

REGION 6

MADAGASCAR

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Introduction

Madagascar island is located some 300 km off the southeastern part of the African continent, separated from it by the Mozambique Channel. It is the fourth largest island in the world after Greenland, New Guinea and Borneo. It has a north-south length of 1600 km between latitudes 11°57' and 25°35'S, and a maximum width of 580 km between longitudes 43°14' and 50°27'E. The surface area is 587 000 km². The population of 10 600 000 (in mid-1986) has a mean density of 18.1 persons/km². Population distribution is very uneven with most people living in the central highlands and eastern coastal plain.

The physiography of the island consists of a rugged central highland plateau (with axis running NNE-SSW) surrounded by coastal plains of varying width. The main axis of relief is assymmetrically located. Highland elevations are mostly between 1000 and 2000 m asl, with occasional peaks reaching nearly 3000 m. Along the nearly straight eastern coastline, the plateau fans steeply to a narrow continuous coastal plain which develops a string of small lagoons. The western slope is much gentler, and more extensive river basins are present with complex features (floodplains, lakes, extensive coastal mangrove swamps, estuaries).

Climate

Two temperature regimes exist: a tropical lowland regime and a more temperate highland regime. Lowlands have a fairly uniform mean annual temperature which decreases from north (27°C) to south (23°C). Mean annual range in the north is around 3°C and increases to 7.5°C in the dry southwest. The warm Mozambique Channel moderates conditions in the west. On the central plateau mean annual temperatures are between 16° and 19°C. Frost may occur above 1500 m, and rarely snow. Mean annual ranges are 5-6°C in the north and 7°C in the south. Diurnal range is greater, in the order of 10°C at the capital, Antananarivo (1381 m asl, 18°56'S).

Two gradients govern rainfall: annual precipitation decreases from east to west and from north to south, and seasonality increases in the same direction. Thus, in the west and south, the dry season is longer. In the extreme southwest the climate is semi-desert or Sahelian, while the eastern coast is sub-equatorial with high rainfall and humidity throughout the year. Where seasonality exists, the dry and cool seasons coincide (June to October).

Rainfall is controlled by the interaction of the southeast trade wind with the direction of principal relief on the island. North and northwest monsoon air currents exert an important secondary effect. Unstable moisture-laden air carried against the eastern escarpment leads to

extensive cloud formations and heavy rainfall in this region. A higher layer of drier stable air mass, markedly subject to subsidence inversion from July to September, limits cloud formation and rainfall, leading to dry clear winter weather on the western slopes. In the summer, monsoon air currents bring heavily moisture-laden air which produce a large amount of rain, with reduced effects eastwards and southwards.

The variations in rainfall and temperature produce five bio-climatic regions. On the east coast rainfall exceeds 1500 mm and sometimes 3000 mm, there is no dry month and temperatures are high throughout the year. On the eastern slopes of the plateau rainfall exceeds 1500 mm but there is a dry season of 1-4 months duration and a mean temperature of between 10-15°C during the coldest months. On the western slopes of the plateau the dry season lasts 5 or 6 months and rainfall is usually less than 1500 mm (although humidity is high during the dry season due to the trade winds). On the western plains the dry season is 7 or 8 months in southern regions and rainfall is 500-1500 mm while in northern regions the dry season is somewhat shorter and rainfall is around 1500 mm. In the extreme south rainfall is sparse, highly irregular in occurrence, stormy and very localized (some areas may not experience precipitation for 12-18 months).

Madagascar is prone to cyclones which hit the island during the summer only, mainly from mid-January to mid-March. Most hit the northeast coast first and travel southwest (then curve southeast). Others come via the Mozambique Channel. Winds of up to 300 km/hr and rainfall of 600-700 mm in four or five days cause large-scale flooding and massive destruction of crops and forests.

Wetlands

Water courses draining the eastern slopes (c. 25 % of the island) are comparatively short with steep profiles, while those of the western slopes (over 60% of the island) are much longer with gentler slopes. All rivers show high discharges during the rainy season from November-March/April. Response to rainfall is almost instantaneous, producing sudden violent spates. In the north and east, water flow is abundant throughout the year. Flood waters are violent along the east coast. Large westward flowing rivers show more seasonal variation in discharge, but dry season rain in the highlands sustains low water flows. In the south rivers show very rapid spate and extreme variations in level. During the long dry season discharge at the mouth falls to nil in most southern watercourses.

The most extensive wetland habitat type in Madagascar is the coastal mangrove swamp. Mangroves are almost entirely confined to the west coast and cover an area of 3300 km². River floodplains are the second most extensive system, and occupy some 2000 km² on the lower reaches of westward flowing rivers. Natural lakes, scattered throughout the upland and lowland regions, occupy some 1400 km² (at high water level). Coastal lagoons are confined to the east coast and cover c. 400 km². Reservoirs are of only minor importance (c. 63 km² combined).

The largest wetland of Madagascar is Lake Alaotra, which exceeds 1000 km² during the rainy season. This is followed by the floodplains of the rivers, Betsiboka (850 km²) and Tsiribihina (700 km²) and the large mangrove swamps of Betsiboka (460 km²) and Besalampy (457 km²). The largest coastal lagoon is Loza (156 km²), but other lagoons are much smaller. Tsiazompaniry, the largest reservoir, is only 31 km² at full capacity.

Agriculture is by far the most important economic activity on the island, and rice is the most important crop. 'Tavy' (slash-and-burn) cultivation is the principal source of destruction to forests. Deforestation has resulted in severe erosion, leading to heavy silt loads in many rivers. In some regions flow has been reduced in rivers and into lakes, and water tables have lowered. Marshes throughout the island have been transformed into rice-fields and fish-farms. Some 25 000 ha of rice fields are used for aquaculture, and there are in addition c. 1000 ha of fish ponds.

Vegetation

The Madagascar flora is estimated to consist of between 7370 and 12 000 species, giving Madagascar perhaps the highest area-richness index in the world (if the upper range is the true figure). Up to 86% of the species may be endemic but the level of endemism is lower for wetland floras (56% for marshes; 21 % for littoral formations). The western regions are less rich floristically than the eastern regions.

Tidal Wetlands: Mangrove systems are composed of the following species: *Rhizophora mucronata*, *Avicennia marina*, *Sonneratia alba*, *Ceriops tagal* (= perhaps an endemic species, *C. boiviniana*), *Bruguiera gymnorrhiza*, *Xylocarpus granatum*, *X. moluccensis*, *Lumnitzera racemosa* and *Heritiera littoralis*.

Riverine & Lacustrine Floodplains: Aquatic macrophytes commonly found in freshwater wetlands include *Cyperus madagascariensis*, *C. latifolius*, *C. imeriniensis*, *Eleocharis plantaginea*, *Typhonodorum lindleyanum*, *Jussiaea* sp., *Pandanus coneretus*, *Crinum* sp., *Eleocharis plantaginea*, *Phragmites communis*, *Ravenala madagascariensis*, *Polygonum* sp., *Nymphaea stellata*, *N. lotus*, *Salvinia natans*, *Pistia stratiotes*, *Ceratophyllum* sp., *Potamogeton* sp., *Najas australis* and *Utricularia vulgaris*. The introduced water hyacinth, *Eichhornia crassipes*, has invaded many lakes and rivers and has blocked several of them. The following salt tolerant macrophytes occur around saline lakes: *Chara zeylanica*, *Salicornia pachygastra*, *Cressa cretica*, *Arthrocnemum indicum*, *Sporobolus virginicus* and *Sclerodactylon macrostachyum*.

Wetland Fauna

Fish: The native fish fauna is relatively depauperate, but a large number of the species are endemic. *Oxylapia polli* and *Ptychochromoides betsileanus* are considered highly threatened. *Paratilapia polleni*, *Paretroplus dami*, *P. kieneri*, *P. maculatus*, *P. petiti* and *Ptychochromis oligacanthus* may be vulnerable. *Acentrogobius therezieni*, *Oryzias madagascariensis*, *Pachypanchax homolonotus*, *Rheocloides pellegrini*, *Typhleotris madagascariensis* and *T. pauliani* are probably rare. Other endemics whose status is sometimes not fully known are *Rheocles alaotresis*, *R. sikorae*, *Paretroplus polyactis*, *P. betsileanus*, *Pantanodon madagascariensis*, *Ancharius brevibarbis*, *A. fuscus*, *A. madagascariensis*, *Bedotia geayi*, *B. longianalis*, *B. madagascariensis*, *B. tricolor*, *Ambassis fontoynti*, *Eleotris tohizonae*, *E. vomerodontata*, *Ratsirakia legendrei*, *Bathygobius samberanoensis*, *Chonophorus macrorhynchus*, *Gobius polyzona*, *Platygobius hypselosoma*, *P. madagascariensis*, *Stenogobius vergeri* and *Gobitrichinotus arnoulti*. Endemic subspecies are *Anguilla nebulosa labiata*, *Pachypanchax playfairi sakaramy*, *Hepsetia duodecimalis waterloti*, *Kuhlia rupestris sauvagei*, *Agonostomus telfairii catalai*, *Eleotris ophiocephalus madagascariensis*, *Gobius criniger decaryi* and *Periophthalmus koereuteri papilio*. Regional endemic species are *Kuhlia*

splendens, *Agonostomus dobulooides*, *Salarias monochrous*, *Sicyopterus acutipinnis*, *S. fasciatus*, *S. lagocephalus* and *S. laticeps*.

Many euryhaline species enter inland waters seasonally. These include species of the genera *Carcharinus*, *Pristis*, *Megalops*, *Elops*, *Pellonulops*, *Chanos*, *Arius*, *Anguilla*, *Liza*, *Mugil*, *Ambassis*, *Monodactylus*, *Kuhlia*, *Chorinemus*, *Therapon*, *Lutianus*, *Leiognathus*, *Gerres*, *Sillago*, *Caranx*, *Scatophagus*, *Glossogobius*, *Gobius* and *Eleotris*.

Many species have been introduced into Madagascar to support commercial fisheries, and to control nuisance aquatic weeds and disease vectors. These include *Carassius auratus*, *Cyprinus carpio*, *Ganzbusia affinis*, *Heterotis niloticus*, *Hypophthalmichthys molitrix*, *Labeo rohita*, *Lepomis auritus*, *L. gulosus*, *Micropterus salmoides*, *Oreochromis macrochir*, *O. mossambicus*, *O. niloticus* and *Osphronemus gouramy*. Stocking of *Salmo gairdneri* and *S. trutta* at altitudes over 1700 m asl has seemingly not benefited river fisheries. The herbivorous cichlids *Tilapia rendalli* and *T. zillii* have been cited as being responsible for reducing vegetation cover in lakes, thus removing breeding and feeding sites for fish, invertebrates and birds. *Paretroplus kieneri*, which frequents heavily vegetated areas, has probably been so affected. Several of the introduced fish species are now of great economic importance in fisheries, but have almost certainly had considerable impact on the native species, either as competitors or predators. The importance of native species such as *Paratilapia polleni* in catches has declined drastically, but native species are not thought to be threatened with extinction as a direct result of fishing. *Carp* and *tilapia* are widely used in aquaculture.

Amphibians: All frogs associated with wetlands in Madagascar are endemic. Species include *Mantidactylus aerumnalis*, *M. aglavei*, *M. albofrenatus*, *M. alutus*, *M. ambohitombi*, *M. betsileanus*, *M. biporus*, *M. blommersae*, *M. curtus*, *M. domerguei*, *M. femoralis*, *M. grandidieri*, *M. liber*, *M. lugubris*, *M. opiparis*, *M. pauliani*, *M. ulcerosus*, *M. wittei*, *Boophis difficilis*, *B. goudoti*, *B. granulatus*, *B. hillenii*, *B. idae*, *B. luteus*, *B. mandraka*, *B. microtyrnanum*, *B. opisthodon*, *B. tephraeomystax*, *B. untersteini* and *B. williamsi*.

Reptiles: Freshwater turtles include *Pelomedusa subrafa*, *Pelusios castanoides* and *P. subniger*. The endemic *Erymnochelys madagascariensis* suffers from over-exploitation for food and habitat loss, and is considered rare (and may be declining). *Crocodylus niloticus* has been widely persecuted and is listed as vulnerable. The endemic lizard *Zonosaurus maximus* occurs along riverbanks. Several endemic snakes frequent wetlands, including *Acrantophis dumerilii*, *A. madagascariensis*, *Liophidium chabaudi*, *Liopholidophis sexlineatus*, *L. thieli* and *Ithyciphys miniatus*. Other reptiles are *Liotherodon madagascariensis* and *Sternotherus* sp.

Birds: Endemic species associated with wetlands are *Ardeola idae*, *Anas melleri*, *Sarothrura watersi*, *Dryolimnas cuvieri*, *Glareola ocularis*, *Cuculus rochii*, *Alcedo vintsioides*, *Ipsidina madagascariensis*, *Leptopterus viridis*, *L. chabert*, *Tylas eduardi*, *Acrocephalus newtoni*, *Cisticola cherina*, *Dromaeocercus seebohmi* and *Foudia saka lava*. *Tachybaptus rufolavatus*, *Aythya innotata* and *Haliaeetus vociferoides* are considered endangered species. The latter is listed in CITES Appendix II. *Anas bernieri* is listed as vulnerable, while *Tachybaptus pelzelni* and *Ardea humbloti* are insufficiently known to establish their status.

Non-endemic species found elsewhere in Africa are *Nycticorax nycticorax*, *Butorides striatus*, *Ardeola ralloides*, *Bubulcus ibis*, *Egretta gularis*, *E. alba*, *Ardea cinerea*, *A. melanocephala*, *A. purpurea*, *A. goliath*, *Scopus umbretta*, *Anastomus lamelligerus*, *Mycteria ibis*, *Threskiornis*

aethiopica, *Phoenicopterus ruber antiquorum*, *P. minor*, *Thalassornis leuconotus*, *Porphyrio porphyrio*, *P. alleni*, *Tringa stagnatilis*, *Sarkidiornis melanotus*, *Denrocygna viduata*, *Melanophloix ardesiaca*, *Corythornis cristata*, *Milvus migrans* and *Merops superciliosus*.

Mammals: The endemic *Limnogale mergulus* is associated with wetlands and may possibly be vulnerable or endangered. *Dugong dugon* enters mangrove areas.