

Information Sheet on Ramsar Wetlands (RIS)

Categories approved by Recommendation 4.7, as amended by Resolution VIII.13 of the Conference of the Contracting Parties.

Note for compilers:

1. The RIS should be completed in accordance with the attached *Explanatory Notes and Guidelines for completing the Information Sheet on Ramsar Wetlands*. Compilers are strongly advised to read this guidance before filling in the RIS.
2. Once completed, the RIS (and accompanying map(s)) should be submitted to the Ramsar Bureau. Compilers are strongly urged to provide an electronic (MS Word) copy of the RIS and, where possible, digital copies of maps.

1. Name and address of the compiler of this form:

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Designation date

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Site Reference Number

2. Date this sheet was completed/updated:

4th July 2003

3. Country:

Mozambique

4. Name of the Ramsar site:

Marromeu Complex

5. Map of site included:

Refer to Annex III of the *Explanatory Note and Guidelines*, for detailed guidance on provision of suitable maps.

a) **hard copy** (required for inclusion of site in the Ramsar List): *yes* -or- *no*

b) **digital (electronic) format** (optional): *yes* -or- *no*

6. Geographical coordinates (latitude/longitude):

35° 55' 30" of Longitude and 18° 35' 00" of Latitude

7. General location:

Include in which part of the country and which large administrative region(s), and the location of the nearest large town.

The Marromeu Complex comprises the protected Marromeu Buffalo Reserve (*Reserva especial de Marromeu*) and four surrounding hunting concessions (Coutadas 10, 11, 12 and 14) in Northern Sofala Province (Anderson *et al* 1990, Bento 2002). The Southern Bank portion of the complex belongs to two districts: Marromeu and Inhaminga Districts. Both districts are part of Sofala Province. At the coast the northernmost portion of mangrove area is part of Chinde District, Zambezi Province (Northern of Mozambique). The nearest large town is the port city of Beira located about 200 km south of the Marromeu Complex.

8. Elevation: (average and/or max. & min.)

2m to 13 m

9. Area: (in hectares)688 000 ha

10. Overview:

Provide a short paragraph giving a summary description of the principal ecological characteristics and importance of the wetland.

The Marromeu complex supports a great diversity and abundance of wildlife including Cape buffalo *Syncerus caffer*, waterbuck *Kobus ellipsiprymnus*, sable antelope *Hippotragus niger*, Lichtenstein's hartebeest *Sigmoceros lichtensteinii*, Burchell's zebra *Equus burchellii* and African elephant *Loxodonta africana*. The area supports numerous waterbirds of special concern including wattled crane *Bugeranus carunculatus* (>1% global population), grey crowned crane *Balearica regulorum*, African skimmer *Rynchops flavirostris*, great white pelican *Pelecanus onocrotalus* (>1% global population), pink-backed pelican *P. rufescens*, woolly-necked stork *Ciconia episcopus*, Abdim's stork *C. abdimii*, African openbill *Anastomus lamelligerus* (>1% global population), saddlebill stork *Ephippiorhynchus senegalensis*, yellowbill stork *Mycteria ibis*, collared pratincole *Glareola pratincola* and Caspian tern *Sterna caspia* (Beilfuss and Allan 1996, Beilfuss and Bento 1998). The Delta's coastal mangroves support one of the largest breeding colonies of white pelicans *Pelecanus rufescens* in southern Africa (Goodman 1992). Large mixed-breeding colonies of herons, egrets, storks, and cormorants have also been recorded (Beilfuss and Bento 1998). The Delta is also home to thousands of farmers and fishermen who depend on the floodplain for their livelihoods. The Zambezi Delta is most threatened by the cessation of natural flooding processes caused by the management of upstream dams on the Zambezi River as well as by the construction of roads, railways, and flood protection dykes in the Delta.

11. Ramsar Criteria:

Circle or underline each Criterion applied to the designation of the Ramsar site. See Annex II of the *Explanatory Notes and Guidelines* for the Criteria and guidelines for their application (adopted by Resolution VII.11).

(1) • (2) • (3) • 4 • (5) • (6) • (7) • (8)

12. Justification for the application of each Criterion listed in 11, above:

Provide justification for each Criterion in turn, clearly identifying to which Criterion the justification applies (see Annex II for guidance on acceptable forms of justification).

Criterion 1 - The Marromeu Complex contains representative examples of natural wetland types found in Southern Africa especially in the Zambezi basin. This site includes the Zambezian coastal flooded savanna, coastal dunes, grassland, and freshwater swamps, dambos associated with miombo forest, mangroves, and sea grass beds.

Criterion 2 - The mangroves and floodplain areas of the Marromeu Complex shelter a large population of wattled crane (*Grus carunculatas*) identified as a vulnerable species in the IUCN red list. The Zambezi delta mangrove and adjacent intertidal areas support numerous bird species with threatened global concern status, including the white and pink-backed pelicans (*Pelecanus onocrotalus*, *P. rufescens*), various species of storks (e.g. *Ciconia episcopus*, *Anastomus lamelligerus*, *Ephippiorhynchus senegalensis*, *Mycteria ibis*) and the Caspian tern (*Sterna caspia*). More than 10,000 African Openbill storks have been recorded on Zambezi River sandbars in the Zambezi Delta (Bento and Beilfuss, 1999 and Beilfuss 2000). The area is also considered an important breeding colony for the white pelican, with thousands of breeding pairs being observed nesting on the mangrove trees; this is in fact one of the largest breeding colonies in southern Africa (Beilfuss & Bento, 1997). In a study carried out in 1991, Finlayson et. al. (1991) reported 75 sightings of the humpback whale (*Megaptera novaeangliae*) identified as vulnerable in the IUCN red list and one sighting on the minke whale (*Balaenoptera acutorostrata*) of the coast of the reserve.

Criterion 3 - The mangrove crab *Scylla serrata* and other mangrove dwelling crustaceans (portunids, etc) are present and exploited by the local population. Bivalves and gastropods are also present in the

mangrove swamps. The marine fish fauna of the Zambezi Delta and northern Sofala Bank is characterized by a great variety of species. In one of the research surveys made by the vessel "E. Heackel" 341 species of fish were recorded, of which 288 were demersal species (in 110 families), 45 were pelagic (8 families) and 8 mesopelagic (5 families) (Brinca et al., 1983). Nine species of mammals were found to live in close association to the mangrove vegetation. Marine mammals are abundant in both shallow and offshore waters of the Zambezi delta. Bottlenosed dolphins (*Tursiops truncatus*) and humpback dolphins (*Sousa chinensis*) are commonly observed around the delta. The Zambezi delta mangrove and adjacent intertidal areas support numerous bird species with threatened global concern status, including the white and pink-backed pelicans (*Pelecanus onocrotalus*, *P. rufescens*), various species of storks (e.g. *Ciconia episcopus*, *Anastomus lamelligerus*, *Ephippiorhynchus senegalensis*, *Mycteria ibis*) and the Caspian tern (*Sterna caspia*). Small birds like the red-eyed dove (*Streptopelia semitorquata*), Black-headed oriole (*Oriolus larvatus*) and yellow-breasted apalis (*Apalis flavida*) nest on the mangroves trees. The mangrove area is also important for African fish eagles, egrets, kingfishers, flamingos, waders, cormorants and herons by acting as nesting and feeding grounds. The mangrove and floodplain areas of the Marromeu Complex shelter a large population of wattled crane (*Grus carunculatus*). Bento (2000) recorded 32 species of birds in the mangrove and floodplains.

Criterion 5 - More than 20,000 waterbirds were counted in the Marromeu Complex during a May 1997 aerial survey (Beilfuss and Bento 1997). Recent surveys suggest comparable numbers of waterbirds in other years, but total waterbirds have not been enumerated. The delta has the largest concentration of waterbirds in Mozambique (Carlos Bento, *pers. comm.*).

Criterion 6 - The Marromeu Complex supports more than 1% of the global population of wattled cranes (*Grus carunculatus*). In September 1990, 2570 Wattled Cranes were counted in the Zambezi Delta, the largest concentration of wattled cranes ever observed in Africa (Goodman, 1992). Repeated annual and seasonal surveys since 1995 suggest that wattled cranes typically number about 300 in the delta region (Bento 2002), and that this 1990 concentration was an irruption of birds from other regional wetlands, perhaps triggered by the extreme regional drought in Zambia and Botswana (Beilfuss et al 2003). Recent regional Wattled Crane surveys coordinated by the International Crane Foundation and South African Crane Working Group indicate a global population of 8 000 (Beilfuss *et al* 2003; also Wetlands International 2000). Therefore, the Zambezi Delta supports 3-4% of the global Wattled Crane population, and may provide critical wetland refuge during extreme regional droughts when more than 30% of the global population may temporarily occur in the Delta. A great attention is being paid to ecological aspects of the wattled crane and its relation to the hydrological cycle (C. bento, *pers. com*). Beilfuss and Allan (1996), counted in 1992, 156 individuals of wattled cranes, including 58 pairs (74%) on territories and others in small flocks of 3-11 birds. Based on these numbers and assuming that 75 % of the floodplain was accurately surveyed they extrapolated a total population of 208 wattled cranes and 7 breeding pairs. Only the Okavango delta and Kafue Flats have reported a greater number of breeding pairs in one setting (Beilfuss & Allan, 1996).

The Marromeu Complex also supports 7000-10,000 African Openbill storks *Anastomus lamelligerus* throughout the dry season and possibly year-round (Beilfuss & Allan 1996; Beilfuss & Bento 1997; Bento & Beilfuss 1999), more than 1% of the global population which is estimated as 4,000 birds (Wetlands International 2002).

Criterion 7 - The marine fish fauna of the Zambezi Delta and northern Sofala Bank is characterized by a great variety of species. In one of the research surveys made by the vessel "E. Haeckel" 341 species of fish were recorded, of which 288 were demersal species (in 110 families), 45 were pelagic (8 families) and 8 mesopelagic (5 families) (Brinca *et al.*, 1983). These species were assigned to four ecological groups: coastal estuarine, transition, neritic-oceanic and oceanic. These groups reflect the approximate distribution of the species based on the depth they were collected. The great variety of fishes occurred in shallow waters and at the mouths of rivers and species occurring in zones where coastal waters mix with oceanic waters. About 176 species were found in these areas. In terms of abundance *Hilsa kelee* is the dominant species of the coastal estuarine group. The transition group was mainly composed of shallow-water shrimp by-catch species being the Carangidae, Scianidae and Haemulidae the most important

families. The neritic-oceanic and oceanic species were distributed in waters with high values of salinity, at the lower limit of the continental shelf or at the open ocean. About 165 species were identified.

The freshwater fishes of the southern African region are relatively well known and this knowledge has been well synthesised by Bowmaker *et al.* (1978). Skelton (2001) provides a comprehensive guide of the freshwater fishes of the region. The great majority of published information on this group is concerned with taxonomic and fisheries aspects of the Upper and Middle Zambezi. There are very few on the Lower Zambezi, and according to Timberlake (1998), there appears to be no publication on the freshwater fish of the Zambezi Delta. The exception seems to be the small note on the distribution of the tiger fish (*Hydrocynus vittatus*) on the Zambezi and Limpopo rivers by Jubb (1952). This voracious predator is a highly prized game fish. According to Bowmaker (1978), 66 species (21 families) of freshwater fishes occur in the Lower Zambezi. The fish fauna is dominated by the Cyprinidae family with 19 species already identified. Other important families include Cichlidae and Mormyridae.

Criterion 8 – The shallow waters of the Marromeu site are important source of food for fishes, spawning ground, and nursery and/or migration path on which fish stocks, either within the wetland or elsewhere, depend. About 176 species were found in these areas. In terms of abundance *Hilsa keele* is the dominant species of the coastal estuarine group. The transition group was mainly composed of shallow-water shrimp by-catch species being the Carangidae, Scianidae and Haemulidae the most important families. The neritic-oceanic and oceanic species were distributed in waters with high values of salinity, at the lower limit of the continental shelf or at the open ocean. About 165 species were identified. Mangroves are also important spawning areas for the prawn species, especially given the economic importance of this species for Mozambique.

13. Biogeography (required when Criteria 1 and/or 3 and /or certain applications of Criterion 2 are applied to the designation):

Name the relevant biogeographic region that includes the Ramsar site, and identify the biogeographic regionalisation system that has been applied.

a) biogeographic region:

Alluvial valleys and swamps characterize the morphology of the coastal area, with soil rich in clay and steppe-like vegetation. The mangroves are the predominant vegetation.

Marromeu Reserve and surroundings is integrated in the larger Zambezi basin, 1.33 million Km² in extent, which incorporates four distinct biomes and numerous habitats. Although the Zambezian biome covers 95% of the area, the Montane and the Congolian biomes are exceptionally species rich (Timberlake, 2000).

From a continental perspective there are four significant areas of special biodiversity conservation interest situated within the Zambezi basin. These are lake Malawi/Niassa/Nyasa, the swamps, floodplains and woodlands of the palaeo-Upper Zambezi in Zambia and northern Botswana; the Middle-Zambezi, Valley in northern Zimbabwe and the Luangwa valley in eastern Zambia; and the Gorongosa/Cheringoma/Zambezi Delta are of central Mozambique.

The Mount Gorongosa-Urema-Cheringoma-Zambezi Delta area is extensive but covers an enormous diversity of habitats from mountain to mangrove, not found in such proximity elsewhere on the Continent. Mt Gorongosa, although just outside the Zambezi basin supports a wide range of mountain and forest species, and the valley floor of the Gorongosa National Park has, in recent past, supported large numbers of wildlife. The Cheringoma Plateau, clothed in miombo woodland and dry forest containing many unusual species, rises up on the other side and then gently descends to the extensive grasslands of Marromeu, coastal dunes and mangrove swamps. Over this large area not only can viable populations of multitude of species survive, but

also the ecological processes that sustain such a landscape can continue to operate (Timberlake, 2000).

b) biogeographic regionalisation scheme (include reference citation):

- The Eastern Africa marine Eco-region
 - The Eastern African Mangrove Forest
 - The Zanzibar-Inhambane Coastal Forest
 - The Miombo Eco-region
- (WWF, 2000)

14. Physical features of the site:

Describe, as appropriate, the geology, geomorphology; origins - natural or artificial; hydrology; soil type; water quality; water depth, water permanence; fluctuations in water level; tidal variations; downstream area; general climate, etc.

About 40 km downstream of the Rift Valley confluence, the Zambezi anabranches give way to a distributary's channel network of the Zambezi Delta. The delta is a broad, flat alluvial plain, 0-100 m, supporting a vast mosaic of grassland, palm, thicket, woodland, and mangrove communities. From its apex near Mopeia, 120 km from the main mouth of the Zambezi, the delta forms a large triangle with the Indian Ocean coast. The delta extends 200 km along the coast from mouth of Zuni River in the south to the Cuacua River outlet near Quelimane in the north. The delta covers an estimated total area of 1.2 million ha.

The Zambezi Delta formed from the accumulation of sediments and alluvium transported downstream by the Zambezi River over several thousand years. Alluvial plains, colluvium, and eluvium from the Quaternary cover the entire delta region, with mosaics of various clays, clay loams, and organic silts underlying much of the permanently and seasonally flooded plain (Loxton, Hunting and Associates *et al.* 1975c&d). Most of the delta is covered by heavy textured, gleyed soils. At the floodplain periphery and on the reverse slopes of river levees, vast areas of the delta are dominated by hydromorphic vertisols that swell during the rainy season, with minimal permeability, and become dry and deeply cracked during the dry season. These soils often feature hummocky microrelief. In the extensive lowland depressions of the central delta plains, humid gleys become dominant. These areas either remain saturated or have high-water table conditions throughout the dry season (Tinley 1994). The thin topsoils, on drying, form a hard crust that is impermeable when the first rains arrive.

At the onset of the rainy season, local rainfall saturates and pools on the delta soils. Rainfall over the delta, as elsewhere in the Zambezi catchment, is strongly influenced by the movement of the Inter-Tropical Convergence Zone¹. The main rainy season in the delta usually occurs over a 4-6 month period between October and April, and is characterized by brief periods of thunderstorms followed by periods of drier weather (There are only 10 rainy days on average during the peak months of January and February, and 70 rainy days per year occur on average). The delta is subject to torrential rains from cyclones that can occur in any month from December to March and cause widespread local flooding. The maximum 24-hour rainfall is 251 mm at Chinde and 146 mm further inland at Marromeu.

As the rainy season continues, local runoff from the surrounding Rift Valley escarpment more deeply inundates floodplains along the northern and western perimeter of the delta. On the north bank, rainfall drains from the undulating terrain of the Morrumbula Plateau that separates the Shire and Zambezi Valleys. The plateau is covered in fairly dense woodlands from which emerge towering outcrops of sedimentary rocks of the Great Rift Valley. The Morrumbula surface is covered by deep unconsolidated eluvium of fine-grained sands, incised by a series of rivers (including the perennial Luaua and Licuria Rivers and several smaller streams) that drain southwards into the northern delta floodplains (Loxton, Hunting and Associates *et al.* 1975d). The quartz-rich sands may attain a thickness of 30 m on the upper escarpment, but thin to less than 100 cm where the plateau surface folds under the deltoid plain (Smidt 1988). Runoff that is not channelized moves as subsurface and groundwater flow through the sands and

discharges to the sandy, hydromorphic soils at the base of the escarpment. The total catchment area of the northern escarpment draining to the delta is approximately 25,000 km².

On the south bank, the gentle backslope of the Cheringoma Plateau rises gradually from the western alluvial lowland plains at a 3° -5° incline to an elevation of 394 m, and forms the eastern side of the Rift Valley. The plateau is composed of Cretaceous and Tertiary limestones, overlain by Quaternary sands (Tinley 1977). Characteristic red loamy soils cover the upper summit area, with Pleistocene sands over clay subsoils on the backslope. The Mungari, Ruave, Sanga, and Zuni Rivers rise on the crest slope of the Cheringoma escarpment and fan out in distinct outwash plains of alluvial sand fans along the western edge of the Zambezi Delta. The convex fan surfaces support miombo woodland, with wet grassland on the interdistributary slacks. The total catchment area of the Cheringoma escarpment is 10,766 km², of which approximately 8,300 km² drains directly delta. The Zuni River discharges to the far southeastern corner of delta, and is tidal in its lower reaches as it follows a torturous path through coastal mangroves to the Indian Ocean. Along the western edge of the Marromeu floodplains, the Nhandue River drains runoff from the escarpment, especially the Ruave and Sanga channels, and discharges to the coast along a narrow, meandering path incised through mangrove mudflats. Runoff from the Mungari River drains into the Marromeu floodplains, and combines with runoff from the Cuncue distributary of the mainstem Zambezi channel. These streams follow an anastomosing flow path through the low-lying delta floodplains, and drain to the sea via the broad outlet channel of the Luaua River. Surface water runoff from smaller streams collects in a series of shallow lakes and lagoons in this region.

Inundation of the entire delta occurs when the Zambezi River overtops its banks and spreads laterally over the delta or through distributary channels. As the Zambezi enters the delta region, the river divides into a complex network of distributary channels. The Cuacua waterway breaks off first, just south of Mopeia, to feed the dense distributary network of the north bank plains. Historically, the Cuacua was a major perennial branch of the Zambezi River. Early explorers and traders, including Livingstone, traveled up the Cuacua channel from Quelimane to reach the mainstem Zambezi and points further inland (e.g., Livingstone 1857). The Cuacua collects substantial wet season runoff along its course adjacent to the Morrumbula plateau. Several channels break off and drain to Indian Ocean between Quelimane and Chinde, flooding low-lying areas along the coast and eventually discharging into a vast papyrus swamp (<0.5 m amsl) along the northwest perimeter of the delta. The Muta River runs parallel to the Cuacua to the south, exchanging runoff during high flows. Much of the remaining north bank region south of the Muta is characterized by relict channels that served as distributaries from the mainstem Zambezi before the river down-cut to its present-day base level. These channels include the Mucacau, Bazar, Nhangone, and Inhamara Rivers that drain local runoff directly to the coast and the Inhaombe and Maucane Rivers that drain into the Catarina branch of the Zambezi River.

Along the south bank of the mainstem Zambezi between Chupanga and Marromeu, three distributary channels drain to the low-lying floodplains (0-1 m amsl) of the Marromeu complex. The Salone River breaks off first, flowing along the western edge of the delta and collecting runoff from the Cheringoma plateau before discharging into the northwestern portion of the Marromeu complex. The Cuncue River drains directly into the northern portion of Marromeu floodplain. The Nhasua River flows parallel to the mainstem Zambezi and discharges to the eastern portion of the Marromeu floodplain. Figure 2-54 shows a cross-sectional profile of the Zambezi downstream of this reach. Historically, these channels began discharging to the delta when Zambezi flows exceeded about 4500 m³/s. The south bank drains from the delta to the Indian Ocean coast through the Luaua, Nhandue, and Zuni outlets. Floodwaters collecting in the broad central depressions of Marromeu floodplains maintain ponded or saturated soil conditions throughout the dry season, lost slowly through evapotranspiration.

At about 5000 m³/s, the Zambezi reached bankful capacity and spread laterally into the upper floodplains. On the north bank, floodwaters spread across the floodplains near Mopeia and formed a large shallow lake with the Cuacua and Muta channels. South bank floodwaters moved slowly as overland sheet flow through the Salone depression from the mainstem Zambezi to the southwest corner of the delta. Highland areas near the present-day villages of Marromeu and Luabo formed natural islands in the

floodplain that were inundated only during exceptional flooding events Hogue, A. M. & Dove, V. F. (2002).

About 25 km downstream of Marromeu the Mucelo River branches off from the mainstem Zambezi. The Mucelo, which defines the eastern boundary of Marromeu Reserve, follows a flat, meandering path to the coast through coastal grasslands (2-3 m amsl) and dense mangroves. The Mucelo captures runoff from the relict Sagasse River channel that rises on old alluvium and flows parallel to the mainstem Zambezi below Marromeu. During peak flooding, the Mucelo spills overbank into the surrounding floodplains and forms a broad channel to the ocean.

Further downstream, some 30 km from the coast, the main Zambezi channel divides in two, with the Chinde River to the north and the mainstem Zambezi River to the south. The Chinde River meanders eastward to form a navigable channel leading to a shallow harbor at the coastal port of Chinde. Near the coast, the Chinde captures runoff from the Maria River, a small channel that breaks from the mainstem Zambezi just north of the Chinde River divide and collects runoff from the northern floodplains. The main Zambezi channel divides a final time about 15 km from the sea, opening up into two large coastal outlets, the Zambezi mouth (*Boca do Zambeze*) and smaller Catarina River. The lower Zambezi channels near the coast have gently sloping banks, and much of the region is inundated as floodwaters rise.

Flooding patterns near the delta coast are also influenced by oceanic tides (Hidrotécnica Portuguesa 1961). The delta region has the highest tidal variation in Mozambique and one of the highest along the East African coast (Tinley 1971). At spring tide, the maximum tidal amplitude is 4.1 m at Chinde and 4.7 m at Quelimane. During the rainy season, high tide levels back up Zambezi flows and spread floodwaters over the coastal plains. During the dry season, tidal influence is evident for 80 km upstream (this section excerpted from Beilfuss and Santos in review).

15. Physical features of the catchment area:

Describe the surface area, general geology and geomorphological features, general soil types, general land use, and climate (including climate type).

The Marromeu Complex includes more than 688,000 ha of dry forest and woodland, savanna, floodplain grassland, deep-water swamp, coastal dune and mangrove forest. The Quaternary Deltoid Plain underlies the core floodplain areas and supports vast expanses of open floodplain grassland and shallow swamps on a mosaic of clay, clay loam, and organic silt soils (Loxton Hunting and Associates 1975). Zambezi floodwaters are distributed to the plains through an intricate network of recent alluvial channels cut into the deltoid plain, most important of which are the Salone, Cuncue, and Nhausau Rivers with associated levees and backwater pans. At the western margin of the deltoid plain, the Cheringoma escarpment of the Limpopo Surface rises gradually at 3°-5° to a height of 394 m amsl, where it forms the eastern side of the Rift Valley (Tinley 1977). The plateau is composed of Cretaceous and Tertiary limestones, overlain by Quaternary sands (Tinley 1977). The Mungari, Ruave, Sanga, and Zuni Rivers drain from the Cheringoma escarpment, fanning out in a series of outwash plains of alluvial sand fans along the western edge of the Zambezi Delta. The total catchment area of the Cheringoma escarpment draining to the Marromeu Complex is approximately 8,300 km².

Two distinct seasons occur in the region, a wet season and a dry season, as influenced by the movement of the Inter-tropical Convergence Zone (ITCZ). The main rainy season usually occurs over a 4-6 month period between October and April, and is characterized by brief periods of thunderstorms followed by periods of drier weather. Mean annual rainfall ranges from 1000 mm near Mopeia to more than 1400 mm at Quelimane, and there is a considerable inter-annual variation.

At the onset of the rainy season, local rainfall saturates the low-lying soils of the Marromeu Complex. As the rainy season continues, runoff from the Cheringoma escarpment further inundates the floodplains along the western perimeter of the Delta, filling shallow lakes and lagoons. Deep and prolonged inundation of the vast Marromeu floodplains occurs when the Zambezi River overtops its banks (typically during the peak flooding months of February and April) and spreads laterally across the Delta and

through the main channels (Davies 1986).

Surface waters are subsequently lost through seepage and evapotranspiration during the dry season. Drought years may result in minimal runoff and accumulation of surface waters at the base of the Cheringoma escarpment, leaving the floodplain grasslands dry for most of the year. Alternatively, years of extreme rainfall may result in deep and prolonged inundation of the floodplain for up to six months, independent of Zambezi floodwaters.

Historically, the hydrological regime of the Zambezi Delta was primarily determined by the cumulative, unregulated runoff of the Upper, Middle and Lower Zambezi Catchments. The Upper Zambezi drains from the headwaters in northwestern Zambia to Victoria Falls, and has a mean discharge of 1044 m³/s (Beilfuss 2002, Beilfuss and dos Santos in review). Peak flood flows from the Upper Zambezi catchment are partially attenuated by the vast Barotse Plain (Reeve and Edmonds 1966). From Victoria Falls through Kariba Gorge to Cahora Bassa Gorge the Zambezi River drains the Middle Zambezi catchments (Balon and Coche 1974). With the exception of the Kafue River catchment, the Middle Zambezi catchment has few significant floodplains and runoff occurs rapidly during the rainy season relative to the Upper Zambezi catchment. Differences in runoff patterns between the Upper and Middle Zambezi catchments result in a bimodal flooding pattern along the Zambezi River, with an early flood locally known as “Gumbora” from the Middle catchment and the major annual flood known as “Mororwe” from the Upper catchment (Davies 1986). The mean runoff into Cahora-Bassa Gorge is 2494 m³/s, with peak floods discharges generally in February-March (Beilfuss 2002, Beilfuss and dos Santos in review). Below Cahora-Bassa Gorge, the Zambezi receives runoff from several rapidly draining tributaries, most notably the Luia, Revuboe, and Luenha Rivers. The largest tributary of the Lower Zambezi catchment, the Shire River, enters the Zambezi approximately 40 km upstream of the apex of the Zambezi Delta. The estimated average Zambezi runoff volume reaching the Delta is 3424 m³/s (Beilfuss 2002, Beilfuss and dos Santos in review). This runoff is supplemented by local runoff from the Morrumbala and Cheringoma escarpments that border the Delta.

Floodwaters are spread across the Zambezi Delta through a complex channel network (Beilfuss 2002, Beilfuss and dos Santos in review). Near the Delta apex at Mopeia, the Cuacua River splits off from the Zambezi, collects runoff from the Morrumbala escarpment, and spreads over the northern bank of the Delta. Further downstream, three major tributaries - the Salone, Cuncue and Nhasaua Rivers - split off to the southern bank. The Salone River runs along the west edge of Delta floodplain, collects runoff from the Cheringoma escarpment, and discharges into the northwestern portion of the Marromeu Complex. The Cuncue River spreads its waters into the northern portion of Marromeu Complex, and the Nhasaua River discharges into the eastern portion of Marromeu. Historically, these Zambezi distribution channels began discharging to the Delta Floodplain when flows in the Zambezi River exceeded 4500m³/s (Beilfuss 2002, Beilfuss and Santos in review).

16. Hydrological values:

Describe the functions and values of the wetland in groundwater recharge, flood control, sediment trapping, shoreline stabilization, etc.

The wetland plays an important role in groundwater recharge, flood control, sediment trapping and shoreline stabilisation, although some of these values have greatly declined since the Zambezi River has been regulated by dams.

17. Wetland Types

a) presence:

Circle or underline the applicable codes for the wetland types of the Ramsar “Classification System for Wetland Type” present in the Ramsar site. Descriptions of each wetland type code are provided in Annex I of the *Explanatory Notes & Guidelines*.

Marine/coastal: A • B • C • D • (E) • (F) • G • (H) • (I) • J • (K) • Zk(a)

Inland: (L) • (M) • (N) • O • (P) • Q • R • Sp • Ss • (Tp) • (Ts) • U • Va • Vt • W • Xf • Xp • Y • Zg • Zk(b)

Human-made: 1 • 2 • (3) • 4 • 5 • 6 • 7 • 8 • 9 • Zk(c)

b) Dominance:

List the wetland types identified in a) above in order of their dominance (by area) in the Ramsar site, starting with the wetland type with the largest area.

I, H, L, 3

18. General ecological features:

Provide further description, as appropriate, of the main habitats, vegetation types, plant and animal communities present in the Ramsar site.

The vegetation of the Delta includes a mosaic of acacia and palm savanna, seasonal and permanent freshwater floodplain grassland, papyrus swamps, saline grassland, and coastal mangrove and mudflats. The northbank of the Zambezi Delta supports one of the largest papyrus swamps in southern Africa. Extensive coastal mangroves and estuaries support a productive prawn fishery (Hoguane 1997).

The Marromeu Complex contains representative examples of natural wetland types found in Southern Africa especially in the Zambezi basin. This site includes the Zambezian coastal flooded savanna, coastal dunes and freshwater swamps, dambos associated with miombo forest, mangroves, and sea grass beds.

The marine fish fauna of the Zambezi Delta and northern Sofala Bank is characterized by a great variety of species. The area is also considered an important breeding colony for the white pelican, with thousands of breeding pairs being observed nesting on the mangrove trees, making this one of the largest breeding colonies in southern Africa (Beilfuss & Bento, 1997).

For further information please see point 19 and 20 on noteworthy flora and fauna.

19. Noteworthy flora:

Provide additional information on particular species and why they are noteworthy (expanding as necessary on information provided in 12. Justification for the application of the Criteria) indicating, e.g., which species/communities are unique, rare, endangered or biogeographically important, etc. *Do not include here taxonomic lists of species present – these may be supplied as supplementary information to the RIS.*

Coastal and Marine

Submerged Flora

The marine and coastal submerged flora of the Mozambique coast is mainly composed of seaweeds and seagrasses. Seaweeds are not true plants as they lack true plant-like structures such as stems, leaves and roots. Seagrasses, belonging to the monocotyledons and therefore being higher plants, comprise a group of marine plants, which have adapted, through various reproductive, morphological and physiological mechanisms, to live in the marine environment. Seagrasses play an important role in shallow-water ecosystems of tropical and temperate zones, being important nursery areas for juveniles of various commercial species. A total of 12 species have been identified in Mozambique (Bandeira, 2000). At the Zambezi delta, due to the high levels of turbidity and sedimentation, growth and development of seagrass beds, is therefore constrained (Timberlake, 1998). The closest records of seagrass beds and seaweed communities are from the Primeiras and Segundas Archipelago (Rodrigues *et al.*, 2000).

Mangroves

Mozambique has approximately 400 000 ha of mangrove forests (Doddema, 2000), approximately 5% (19 600 ha) are located in Marromeu (Doddema, 2000). In a recent survey (Cuambe, 2000) identified 12 arboreal species within the mangrove forest, eight being true mangrove species and four mangrove-associated species.

Mangrove zonation patterns are described in detail by Cuambe (2000), and will not be reproduced here. The mangrove forests are dominated by *Ceriops tagal* with a percentage of occurrences as high as 40 % (Cruz, 1999; Cuambe, 2000). Generally, it was found that the mangroves of Marromeu were in good condition. This was confirmed by the high values of tree density, height and overall high species diversity. Only in areas where human settlements are located, mangroves show signs of utilization.

Terrestrial

The vegetation communities in the Marromeu complex are diverse and include floodplain with swamp forest; *Papyrus* swamp; oxbow lakes; seasonally inundated grassland; deciduous miombo woodland; and palm and acacia savannas (Singini, 1996; Anderson *et al.*, 1990). Dambos occur throughout the miombo forest area (Beilfuss & Allan, 1996).

In a survey carried out in 1999, Cruz (1999) identified 17 arboreal species. An average volume of 3.1 m³/ha was estimate for two areas: Megugune and Maquerro. The Arecaceae family dominated the floristic composition of these two areas being *Borassus aethiopum*, *Hyphaene coriacea* and *Phoenix reclinata* the most abundant species.

Beilfuss & Allan (1996) reported that agricultural and livestock grazing fields were observed around Marromeu and Luabo villages, but no agricultural development across most of the floodplains. In general, the plant diversity of the area is poorly known, being the majority of the exiting information small-scaled surveys, with a very limited focus on the diversity and floristic composition of the flora.

Freshwater

The distribution and ecology of freshwater plants in the Marromeu and Lower Zambezi areas is poorly known. The remoteness of the area, shortage of manpower and expertise in the field are some of the reasons that help to explain this lack of information (Mitchell, 1978).

This is further accentuated when one looks at microphytes (algae). Although extensive studies were carried out in the 60's and early 70's (Sampaio, 1964; Rino, 1969, 1971, 1972), they did not pay much attention to this part of the country, with the exception of Sampaio's collection near Pebane. Nevertheless, Rino (1972) stated that "...the Zambezi region, with higher levels of humidity and temperature should provide better and richer collections..." comparing to the ones made south of the Save River, which yield 344 taxa of freshwater algae. The existing information relates to the Cahora Bassa lake (Bond *et al.*, 1978).

Aquatic weeds and their explosive invasion of newly-created water bodies (dams), as well as the invasion of swamps with standing water, have given rise to a number of studies in the Zambezi basin and efforts at control (Timberlake, 1998). Invasion by the water fern (*Salvinia molesta*) has been documented for the Cahora Bassa dam (e.g. Bond & Roberts, 1978). Although no in-depth study has been carried out in the Marromeu Complex, Timberlake (1998) considered that the true wetland and freshwater species, those confined to semi permanently wet conditions, are quite widely distributed through the Zambezi basin. There are little differences in vegetation structure and composition, given similar hydrological conditions, from the Upper Zambezi to the Delta. He concludes that the species composition is not that different from wetlands in the rest of tropical Africa.

20. Noteworthy fauna:

Provide additional information on particular species and why they are noteworthy (expanding as necessary on information provided in 12. Justification for the application of the Criteria) indicating, e.g., which species/communities are unique, rare, endangered or biogeographically important, etc., including count data. *Do not include here taxonomic lists of species present – these may be supplied as supplementary information to the RIS.*

Coast and marine

Invertebrates - Other marine and coastal invertebrate fauna (beside shrimp) is not well known and only anecdotal reports or unpublished information in form of grey literature exists. The mangrove crab *Scylla serrata*, and other mangrove dwelling crustaceans (portunids, etc) are present and exploited by the local population. Bivalves and gastropods are also present in the mangrove swamps and are used by the local population as an important complement to the animal protein intake provided by fish.

Fish - The marine fish fauna of the Zambezi Delta and northern Sofala Bank is characterized by a great variety of species. For further information see 12. Justification for criteria.

Reptiles - It has been reported that the extensive seagrass beds between the Primeiras and Segundas islands and the mainland support turtles and dugongs (UNEP/IUCN, 1988). The Primeiras Islands have been reported to have the most important Green turtle (*Chelonia mydas*) nesting beaches of Mozambique with about 200 females nesting annually. Large specimens of Loggerhead turtle (*Caretta caretta gigas*) and Green turtle (*Chelonia mydas*) have also been recorded in the Segundas islands (Whittington & Heasman, 1997) although the presence of fishermen on most of the islands threatens the chances of breeding success. However, one must take in consideration, two important aspects regarding the occurrence of sea turtles in the area: the Primeiras and Segundas islands are quite far from the Zambezi delta and that sea turtles mainly nest on sandy beaches. So, if confirmed sighting of turtles in the area are made, they will most certainly occur offshore and caught in the shallow-water shrimp trawling nets.

Birds - The Zambezi delta mangrove and adjacent intertidal areas support numerous bird species with threatened global concern status, including the white and pink-backed pelicans (*Pelecanus onocrotalus*, *P. rufescens*), various species of storks (e.g. *Ciconia episcopus*, *Anastomus lamelligerus*, *Ephippiorhynchus senegalensis*, *Mycteria ibis*) and the Caspian tern (*Sterna caspia*). The area is also considered an important breeding colony for the white pelican, with thousands of breeding pairs being observed nesting on the mangrove trees; this is in fact one of the largest breeding colonies in southern Africa (Beilfuss & Bento, 1997).

Small birds like the red-eyed dove (*Streptopelia semitorquata*), black-headed oriole (*Oriolus larvatus*) and yellow-breasted apalis (*Apalis flavida*) nest on the mangrove trees. The mangrove area is also important for African fish eagles, egrets, kingfishers, flamingos, waders, cormorants and herons by acting as nesting and feeding grounds. The mangrove and floodplain areas of the Marrromeu Complex shelter a large population of wattled crane (*Grus carunculatus*). Bento (2000) recorded 32 species of birds in the mangrove and floodplains.

Mammals - Nine species of mammals were found to live in close association to the mangrove vegetation (Bento, 2000). Marine mammals are abundant in both shallow and offshore waters of the Zambezi delta. Bottlenosed dolphins (*Tursiops truncatus*) and humpback dolphins (*Sousa chinensis*) are commonly observed around the delta (Saetre & Paula e Silva, 1979; Bento, 2000).

On a study carried out in 1991, Findlay *et al.* (1994) reported 75 sighting of the humpback whale (*Megaptera novaeangliae*) and one sighting on the minke whale (*Balaenoptera acutorostrata*). An important conclusion of this study was that the northern Sofala bank is an acting nursery and calving area for humpback whales. It has been reported (UNEP/IUCN, 1988) that the region between the Primeiras and Segundas islands and mainland is the most important in the western Indian Ocean for dugong (*Dugong dugon*), although no recent sightings of this marine mammal have been made in the area. Other evidence that dugongs might not occur in the area (contrary to previous references e.g. Lopes, 1936; Hughes, 1971) is provided by Timberlake (1998), who also highlighted the fact that although dugongs can enter brackish

waters, it is generally absent from the Zambezi delta mainly due to the high sediment content and lack of its main food item, seagrasses.

Terrestrial

Invertebrates - Despite being one of the largest and most diverse biological groups, in terms of published literature invertebrates are one of the smallest. By far, the majority of references are taxonomic, lists of specimens collected or checklists (Timberlake, 1998). Some lists of invertebrate groups have been published for the Marromeu Complex and Zambezi delta, covering grasshoppers (Orthoptera) and beetles (Coleoptera) (Ferreira, 1963, 1964ab).

Reptiles and amphibians - Reptiles and amphibians are a relatively small group, comparatively well known over much of the region and this knowledge has been well synthesised (Poynton, 1964, 1966).

A recent survey (Bento, 2000) identified two species of reptiles in the Zambezi delta mangrove forests: the Nile crocodile (*Crocodylus niloticus*) and the Nile monitor (*Varanus niloticus*). Bento (2000) recognized that the survey was too short to reflect the true species richness of the reptile fauna.

A total of 41 species have been identified. Snakes and frogs and toads comprise the largest groups with 16 and 14 species recorded respectively. Lizards are also an important group with 8 species already identified.

Mammals - Marromeu once enjoyed an international reputation for its diverse and extensive wildlife populations, particularly of large ungulates (Singini, 1996). Today, the vast herds of buffalo and waterbuck in the floodplain have been decimated by the past 16 years of civil war. Between 1979 and 1992, a 90% reduction in buffalo, waterbuck, and reedbuck, 80 % reduction in hippo, and 52% reduction in zebra were observed (Goodman, 1992). More recent surveys suggest an even further decline: fewer than 1000 buffalo were observed during surveys of the floodplain in March 1995 (Beilfuss, 1995) in contrast to an estimated population of 55 595 buffalo in 1997 (Tello & Dutton, 1979).

Repeated mammal surveys have been conducted in the Marromeu complex since 1968. The civil war in Mozambique prevented surveys between 1979 and 1990. The surveys carried out by Beilfuss & Allan (1996) further confirm the dramatic decline in large mammal species that has occurred since the civil war and the closure of the Cahora Bassa dam. Tello and Dutton (1979) counted 55,595 Cape buffalo in 1977, 43,992 in 1978, and 30394 in 1979. By 1990, only 3,696 were observed (Anderson *et al*, 1990). In survey by Beilfuss & Allan (1996), an estimated 1000 cape buffalo were counted. The buffalo occurred in three separate herds in the open floodplain.

Similarly, counts of 40,300 and 47,227 waterbuck were reported in 1968 (Tinley 1969) and 1978 (Tello & Dutton, 1979), respectively. The 1990 survey team observed 440 (Anderson *et al*, 1990) and only a few hundred waterbuck were observed by Beilfuss & Allan (1996). Almost no zebra were observed, down from a peak count of 2720 in 1979 and 2820 in 1977 respectively (Tello & Dutton, 1979). A few observations were recorded of Lichtenstein's hartebeest and sable antelope. The decline in elephant and hippo is perhaps even more recent. A population of 330-360 elephants was reported in the last 1970s and 1990s. The 1996 survey team, observed only 36 elephant all in one herd in a patch of mesic forest surrounded by floodplain. Only a few hippos were observed in 1996 (Beilfuss & Allan, 1996).

Birds - Although the bird fauna of the Zambezi basin is relatively well known the study of the bird life of the Lower Zambezi and Marromeu Complex initiated very recently.

Twenty-nine waterbird species, totaling 5,930 individuals were counted during the transect surveys. 6 species of storks were observed including a substantial population of 1,890 African openbilled storks (*Anastomus lamelligerus*) concentrated in large flocks on the sandbars of the lower Zambezi River. Thirty-six endangered saddlebilled storks (*Ephippiorhynchus senegalensis*) were observed. Nine pairs of grey crowned cranes (*Balearica regulorum*) were observed, being most of them associated with wattled crane territorial

pairs. Only 9 eastern white pelicans (*Pelecanus onocrotalus*) were observed although major breeding colonies were reported in earlier surveys.

Marromeu is a major habitat for most of the common southern African waterfowl species and occasionally for more northern species including pintail (*Anas acuta*) and garganey (*Anas querquedula*). The largest colony of white pelicans (*Pelecanus onocrotalus*) in southern Africa has been recorded in this area. Thirty species of waterbirds were observed during aerial surveys in March 1995 including substantial populations of openbilled storks (*Anastomus lamelligerus*) and saddlebilled storks (*Ephippiorhynchus senegalensis*). The woodland and forest habitats support rarities such as the specklethroated woodpecker (*Campethera scripticauda*) and whitebreasted alethe (*Alethe fuelleborni*).

Freshwater

Invertebrates - The freshwater mollusks of southern Africa show in general a low level of diversity, at specific and higher ranks, in comparison with some other groups of aquatic organisms especially fishes and insects. The Marromeu and Lower Zambezi area is no exception. This is justified by the short life of most bodies of freshwater existing in the area and by the reliance of these organisms on passive transport to dispersal (Brown, 1978). The freshwater mollusk fauna of the area is poorly known (Appleton, 1996). Brown (1978), citing various sources, and dividing the southern Africa region in latitudinal zones of 5° suggested for the Zambezi river-Beira area (Latitude zone 15°–20°) a number of 21 species of freshwater gastropod snail. On the only study carried out in the area (Azevedo *et al.*, 1961), it was identified (from samples collected at Chinned) 8 species, being the great majority of them pulmonates. Although, the general diversity of this group in the region is low, it is likely that the total number of species for the Marromeu and Lower Zambezi area will increase as more research is carried out in the area.

Fish - The freshwater fishes of the southern African region is relatively well known and this knowledge have been well synthesised by Bowmaker *et al.* (1978). Skelton (2001) provides a comprehensive guide of the freshwater fishes of the region. The great majority of published information on this group is concerned with taxonomic and fisheries aspects of the Upper and Middle Zambezi. There are very few on the Lower Zambezi, and according to Timberlake (1998), there appears to be no publication on the freshwater fish of the Zambezi Delta. The exception seems to be the small note on the distribution of the tiger fish (*Hydrocynus vittatus*) on the Zambezi and Limpopo rivers by Jubb (1952). This voracious predator is a highly prized game fish. According to Bowmaker (1978), 66 species (21 families) of freshwater fishes occur in the Lower Zambezi. The fish fauna is dominated by the Cyprinidae family with 19 species already identified. Other important families include Cichlidae and Mormyridae.

21. Social and cultural values:

e.g., fisheries production, forestry, religious importance, archaeological sites, social relations with the wetland, etc. Distinguish between historical/archaeological/religious significance and current socio-economic values.

Marromeu wetland is important for education and scientific research, grazing, fisheries production, presence of medicinal plants, agriculture, collection of reeds, handcraft production, sustenance of livelihoods of communities, etc.

22. Land tenure/ownership:

(a) within the Ramsar site:

According to the Land Law in Mozambique, all the land belongs to the State. In the case of Marromeu Reserve, it not only belongs to the State but is also managed, in principle, by Government authority.

(b) in the surrounding area:

The Coutadas (Hunting Areas) surrounding the Reserve area are also State owned, but in this case, leased to the private under an agreement of management. Outside these areas, there are also two Forest Reserves, State owned and controlled. The rest of the land permits for community rights.

23. Current land (including water) use:

(a) within the Ramsar site:

In the Ramsar Site basically occurs farming, livestock grazing, forestry, fishing and hunting.

(b) in the surroundings/catchment:

Coutadas (Hunting Areas) are being used under leasing agreements with the Government.

24. Factors (past, present or potential) adversely affecting the site's ecological character, including changes in land (including water) use and development projects:

(a) within the Ramsar site:

Over the past half-century upstream impoundments and the construction of dykes along the Lower Zambezi have changed the hydrology of the Delta (Beilfuss et al 2000, see above). Since the construction of flood protection dykes, around Marromeu Town, water flow was blocked preventing the water spread along Marromeu Complex. In 1926, the dykes were raised and strengthened, and have been overtopped only five times since, in 1939, 1940, 1952, 1958 and 1978 (Bolton 1983). In the 1930s, a railway and road were constructed between Marromeu and Sena (80 km upstream); these further obstructed the passage of water into the upper channels between Mopeia and Marromeu (Tinley 1994). Water movement in this region was additionally restricted during the 1970s by the construction of a railway line between Marromeu and Inhamitanga on the Cheringoma escarpment. The cumulative impact of these road and dyke works has been a significant reduction in the movement of floodwaters between the Zambezi River and Marromeu Complex (Beilfuss 2001, Beilfuss and Santos in review).

Adding drought and civil war had profound effects on the human welfare in the Zambezi Delta. Land use changes have had effects on the local communities including loss of floodplain agriculture, reduced livestock grazing and carrying capacity, loss of floodplain fisheries, changes in natural resource utilization patterns and reduced wildlife hunting (Beilfuss et al 2000).

(b) in the surrounding area:

The factors affecting the surrounding of the Ramsar Site are similar to those within the Ramsar site.

Over the past 40 years, the impact of dykes, roads, and railways has been greatly exacerbated by the construction of large hydroelectric dams on the Zambezi River. In December 1958, Kariba Dam, the first major dam on the Zambezi River, began impounding water and further altered flooding patterns in the Delta. Kariba Dam controlled more than 40% of the total Zambezi runoff and was operated to generate steady hydroelectric power by storing peak floodwater and releasing a constant outflow of water (Reeve and Edmonds 1966). Kariba has reduced peak floods volume in March by 36%, and in April by 41%, relative to pre-dam conditions (Beilfuss 2001, Beilfuss and dos Santos in review). During the 1960s and 1970s, a major tributary of the Middle Zambezi, the Kafue River, was dammed, first at Kafue Gorge and then at Itezihitezhi Gorge, further stabilizing the Zambezi flow regime downstream of Kariba (Balasubrahmanyam and Abou-Zeid 1982).

The control of the Zambezi River culminated in December 1974 with the completion of Cahora Bassa Dam. Cahora Bassa Reservoir regulates the Zambezi River flow for hydropower production, and since completion of the dam the natural flood cycles of the Zambezi River have been fundamentally changed. During years of low to average runoff in the Zambezi catchment, Cahora Bassa discharges almost constant flow throughout the year (Beilfuss 2002, in review (b)). Inundation of the Marromeu Complex, when it occurs, is now dependent on local runoff from the Cheringoma escarpment or on very high volume, short-duration water releases from Cahora Bassa to protect the dam wall during years of exceptional flooding in the upper basin (Beilfuss and Davis 1999). Mean monthly flows have decreased by 64% during the peak flooding months of February, March, and April, and by 45% during January and May. By contrast average

monthly flows in November are four times greater than they were historically (Beilfuss 2002, Beilfuss and Bento in review). Cahora Bassa directly reduces inflows by 46% during the peak flooding months of February and March, and by 20% in January and May (Beilfuss, 2002). The reduction in peak flows and increase in dry season flows have resulted in degradation of the main Zambezi channel. The Zambezi River has downcut below its distributary channels in the Delta, further reducing the spread of floodwaters into the Delta (Davies *et al* 2001). The minimum flood level required to overtop and discharge through its distributaries is approximately 4500 m³/s, a level that rarely occurs in the regulated Zambezi but which occurred in most years prior to regulation (Beilfuss 2002, Beilfuss and Santos in review). The cumulative effect of Zambezi regulation and associated physical changes is a reduction in the magnitude, duration, and extent of flooding in the Delta. These changes have affected the breeding success of wildlife into the Marromeu Complex (Bento 2002).

The construction of a dam downstream of Cahora Bassa, at Mphanda Nkuwa, and others planned for Boroma and Lupata, are a potential threat to the Zambezi delta's ecological character. Large-scale irrigation schemes planned for the Zambezi River upstream, and oil exploration in the Zambezi delta could also potentially threaten the area in the future.

25. Conservation measures taken:

List national category and legal status of protected areas, including boundary relationships with the Ramsar site; management practices; whether an officially approved management plan exists and whether it is being implemented.

The Marromeu wetland is a Reserve. According to IUCN criteria for the status of protected areas, Marromeu Reserve would fall in category IV. There is no Administration (or Park Warden) positioned in the Reserve now. No management plan exists.

26. Conservation measures proposed but not yet implemented:

e.g. management plan in preparation; official proposal as a legally protected area, etc.

There is intention to elaborate a management plan (resources to be identified).

A tremendous first step has been taken by the Government of Mozambique in officially acknowledging the Marromeu Complex as a *Wetland of International Importance*. The next step is to assist the national government agencies (including Zambezi Valley Planning Authority, Ministry of Environment, Ministry of Tourism, Ministry of Agriculture, and Ministry of Fisheries), provincial and district governments, and community representatives in their efforts to coordinate the management plan. Technical support will be provided by various institutes involved in research in the delta, including the University of Eduardo Mondlane and Museum of Natural History and non-government organizations such as ICF, IUCN, and WWF. The planning process must be transparent and inclusive of everyone with a stake in the management of the Zambezi Delta, including local residents, the private sector (e.g., Sena sugar, hunting concessions), and regional operators such as Hidroeléctrica de Cahora Bassa. To help facilitate this process, Mozambican resource managers now have access to training opportunities in wetland management and monitoring through the Ramsar Bureau and related programs.

The future of the Marromeu Complex lies in the balance between conservation and sustainable development. With sound ecological management, the social and economic values of the Marromeu Complex will increase over time as the prawn fisheries, subsistence production systems, hunting opportunities, forest products, and ecotourism prospects are enhanced. If we are successful, Mozambique may one day expand the Ramsar site to include the northbank of the Zambezi Delta—which contains one of the largest papyrus swamps in southern Africa—and the slopes of the Morrumbula escarpment that help nourish it. We envision the restoration and sustainable management of the entire Zambezi Delta ecosystem in perpetuity.

27. Current scientific research and facilities:

e.g., details of current research projects, including biodiversity monitoring; existence of a field research station, etc.

In recent years, scientists and resources managers have undertaken considerable research to prepare the groundwork for assessing environmental flow needs and improving the management of the Zambezi system. Beilfuss and Santos (2001, *in review*) analyzed long-term changes in regional runoff patterns, flooding processes, and water balance components for the lower Zambezi and demonstrate the effect of Cahora Bassa regulation on hydrological conditions in the delta. Beilfuss (2002) assessed key indicators of hydrological alteration that relate changes in the magnitude, timing, duration, and frequency of river flows to important social and ecological processes in the delta. These studies expand and update previous hydrological research by Hidrotécnica Portuguesa (1973), Rendel Palmer and Tritton (1979), SWECO (1982), Bolton (1983), Sushka and Napica (1988), and others, and review the sources and quality of hydrological data available for modeling flow requirements. Davies *et al.* (2001) examined geomorphic changes in the Zambezi River resulting from Cahora Bassa management.

Several studies link the Zambezi flooding regime with important economic and socio-cultural benefits. Gammelsrod (1992), Gammelsrod and Hogueane (1995) and Hogueane (1997) studied the effect of Zambezi River management on the prawn fishery of central Mozambique, establishing that shrimp abundance is directly related to Zambezi runoff patterns and that past Cahora Bassa operation has resulted in a loss of \$10-20 million per annum. Negrão (1995) examined one hundred years of change in the Zambezi Delta subsistence economy, while Turpie and others (1998) estimated the current economic value of subsistence farming and fishing activities in the Zambezi Delta. Anderson and others (1990) and Chande and Dutton (1997) projected a substantial economic return, in terms of trophy hunting and meat production, on restoring healthy populations of Cape buffalo and other game species that were decimated by illegal hunting following the desiccation of the floodplain grasslands below the dam. During 2000 and 2001, Dr. Arlindo Chilundo, Dr. Wapu Mulwafu, Dr. Allen Isaacmen, and their students collected more than 750 hours of oral history interviews in a sample of communities between Cahora Bassa reservoir and the Zambezi Delta (Beilfuss, 2002). The oral histories describe the economic and cultural importance of the pre-dam flood for the people of the Zambezi, and compare these findings with the current production and social systems of those communities.

Other studies have examined the implications of flow management for Zambezi basin biodiversity. Ecological research by Beilfuss (2000) compared the historical (pre-dam) distribution of vegetation communities of the Zambezi Delta with the current distribution and assessed patterns of change, including woody species invasion into floodplain grasslands, displacement of flood-tolerant species by more upland species, terrestrialization of floodplain water bodies, displacement of freshwater vegetation by salt-tolerant species, and degradation of coastal mangrove. Saket and others (1999) studied the rates of deforestation of the coastal mangrove over the past thirty years. Bento (2002) determined the link between Zambezi flooding patterns and the breeding and feeding ecology of endangered Wattled Cranes, an umbrella species for biodiversity conservation in the lower Zambezi.

Most recently, Beilfuss (2002) simulated the capacity for different flood releases from Cahora Bassa Dam using the HEC-5 reservoir routing model for the entire Zambezi catchment. Using an historical 92-year flow series accepted by the SADCC Hydroelectric Hydrological Assistance Project (Shawinigan-Lavalin and Hidrotécnica Portuguesa 1990) and Unidade Técnica de Implentacao de Projectos Hidroelectricos-Mozambique/ Lahmeyer-Knight Peisold-Electricite' de France Joint Venture Consultants 2000, 2001), he modeled the potential to generate short-duration, high-volume flood releases of different magnitude, timing, and duration from Cahora Bassa Dam. Each flood release is analyzed in terms of its effect on hydropower generation, including firm power reliability and total energy output. The study demonstrates that a variety of options are available for generating meaningful flood pulses during the normal flood season months of January, February, or March, without a significant reduction in hydropower output.

28. Current conservation education:

e.g. visitors' centre, observation hides and nature trails, information booklets, facilities for school visits, etc.

Three international workshops about the Lower Zambezi and Marromeu Complex were organised. The workshop aims were to highlight the importance and role of the lower Zambezi for Mozambique,

regionally and internationally. The meetings also discussed the socio-economic and ecological impacts of developments along the lower Zambezi. Recently the Museum of Natural History-UEM and International Crane Foundation have launched an extensive environmental education program about the lower Zambezi and Marromeu Complex. The aim of this campaign is for public awareness about the real value of this wetland and to get public support on wise use of natural resources by improving Cahora Bassa Water Management. This campaign culminated by the creation of the newsletter "Novidades do Vale do Zambeze" distributed countrywide. The Museum of Natural History and International Crane Foundation has also been involved on series of talks about Marromeu Complex in Mozambique and into the Southern Africa.

29. Current recreation and tourism:

State if the wetland is used for recreation/tourism; indicate type(s) and their frequency/intensity.

Although tourism is still at embryo stage there are few activities going on. Buffalo hunting and other mammals is the major activity. The complex comprises 4 hunting units (coutadas 10, 11, 12 and 14). Every year the area receives thousands of overseas tourists producing incomes for Mozambique government and partially for the local communities. During hunting season each hunting unit employ more the 20 local workers. To improve other tourism activities there is a need to improve the access to the complex. Few birdwatchers tried experimentally to access the floodplain to see specially Wattled Cranes and other waterbirds.

30. Jurisdiction:

Include territorial, e.g. state/region, and functional/sectoral, e.g. Dept of Agriculture/Dept. of Environment, etc.

The chosen areas mostly belong to Sofala province (Southern Bank) except the mangrove area at Chinde District, which is part of Zambézia Province (Northern Bank). Therefore, Marromeu Complex is part of Marromeu, Inhaminga (Sofala Province) and Chinde (Zambézia Province) Districts. The Marromeu Reserve and the hunting units (Coutadas 10, 11, 12 and 14) are under jurisdiction of the Ministry of Tourism and Ministry of Agriculture and Rural development, Enosse, C. & Gaspar, A. (2002).

31. Management authority:

Provide the name and address of the local office(s) of the agency(ies) or organisation(s) directly responsible for managing the wetland. Wherever possible provide also the title and/or name of the person or persons in this office with responsibility for the wetland.

The Marromeu Reserve and Hunting units are jointly managed by Provincial Directorate of Industry, Commerce and Tourism of Sofala - Mr. José Ferreira, Provincial Director and Forestry and Wildlife Provincial Services - Mr. Eng. António Serra, the Head of the Provincial Services, both in Beira city;

The Sofala Province Districts of Marromeu and Inhaminga are under the Administrators, respectively, Mr. Jaime Genro and Mr. Daly Assumane Kumanda, both contactable through Provincial Directorate of Support and Control, in capital city Beira and;

The Chinde District (Zambezia Province) is under the Administrator Mr. Macário Corrente Namuro, contactable through Provincial Directorate of Support and Control, in capital city Quelimane.

32. Bibliographical references:

Scientific/technical references only. If biogeographic regionalisation scheme applied (see 13 above), list full reference citation for the scheme.

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