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# The Tropical Forest Resource of Madagascar Island

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**Abstract**: Madagascar is an island off the east coast of Africa. The natural forest of Madagascar is diverse. The original forest is believed to have been predominantly evergreen or deciduous forest or deciduous, spiny, succulent thicket, with rupicolous shrublands occurring locally on various types of rock outcrop, and montane bushland and thicket occurring on the highest mountains or mangroves swamps. Madagascar's dwindling forests are home to an enormous variety of unique plant and animal life but some of them are endangered because of the constant destruction of their habitat by humans. 60%－85% of forest has been destroyed. Unsustainable shifting subsistence cultivation is the major threat. In some areas burning to create cattle pasture is also important.

**Key words**: tropical forest; forest resource; Madagascar
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Madagascar is situated in the Eastern Indian Ocean, between latitudes 11°57′ and 25°35′ S and between longitudes 43°14′ and 50°27′E. It is located some 400 km off the eastern coast of Africa, just south of the equator. Over 1 580 km long and 570 km wide, Madagascar is the world's fourth largest island, with an area of about 587 000 $km^2$. In addition to the main island, a number of small islands which are parts of the Madagascar Republic are included in this account. The northern and western part of Madagascar is mountainous and covered with an equatorial jungle and many primary forests. The south is half desertic while the central area and the east is mainly alluvial plains. The physical relief of Madagascar is complex[1]: a central highland is formed by a metamorphic pre-Cambrian basement, which has been extensively uplifted, faulted and eroded. Soils are predominantly lateritic clays. To the east of the central highlands, the escarpment is primarily formed, like the central highlands, from the pre－Cambrian basement, but areas of volcanic and granite formations and some recent alluvial deposits give rise to a greater diversity of soils. To the west of the central highlands, the metamorphic basement is replaced by a continuous zone of sedimentary formations. Soils within this western sedimentary zone are diverse, they are frequently sandy and include decalcified clays derived from the limestone karsts. Within the central highland region, mountains rise above the undulating plateau. The mountains are diverse geologically, including volcanic formations of various age, granite and quartzite outcrops. Soils in the mountainous areas are diverse. The people of Madagascar, the Malagasy, come from some eighteen ethnic groups of which principal ones are: the central highlanders and the coast of mixed Arabs, African, Malayo－Indonesian ancestry. Other groups are Comorans, French, Indo－Pakistanis and Chinese. The population numbers nearly fifteen million is rural at 78%. The first language is Malagasy, which belongs to the Malayo－Polynesian family of languages. French is widely spoken, and it is still the main language used in business, although English is becoming more and more influential.

Madagascar's climate is tropical, with two seasons. During the rainy season (December－April), the island receives between 30－355 cm of rainfall annually[2]. During the dry season (May-November), average midday temperatures range from 25℃ in the highlands and 30℃ on the coast. Along the eastern coastal plains, high humidity is tempered by almost－constant ocean breezes. Madagascar is believed to have moved south－eastward relative to the African mainland to its present position, having originally formed part on the ancient Gondwanan continent adjacent to what is now Tanzania[3]. Because of its isolation it is occupied by some of the most unusual and rare species of plants and animals on earth. Of the estimated 12 000 species[4], over 80% are only found in Madagascar[5]. One reason for this diversity is the range of microclimates. In fact, each climatic region in Madagascar is associated with a specific vegetation type where live a distinct set of plants and animals. Rapid deforestation on the island of

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Madagascar has been an important factor in many global issues such as global warming, desertification, soil erosion and decreased biodiversity. More than 1.2×10$^6$ hm$^2$ of forest and bush burn each year, according to the Forestry Service in Madagascar. The total forest area of Madagascar 1.2×10$^7$ hm$^2$ (22% of country superficies), forest coverage

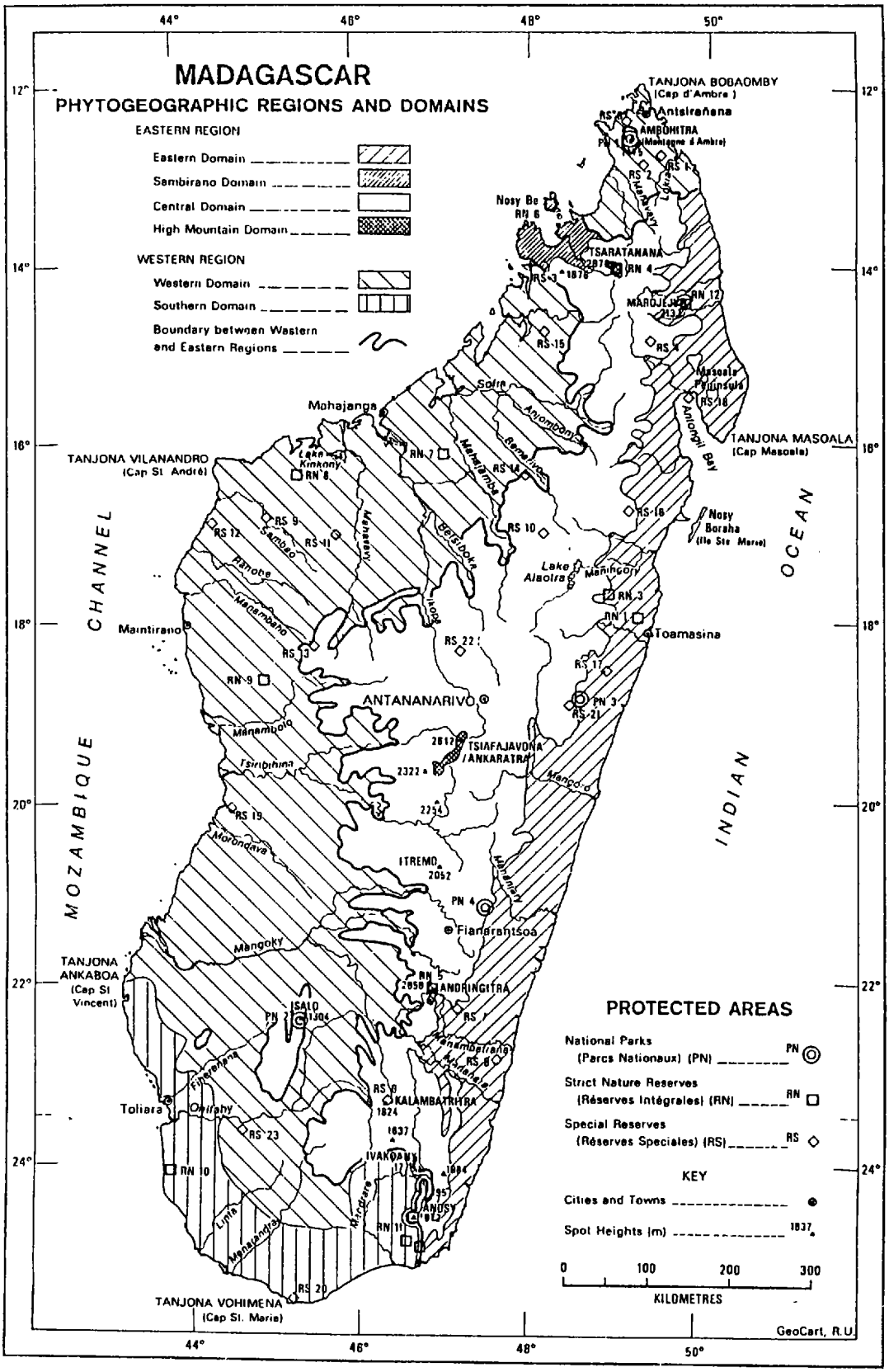


Fig. 1　Phytogeographic regions of Madagascar[6]

factor 28%. Tropical forest of Madagascar can be classified according to the habitat they grow[5]: tropical evergreen rain forest; arid deciduous forest; deciduous thickets and thorny scrub forest; mangrove forest.

## 1 Tropical evergreen rain forest

The humid tropical forest stretches along the eastern coast. Particularly, dense evergreen forest with a canopy exceeding 30 m. Unfortunately, this forest is endangered. The principal threat to the forest lies in the clearing and burning of the trees in order to cultivate the soil (cultivation of pluvial rice, profitable crops…)[5]. Cyclones can also periodically cause extensive damage in the eastern forest, especially in those areas, which are close to the shore and directly exposed to the wind. The increase in population in the eastern forest areas also poses a problem. This tropical forest contains very rare essences covered by traders of exotic wood.

The natural vegetation along the coast is lowland rainforest. The region is characterized by high species diversity and endemism. The climax is variable: low rainforest with an abundance of epiphytes and grassy undergrowth, sclerophyllous forest with trees laden with mosses and lichens and wooded country characterized by bushes of ericoid appearance. Certain families are particularly well represented, especially the palm and orchid families.

There are also more than 1 000 species of orchids. Some of them can be distinguished by their size or their color. So, *Cymbidiella rhodochila*, *Aeranthes* sp., *Angraecum sesquipedale*……Orchid's flowers are fertilized by birds or insects coming to lick the nectar, hook pollen and carry them to other flowers. The specialization is sometimes so advanced that only one insect species can fertilize the flower. Another orchid is the vanilla plant (Madagascar is the first producer of the vanilla plant in the world).

In this forest, we found also many plants of *Ravenala madagascariensis*, which look like banana tree but with a trunk. Its cloves can be eaten in the form of flour.

In frontier of this forest, there are marshes, canals and swampy forest. Among herbaceous plants, we can cite the *Raphia* whose fibers are exported to the entire world. But it gives also, alcohol and building materials. Unfortunately, overexploited, the species is endangered. In the marshes, we found also the famous carnivorous plant *Nepenthes madagascariensis* (mostly growing on substrates poor in mineral nutritients, which trap and digest insects and other small animals).

There are also littoral species with affinitie, with plants in India or Malaysia, which are today endemic to Madagascar, while the introduced foreign species has disappeared: *Cycas thouarsii*. The rain forests extend westward to Madagascar's central plateau. Species is high but the number of endemic species is even higher. *Tambourissa* and *Weinmannia* are the two common forest genera. Other common trees include: *Dalbergia*, *Vernonia*, *Ocotea* sp., *Cryptocarya* sp., *Symphonia* sp., *Soalnea rhodantha*. There are more Epiphytes than in other forest types, ferns and tree ferns are abundant. The shrub layer and the herbaceous stratum are well developed.

Forest of the high mountains enjoys substantial rainfall throughout the year and there is a marked diurnal and seasonal variation in temperature. Species diversity is lower here but endemism is high. Trees in the Compositae family grow in this region and Bryophytes are quite abundant. Set fires are the chief threat.

In the northwest is a small enclave of seasonal moist forest, characterized by high species diversity and a high level of endemism.

In the central part of the Madagascar, one now sees a desolate, open landscape, with small, remnant stands of evergreen forest (thalwegs) restricted to valleys and other protected sites, surrounded by vast expanses of monotonous secondary landscape. In poorly drained areas, edaphic swamps occur with characteristic plants such as palm *Ravenea rivularis* and species of coniferoid *Pandanus*. During the 20th century, species of *Eucalyptus* was abundantly introduced in the region and form today the main vegetable cover of the central plateau with *Poinsettia pulcherrima*. Former forests have entirely disappeared, replaced by immense empty areas burned annually to provide pasture for cattle. However, these vast areas are covered with graminaceous plants: *Aristida similis*, *Aristida rufescens* and some dicotyledons with a great underground system which permit them to resist fire. In certain region one species of mimosa originated from Australia (*Acacia dealbata*) marks thoroughly the landscape. This species is resistant to fire and is an essential source of wood for heating and charcoal.

## 2 Arid deciduous forest

Arid deciduous forest is thought to have covered western Madagascar. The rainfall decreases gradually from

north to south and the dry season, with a high atmospheric aridity.

Vegetation is characteristic of the calcareous karst region of western Madagascar, with dense, dry, deciduous forest and extensive anthropogenic savannas throughout. These areas are regularly burned to clear before cultivation, to destroy dried part of gramineaceous plants and to facilitate the growth of young leaves. During the dry season, the appearance of the forest is really grim. However, the forest is very rich; according to the soil type, there is a great diversity of species of which a lot are endemic to Madagascar.

Among the rare trees found we can mention the following species: *Diospyros perrieri*, *Delonix* sp., *Musa perreri*, *Tamarindus indica*, *Poupartia caffra*, *Acridocarpus excelsus* … and some palms.

Among eccentric species, bottle trees (*baobabs*) are grandiose and are most beautiful. One species of baobab tree is found in all the rest of Africa; eight species are grown in Madagascar, including superb examples of *Andasonia gradidiera* and xerophytic plants such as *Aloe* on rocky formation. Notable families include Orchidaceae, Leguminosae, Bombaceae, Moraceae …. The aquatic *Aponogeton fenestrale* occurs in some rivers. Lianes, particularly Asclepiadaceae and shrubs are common. Herbs and Epiphytes (including Mosses and Lichen) are very few.

This dry forest is, in fact, extremely vulnerable to forest fires. Whether or not the forest at one time covered the whole of the western part of Madagascar, its present condition shows that forest growth has been under constant attack from fire for decades. After each fire the forest gives way to brushwood or to grassland, without passing through the stages of deterioration in growth as in the east.

Because of the erosion caused by the denudation of the western slopes, the rivers in the west carry large quantities of alluvial materials. In the west the principal reason for clearing the forest is sometimes the cultivation of maize, groundnuts or other crops. The clearing is carried out in the same way as in the east, but generally the forest is replaced directly by brush or grassland, owing to the rapid exhaustion of the layer of humus and reforestation becomes lengthy.

## 3 Deciduous thickets and thorny scrub forest

The bush in the southwest and in the south of Madagascar is naturally fire-resistant and is adapted to conditions of drought. Where the bush is sparse, it contains graminaceous plants quickly grazed every year by the cattle.

The climax consists of deciduous forest, wooded country formations or dense bush, with numerous highly adapted aphyllous, prickly or succulent species. Rainfall in this region is sparse and irregular; the dry season is marked and very long.

In the extreme southwest and across the southern part of Madagascar, where conditions are even drier, specialized thicket vegetation is dominated by members of the endemic family Didieraceae (*Didierea madagascariensis*, *Didierea trollii*, *Alluaudia ascendens*) and by shrubby and arborescent species of Euphorbiaceae, such as *Euphorbia stenoclada*, *Euphorbia enterophora*. Other succulents include species of *Kalanchoe* and *Aloe*, as well as trees with bottlelike trunks for water storage, such as *Andasonia*, *Pachypodium* and *Moringa*. Lianes are numerous including many Asclepiadaceae, while epiphyte and the ground layer are generally sparse. The deciduous thickets, like the deciduous forest, have been replaced by secondary grasslands and wooded grasslands over much of its natural area of distribution.

The flora consists mainly of bush species forming a dense thicket that is difficult to penetrate. Many have only very small leaves or sometimes none at all; many are spiny. The leaves are very frequently born on short and very thin branches.

## 4 Mangrove forest

The mangrove forests are evergreen[7, 8]. Mangrove communities occur in many parts of Madagascar, along the northern, western and southern coasts, mainly around the river mouths and bays of the west coast where conditions are more favorable for its establishment. They are estimated to cover a total of about 200 000 $hm^2$. The Madagascar mangroves contain typical Indian Ocean mangrove species. Approximately 9 of the world's species reside in Madagascar[7]. Most species have pneumatophores or are viviparous. The Madagascan mangrove has one endemic species: *Ceriops boiviniana* (Rhizophoraceae), together with *Rhizophora mucronata* (Rhizophoraceae), *Bruguiera gymnorhiza* (Rhizophoraceae), *Avicennia marina* (Avicenniaceae), *Heritiera littoralis* (Sterculiaceae), *Lumnitzera racemosa* (Combretaceae), *Sonneratia alba* (Son-

neratiaceae), *Xylocarpus moluccensis* (Meliaceae), *Xylocarpus granatum* (Meliaceae). There are no significant areas of mangrove within the present system of protected areas.

## 5 Conclusions

The distribution and biodiversity of Madagascar's forests are determined largely by the availability of moisture, temperature, elevation and soil fertility and soil physical properties. These environmental characteristics are also important for forest management and the establishment of tree plantations.

The diversity of climatic and edaphic conditions and gradations of variation that are often extremely sudden, are also conditions that have favoured an intense intra—insular micro—endemism and the diversification of numerous plant formations, which are often remarkable for the form of biological adaptation taken by many of their species. But as nearly everywhere else in the tropical world, the interference of man has greatly modified the distribution of plant formations and the composition of the flora.

Madagascar thus possesses an inheritance of inestimable value, but one, which is gravely threatened. A great effort towards safeguarding it has already been made by the creation of nature reserves in many areas. But the struggle must be intensified to protect this natural heritage, which is so rich and to increase very quickly the means available to perfect our knowledge of it.

Based on floristic and ecological data, Madagascar can be divided into two major phytogeographic regions, which can be subdivided into a number of floristic domains[9]: East Madagascar Region and West Madagascar Region. The original vegetation cover of the two regions is distinguished by the predominance of evergreen species in the east and deciduous species the west, with few species common to both regions. The east Madagascar region, with its more diverse habitats and vegetation type, is considerably higher in total species number, although the highest level (95%) of species endemism is probably found in the Southern Domain of the West Madagascar Region.

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# 马达加斯加的热带森林


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摘要：马达加斯加是非洲大陆的离岛。天然森林类型复杂多样。原生性的森林群落主要为常绿林，落叶林以及多刺、肉质的落叶灌木丛。在不同类型的岩石露头发育着岩生矮林；高山上可见山顶矮林，滨海湿地则为红树林。马达加斯加的森林有着独特的植物和动物种类，有着巨大的生物多样性。但由于人类长期对其生境的破坏，不少生物种类已处于濒危状态。到目前为止，60%～85%的森林植被已遭到破坏。非持续的农业轮作是森林植被完整性的主要威胁。在某些地区，火烧林地建立牧场业是引起森林面积减少的主要因素。



关键词：热带森林；森林资源；马达加斯加

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