and N = total number of individuals.

A cluster analysis (similarity matrix) was produced using hierarchical agglomeration. Comparisons were made between botanical and zoological species richness across the different sties (Docherty et al., 1997; Naidu 2003).

Bio-diversity results

The wetland has the greatest diversity for all types, with a total of 125 different individual insects. The grassland is a far second with a total of 41, whilst the dune scrub had a total of 20 individual insects. The total number of families sampled is 82 for the three habitats. Govender (2001) obtained 64 in sampling at Mabibi, just 100 km to the south. This could be an indication that Ponta do Ouro is more diverse in terms of insect species, with more tropical conditions and the presence of wetlands that are currently richer in biotic activity than in the Mabibi area (Table 2). Of the total species collected, only 12% were not found in the wetland.

The species richness (S) at the order level classification was greatest in the wetland ecotone, followed by the dune forest and grassland ecotone. Whilst the number of individuals (N) was greatest in the wetland, the diversity at order level (d) was greatest in the dune forest. This means that the dune forest, although having less species numbers and total individuals, had proportionately

Table 2. Diversity values for insect species at order level classification.

	N	S	D
Wetland	129	11	2.0
Grassland	45	8	1.8
Dune forest	20	8	2.3

S – number of species, N – number of individuals, d - diversity index.

individuals, had proportionately greater diversity than the grassland ecotone. This is a significant finding for management purposes.

Whilst Govender (2001) found that biodiversity increases with elevation at Mabibi, here we do not find a clear trend. At Ponta, the wetland exhibited low botanical diversity yet high zoological diversity, likely due to canopy height and the mixture of terrestrial and aquatic (zoological) species. We conclude that species richness at order level may be a better tool in land management, than the more difficult to achieve family and species level classifications.

Zoological diversity

Higher order zoology surveys were conducted in 2006 at the same three sites (Figures 1a and 1c). The forest site had a heavy undergrowth of buckweed (*Isoglossa woodii*), which has approximately 10 year lifespan. Three vertebrates were encountered: a 2.5 cm skink, *F. Scincidae*, a 60 cm natal green snake (*Philothamnus natalensis*), F. Colubridae, and a 2 cm bush squeaker frog (*Arthroleptis wahlbergii*), *F. Arthroleptidae*. At least five different bird calls were heard, including a pigeon, *F. Columbidae*. Invertebrates included three large terrestrial mollusk shells, a dead crab, two species of millipedes, nine species of butterflies, a large grub, and various other insects, as reported above in the earlier survey.

We found the Ponta wetland increasingly disturbed by cropping and residential encroachment (Figure 6b). Two different small lizards were seen, one a *Lacertidae* and the other a *Scincidae*. A 20 cm black snake was observed, (a threadsnake, *F. Leptotyphlopidae*), and a 2 cm unidentified dark gray frog. A subsurface tunnel was seen, perhaps from a yellow golden mole (*Calchochloris obtusirostris*), *F. Chrysochloridae*. Some invertebrates were noted, such as a small brown-striped mollusk shell, a large crab hole, and at least four types of butterflies/moths and four types of grasshoppers. At Lake Zilonto (Figure 5a), a less disturbed wetland site, we noted a flock of yellowbilled egrets, *F. Ardeidae*, a pair of yellowbilled ducks, *F. Anatidae*, and a few unidentified terns, *F. Laridae*.

The grassland site was relatively unchanged up to 2005 (Figure 6a); but private property signs were posted – and development commenced in 2007. Some charcoal and trash was found at the site. Many decomposing logs were overturned, but no reptiles or amphibians were found. Three subsurface tunnels were seen, possibly from yellow golden moles (*Calchochloris obtusirostris*), *F. Chrysochloridae*. Some birds observed were the yellow-rumped widow and a sparrow, both *F. Ploceidae*, and a swallow, *F. Hirundinidae*. Several ant hills and some large red flying grasshoppers were seen.

Synthesis on biodiversity studies

Currently, there is not enough known about the status of Mozambique's biological diversity in rapidly developing coastal zones. There is a need for more species richness determinations over the longer term to bridge the information gap that currently exists. The absence of local governance structures in the face of tourism – oriented development has the potential of robbing the country of its natural biodiversity heritage, as conservation is difficult. Mozambique needs development that is well guided, not 'at the expense of the environment'. The main issue as regards conservation is that multiple decisions concerning the environment are made in isolation of one another such that no consensus is reached between the various users. Landscape managers and ecologists are conscious of the increasing threat to biodiversity from development in critical plant and animal habitats (Leakey and Lewin, 1995; Warrick, 1998; Ayres, 1998; de Valk, 1999), however rural communities are largely 'unaware'. To maintain ecosystem processes land management needs to be informed and the community needs to be informed and involved. But who manages the land, and demarcates areas for development? The next section will discuss this issue.

LOCAL GOVERNMENT SERVICES

Ponta do Ouro is growing rapidly since civil war in the 1980s. Many former inhabitants have returned and are joined by twice as many migrant workers (nationals from Maputo etc). The town is short of infrastructure and basic public services to support a growing tourism industry. Changes are therefore needed. However, local government is weak and there is a lack of consensus in the municipal plan between the tribal leader and the Frelimo-aligned Town secretary. The plan (Figure 8) calls for a coastal strip that has formalized residential and commercial property development and an informal area inland with no clear demarcation for roads and other amenities. The town lacks a central park, decent health clinic, municipal office, etc. Because land is publicly owned (by national government), there are infinite disputes amongst the leaseholders as to who has rights to occupy and develop the land. This eliminates local

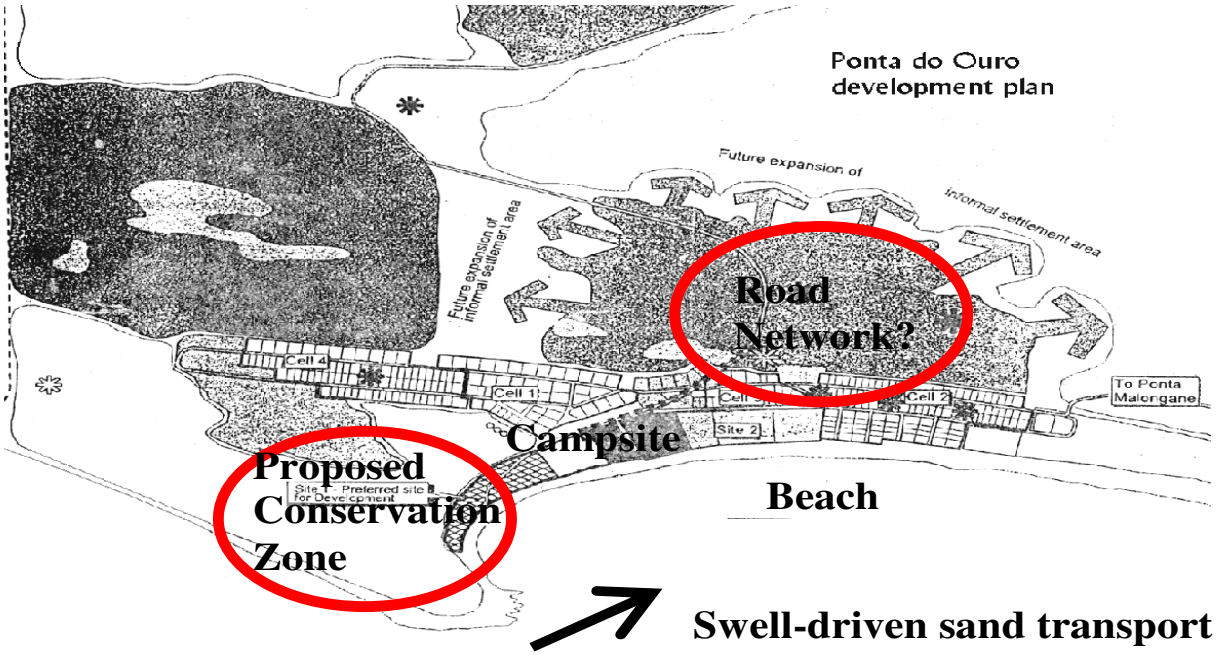

Figure 8. Examples of old town plan for Ponta do Ouro, indicating a formal layout only for a small sector of the town. There is no road network for the informal sector. We propose a conservation zone near the point.

Figure 9a. Community market in 2004.

sources of revenue that would otherwise be determined from property value. The community market is poorly maintained (Figure 9a) partly because of a lack of long-term leasehold rights, according to a survey conducted in April 2004. The management system charges leaseholders a monthly fee, but they seem to get little for it. There is no water supply, no toilet, little refuse removal, etc. The entrance to the market is bare sand.

During the period May - June 2005 our project promoted sustainable development and a plan for local services, through meetings with traditional leaders, members of the business forum, potential contractors of services, government officials, legal experts etc. The plan for local government was outlined: a non-political executive management system at the municipal level (Figure 11). The starting point for such a system is a town plan that controls growth, land-use and architectural codes. Devolving from this are leasehold contracts and value-based property taxes, retained for distribution to the private contractors providing water supplies, garbage collection and road building. Some effort was needed to improve the clinic and school. Community development projects were expected to piggy-back onto private tourism enterprises.

In discussion with key stakeholders, many involved in business, it was clear that leasehold taxes are sent to

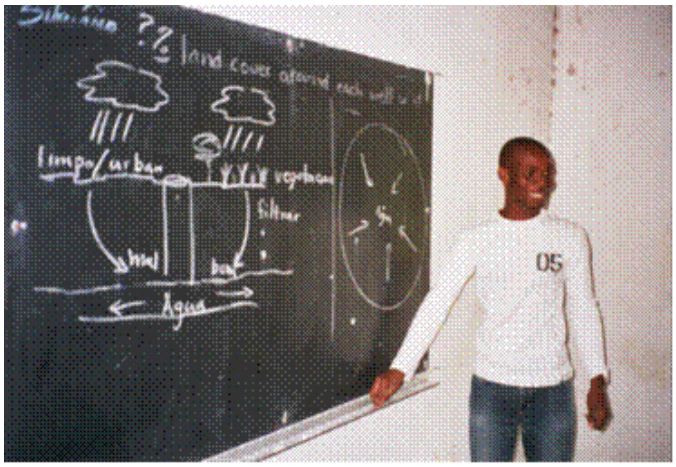

Figure 9b. Environmental lectures.

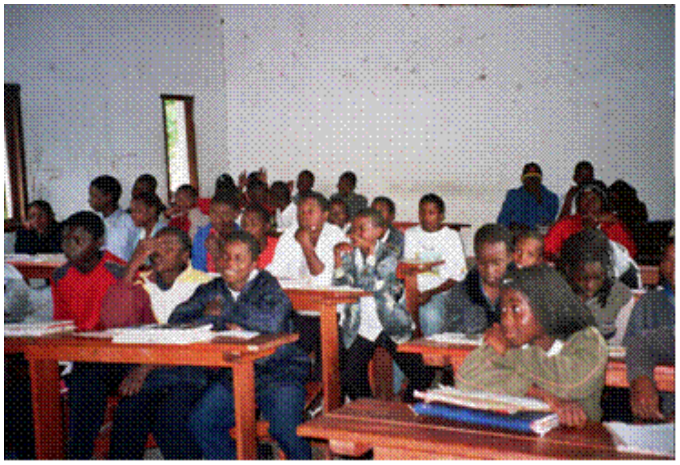

Figure 9c. School class.

the district capital Bella Vista, then 'absorbed' into the Mozambican political system. It is contradictory to think that funds from central government can be used to provide local services. All stakeholders in Ponta do Ouro agreed that the current system inhibits development, but most were unwilling to seek consensus. Some business leaders felt that 'better services (eg. clean water) would attract migrant workers' and contribute to problems! The pace of development 'needs to be slow' to accommodate the gradual rise in demand for tourism services, from both South African visitors and weekenders from Maputo. A planned new road to Maputo could see a sudden upsurge in demand in a few years.

CONCLUSIONS AND RECOMMENDATIONS

Most local people in Ponta do Ouro eek out a minimal existence on a few hundred Rand ($50) a month and spend most of it on imported food. The population has a low level of education due to the lack of school infrastructure and the 'distraction' of temporary tourism jobs during peak times. It is recommended that a school-completion certificate be required to qualify for employment in the tourism industry, to alleviate this problem. Tourism brings in about R 20 M per annum in Ponta, but less than 10% finds its way into the local economy. Tourism can increase stress on coastal marine life, if unregulated and unsupported by adequate infrastructure. Local people should be more involved in decision making so that tourism benefits reach households, through their representative on the business forum. Given the lack of basic infrastructure, tourism appears to have reached a plateau since 2003. Most beach camp operators report no significant increase in numbers in 2004 and 2005, despite the removal of visa requirements. Many tourists head further north for more pristine landscapes where conditions are equally delivery is needed, backed by land

Figure 10. Panoramic views of Ponta do Ouro, Mozambique in 2005.

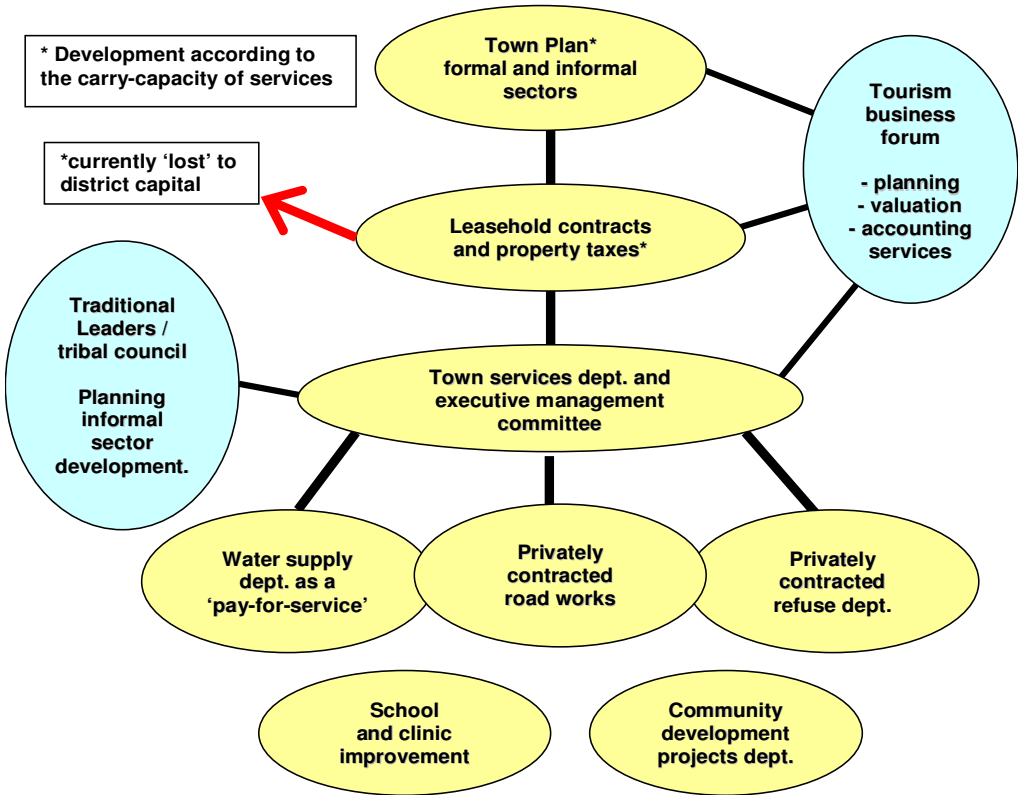

Figure 11. Flow chart for a local government services department.

that is owned, not leased. The transformation of land tenure systems is happening all over Africa, for example in Tanzania where development at the local level is finally moving ahead. Mozambique need not be left behind.

For this to occur, the decentralisation of power from district to town level is needed, such that financial resources are available to support basic services, (eg. refuse, water, roads) as set out in the flow chart (Figure 11). This is the most important recommendation of our work. The public places and market in the town need improvement. If local authorities defined leasehold contracts for commercial activities that required workers to be local residents, then migration could be controlled to the level of the services and carrying capacity. The town plan could have codes stipulating: Location in accordance with activity type; Construction material used;

Aesthetic/architectural appearance and signage permitted; Need for electricity and water supply; Health inspections for selling perishable goods and preparation of food, etc. In parallel to the above items, it would be the responsibility of local authorities to create conditions for: Public toilets; Water supply and sewage facilities; Create and maintain green spaces (parks); Provide a refuse collection service; Ensure that leasehold taxes are collected, accounted for and used properly.

This paper has outlined how a long-term coastal development project can have a useful impact, helping all sectors of the community to interact and drive forward specific projects. Our advice to other researchers involved in similar activities: persevere at one specific site. Keep going back; first to engage in passive monitoring of the ecosystem, next with micro-scale community improvement projects, then attempt macro-scale adjustments with key role players, and finally, continue ecosystem monitoring to assess whether development is really sustainable and within the carry capacity of environmental and management resources.

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Appendix 1. Soil characteristics and nutrients in ecological sites at Ponto do Ouro.

Ecotones	P	K	Nitrate	% Org. C	Org. mat.	% moist./g
Grassland	11	308	4	0.77	1.32	0.70
Forest 1	42	355	21	2.54	4.40	3.76
Forest 2	34	368	14	2.21	3.80	2.89
Wetland	10	347	15	0.45	0.78	1.32

Appendix 2. Plant species identified at each site.

Species name	Common name	Forest	Grassland	Wetland
Vangueria infausta	-	+		
Allophylus natalensis	False currant	+		
Chaetacme arista	Thorny elm	+		
Cordia caffra	Septee	+		
*Deinbollia oblongifoli**	Dune soap berry	+		
Brachylaena discolor	Coast silver oak	+		
Eugenia capensis	Dune myrtle	+		
Euclea natalensis	Thonga Guarri	+		
Oplismenus hirtellus	Basket grass	+		
Panicum deustum	Broad-leaved panicum	+		
Brachypodium flexum	-	+		
Sideroxylon inerme	White milkwood	+		
Albizia adianthifolia	Flat crown	+		
Eragrostis capensis	Heart-seed love grass		+	
Perotis patens	Cats tail		+	
Ischaemum afrum	Turf Grass		+	
Bromus catharticus	Rescue grass		+	
Andropogon appendiculatus	-		+	
Digitaria argyrograpta	Silver finger grass		+	
Sorghum versicolor	Black-seed wild sorghum		+	
Aristida stipitata	Long-awned three-awn		+	
Hyparrhenia anamesa	Bundle thatching grass		+	
Hyparrhenia filipendula	Fine thatching grass		+	
Digitaria eriantha	Finger grass		+	
Eustachys paspaloides	Fan grass		+	
Anthephora pubescens	Wool grass		+	
Eragrostis nindensis	Wether love grass		+	
*Eragrostis pallens**	Broom love grass		+	
Eragrostis plana	Love grass		+	
Diplachne fusca	Swamps grass		+	+
Mariscus congestus	-		+	+
Melica racemosa	Fluffy grass			+
Imperata cylindrica	Cotton wool grass			+
*Acroceras macrum**	Nile grass			+
Cenchrus cilaris	Blue buffalo grass			+
Chloris gayana	Rhodes grass			+
Chloris virgata	Feathered chloris			+
Eragrostis tef	Teff			+
Paspalum dilatatum	Common paspalum			+
Phragmites australis	Common reed			+

Appendix 3. Insect species classification

Order	Family	Dune forest	Grassland	Wetland
Heteroptera (bugs)	Alydidae	0	2	0
	Berytidae	0	0	1
	Coreidae (twig wilter)	0	0	2
	Geriidae	0	0	1
	Lygaeidae (seed bug)	1	0	3
	Miridae	0	0	1
	Nabidae (damsel bug)	0	1	1
	Naucoridae	0	0	2
	Notonectidae	0	0	1
	Pentatomidae (stink and shield bugs)	1	3	4
	Pyrrhocoridae	0	1	0
	Reduviiae (assassin bugs)	0	1	1
	Tingidae	0	0	1
	Veliidae	0	0	1
Hymenoptera (ants, bees, wasps)	Apoidea (bees)	0	0	1
	Sphecidae	0	0	1
	Braconidae	1	1	3
	Chalcidoidea	0	3	11
	Diapriidae	1	0	0
	Formicidae	2	2	8
	Gasteruptiidae	0	0	1
Thysanura (fishmoths)	Cecidomyiidae	0	0	1
	Ephydridae	0	0	1
	Sepsidae	0	0	1
	Therevidae	0	0	2
Dictyoptera (cockroaches)	Blaetidae	1	0	2
DIPTERA (flies)	Bombyliidae (bee fly)	0	0	2
	Calliphoridae	0	0	1
	Chloropidae	0	1	1
	Chironomidae	0	0	1
	Drosophilidae (vinegar fly)	0	1	2
	Muscidae (house fly)	1	4	3
	Phoridae	0	0	2
	Scenopinida	0	0	1
	Sciaroidea	1	0	1
	Sphaeroceridae	0	0	1
	Syprhidae	0	0	1
	Tephritidae	1	1	3

Appendix 3. Continued.

Lepidoptera (moths)	Geometridae (loop caterpillar)	0	0	1
	Heterocera	0	0	3
	Lasiocampidae (moth caterpillar)	1	0	1
	Lymetridae (caterpillar)	1	0	0
	Mycetophilidae (fungus net)	1	0	0
	Noctuidae	0	2	0
	Rhopalocera	0	0	1
Odonata (dragonflies, damselfies)	Coenariidae	0	0	1
Coleoptera (beetles)	Anthrebidae	0	1	0
	Attelabidae	0	0	1
	Bruchidae	0	1	1
	buprestidae	0	1	1
	Carabidae (predatory ground beetle)	0	0	1
	Cerambycidae (longicorn beetle)	1	0	0
	Chrysomelidae (leaf beetle)	0	0	2
	Curculionidae	3	0	3
	Dytiscidae (diving beetle, water beetle)	0	0	1
	Helodidae	0	0	2
	Hydraenidae	0	0	1
	Hydrophilidae	0	0	1
	Mordellidae	0	1	1
	Noteridae	0	0	4
	Staphylinidae (rove beetle)	0	0	1
	Tenebrionidae (toktokkies, darkling beetles)	1	2	0
Neuroptera (antlions)	Chrysopidae (lace wing)	0	1	0
	Myrmeleontidae (antlion)	0	1	1
Orthoptera (crickets, locusts, katydids)	Acridiidae (short horn grasshopper)	0	2	3
	Grylidae (true cricket)	0	1	1
	Mogplistidae	1	1	2

Appendix 3. Continued.

	(scaly cricket)			
	Tetrigidae (locust)	0	1	2
	Tettigonidae (bush cricket)	0	0	3
Homoptera (hoppers)	Cercopidae	0	1	3
	Cicadellidae	0	3	10
	Cixiidae	0	0	1
	Coxiidae	0	0	3
	Delphacidae (delphacid plant hopper)	0	0	1
	Derbidae	0	0	1
	Mantodea (mantis)	0	1	1
	Membracidae	0	0	1

The numerical values in the table denote the number of morphospecies identified per site.

Appendix 4. Families of mature fish found on two reefs at Ponta do Ouro.

Acanthuridae (surgeonfishes)
Apogonidae (cardinalfishes)
Balistidae (triggerfishes)
Carangidae (jacks, pompanos)
Chaetodontidae (butterflyfishes)
Cirrhitidae (hawkfishes)
Dasyatidae (stingrays)
Fistulariidae (cornetfishes)
Gobiidae (gobies)
Haemulidae (grunts)
Holocentridae (squirrelfishes, soldierfishes)
Labridae (wrasses)
Lutjanidae (snappers)
Malacanthidae (tilefishes)
Monocanthidae (filefishes)
Mullidae (goatfishes)
Muraenidae (moray eels)
Ostraciidae (boxfishes)
Pinguipedidae (sandperches)
Plotosidae (eeltail catfishes)
Pomacanthidae (angelfishes}
Pomacentridae (damselfishes)
Pseudochromidae (dottybacks)
Rhinobatidae (guitarfishes)
Scaridae (parrotfishes)
Scorpaenidae (scorpionfishes)
Scombridae (mackerels, tunas, and bonitas)
Serranidae (groupers, anthias)
Tetraodontidae (puffers)
Zanclidae (the moorish idol)