CLIMATE AND VEGETATION IN MELANESIA

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1.THE CLIMATE: A MAJOR ENVIRONMENTAL FACTOR FOR VEGETATION

1.1. THERMAL CYCLES AND ZONES

1.1.1. Latitudinal variations and thermal amplitude

Except in the heart of Papua New Guinea, all Melanesian islands are the tropical west coastal zone. This climatic zone is characterised by a weak annual cycle of temperatures and no extreme heat. In the tropical west coastal zone, the daily thermal amplitude (the difference of mean temperature between the hottest and the coolest hours of the day) is greater than the seasonal thermal amplitude.

Table 7 deals with the situation in Vanuatu, seen as an example of the tropical west coast zone of temperature. This data was collected from the six meteorological stations of Vanuatu over the last 30 years. The table shows:

i) the average yearly minimum temperatures (T min),
ii) the average yearly maximum temperatures (T max),
iii) the yearly average temperatures, AT = (T min + T max) / 2),
iv) the thermal amplitude (T max - T min).

Table 7. The yearly mean temperatures in Vanuatu (1961-1983), from STUBER and AUTONES (1985)

	Tmin	AT	Tmax	Tmax-Tmin
Vanua Lava	23.3	26.1	28.8	5.5
Santo	22	25.2	28	6
Malakula	22.8	25.9	29	6.2
Efate	21.4	24.8	28.1	6.7
Tanna	20.2	23.8	27.4	7.4
Aneityum	20	23.5	26.8	6.8

According to table 7, temperatures decrease with the latitude when we move from the north of the country to the south. Thermal amplitude increases.

Table 8 shows the seasonal thermal amplitude in Vanuatu. Four periods "seasons" are considered: Winter, from July to September; Summer, from December to April; and two transitional seasons, May - June and October - November.

Table 8 - Seasonal temperature variation in Vanuatu (1961-183), from DAVID (1990a)

	May-June	July-Sept	Oct-Nov	Dec-April
Vanua Lava	26.1	25.4	26.0	27.7
Santo	24.8	24.2	25.1	26.0
Malekula	25.5	24.5	25.8	26.8
Vila	24.0	22.8	24.6	26.3
Efate	23.0	21.4	23.6	25.6
Aneityum	22.5	21.0	23.0	25.2

1.1.2. Altitude variations and ground effect

Temperature decreases with altitude from 0,5^{0} to 0,6^{o}c each 100 meters. Example: if the temperature at sea level is 25^{o}c, snow would be found between 4,500 and 5,500m altitude.

At the same altitude (eg. 1,000 m) the thermal amplitude is less above the open sea than on the ground, this is called the "*ground effect*".

1.2. THE WINDS

Four main features characterise the wind regime patterns in the Melanesian islands.

a) The trade winds are the prevailing winds. They blow from the east-south east from April to August-September.

b) Winter is the calm season.

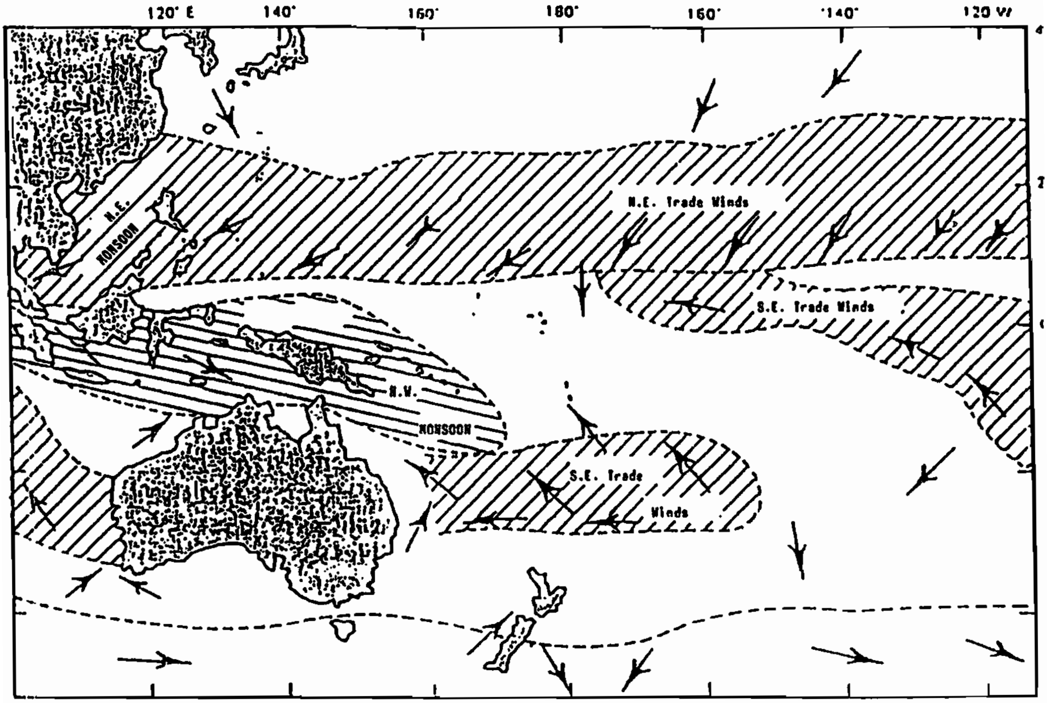


Figure 42. Monsoon and trade winds in the South West Pacific
(After SHOM, 1984)

c) Winter is the Monsoon season close to the Equator. In Melanesia, the North West Monsoon affects all the Solomon Islands and can reach the North of Vanuatu (figure 42).

d) Winter is the cyclone season.

Cyclones need a sea temperature higher than 27 degrees C and a high instability in the troposphere (9,000 m of altitude). Cyclones are not common in the Solomon Islands which are too close to the Equator. A cruel exception to the rule was cyclone "Namu" in 1986.

In theory, cyclones can affect any equatorial and tropical place located at 5° - 10° latitude minimum. Figure 43 shows the number of tropical cyclones that crossed each 5° square of the South pacific region from November 1039 to April 1969. In fact, most of the zones affected by cyclones and tropical depressions lie between 15° and 25° latitude, the latitude of the Vanuatu archipelago. From 1940 to 1985, 58 cyclones and tropical depressions crossed the archipelago of Vanuatu (DAVID, 1990 b)

Figure 44 shows the origin and movements of cyclones in the South Pacific. All of them appear between 5° and 15° latitude. Three zones of cyclone formation may be identified:

i) North of Fiji and West of Wallis and Futuna between Tuvalu and Rotuma Island;

ii) West of the Solomon Islands;

iii) North West of the Coral Sea, to the South of PNG.

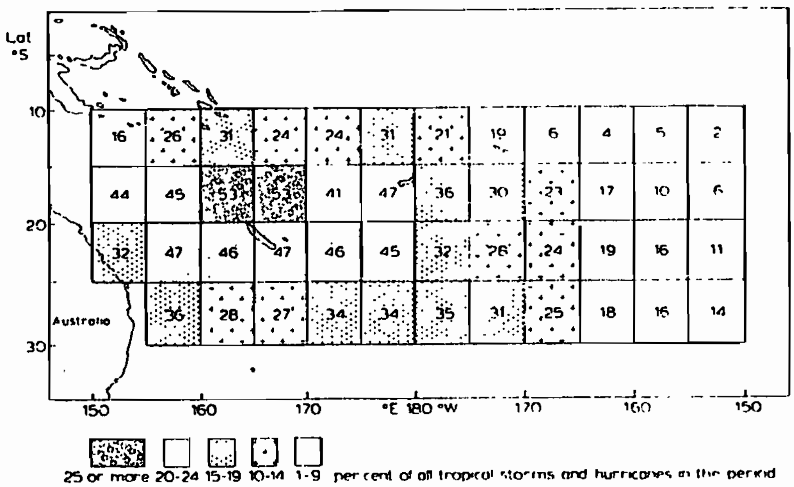


Figure 43. Number of tropical cyclones that ccrossed each 5-degree square in the 30 "seasons" November 1939 to April 1969. Shading shows percentage of total storms (After Kerr, 1976).

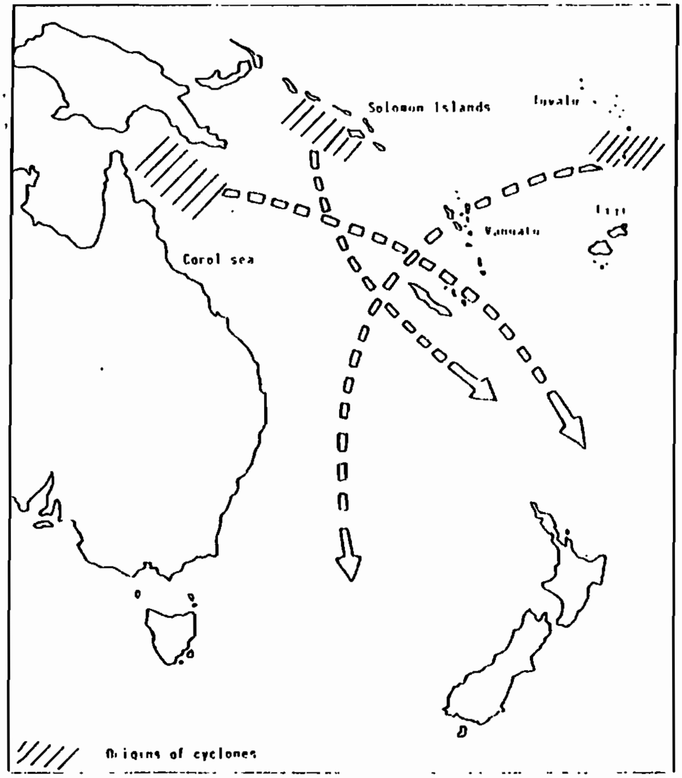


Figure 44. Origins and movements of cyclones in the South-West Pacific

1.3. PRECIPITATION

A maximum of precipitation, more than 5,000mm of rainfall as a yearly average, occurs in the south-east of the Solomon Isl. (Figure 45). Table 9 shows the seasonal precipitations in Vanuatu.

In all meteorological stations, the summertime from December to April is the wet season. Wintertime, July to September, is the dry season.

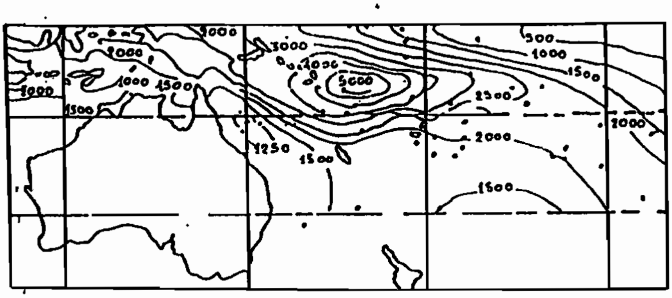


Figure 45. Means of Rainfall all the year round in the South West Pacific (After Taylor, 1973)

Table 9 - Seasonal precipitations in Vanuatu from Stuber and Autones (1985)

	Dec-Apr	May-Jun	Jul-Sep	Oct-Nov	Yr Rd
Vanua Lava	403	355	245	376	4,215
Santo	317	203	140	209	2,832
Malekula	241	149	92	152	2,080
Efate	276	151	106	141	2,281
Tanna	183	103	76	69	1,486
Aneityum	259	158	122	139	2,254

1.4. THE HYPER HUMIDITY OF HIGH ISLANDS

The tropical islands affected by trade winds are characterised by an inversion layer around 3,000m altitude which borders a dry air subsidence above and convection and evaporation of wet air underneath (figure 46).

The intensity and frequency of precipitations changes according to the altitude.

a) In High Islands a maximum of rainfall occurs between 1,000 and 1,200m (figure 47).

b) Up to the level of maximum rainfall is a zone of continuous rainfall from 1,200-1,400m to 1,600-1,800m. With the altitude the drops become smaller and smaller. From 1,600-1,800m to 2,200 to 2,400m a very thin rainfall level is reached. The zone of continuous rainfall and the zone of very thin rainfall are characteristic of the rainfall forest.

c) The "mist zone" also called "the cloud sea" stands between the inversion layer and the thin precipitation level from 2,200-2,400 to 3,000-3,500m. In botanical terms this zone is characteristic of moss forest.

d) In a low unsaturated atmosphere a process of evaporation causes a decreasing of the drop sizes. The evaporation is so high that the drops di$appear before reaching the soil (CABAUSSEL, 1984).

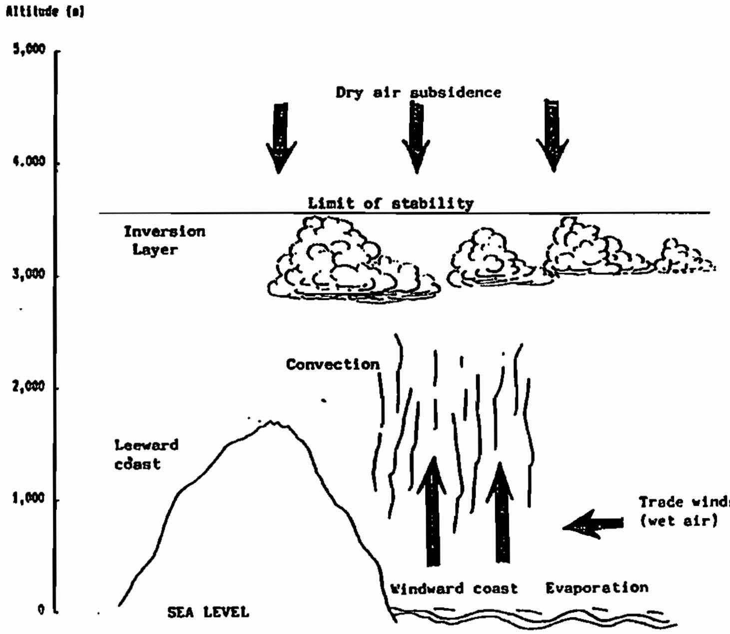


Figure 46. Air movements in a South Pacific Island

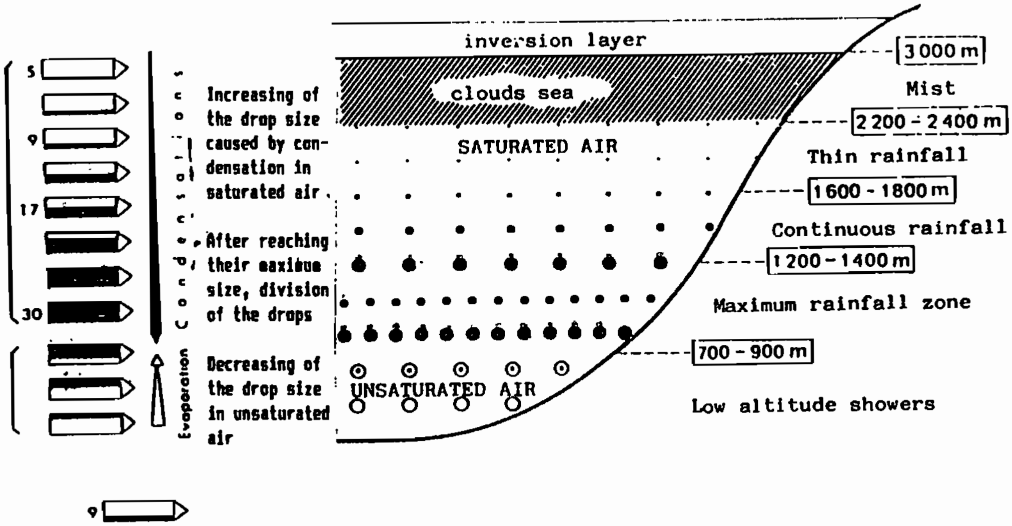


Figure 47. A model of rainfall related to altitude in tropical islands (After Cabaussel, 1984)

2. VEGETATION AND CLIMATE

Vegetation distribution is closely linked to climatic factors.

2.1. THE INFLUENCE OF ALTITUDE AND HUMIDITY ON VEGETATION

a) Coastal vegetation grows in sunny conditions. Coconut trees, yams and cassavas are three typical coastal plants. Coconut trees rarely grow above 600m altitude in Vanuatu.

b) Rain forest grows in cloudy and wet conditions where taro is also grown.

c) Moss and high altitude shrubs grow at "cloud sea" level which is characterised by a permanent mist and cool temperatures of less than 15^{o} C, up to 5^{o} - 10^{o} C, around 3,000m.

2.2. THE CONTRAST BETWEEN WINDWARD AND LEEWARD COASTS

The leeward coast of high islands is drier than the windward coast and slopes covered by rainfall forest.

On the leeward coast of many islands some xeromorphic adaptation such as savanna called white grass and dry forest may be noted.

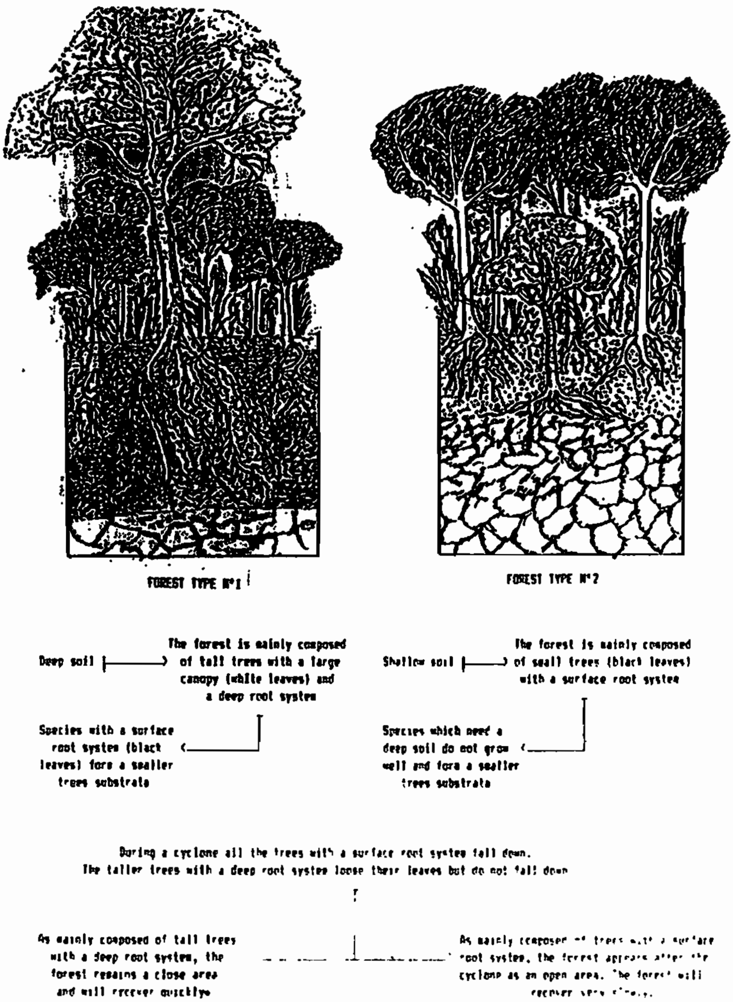
On the leeward plain of Guadalcanal Themeda australis is a good example of a white grass area component.

On the leeward coast of Efate the dry forest grows to 300m altitude. Legumenous trees such as *Acacia spirorbis*, *Leucaena glauca* or *Leucaena leucocephala* and *Acacia forneslana* are the main shrubs which characterise dry forest and grass land savanna.

2.3. THE INFLUENCE OF CYCLONES

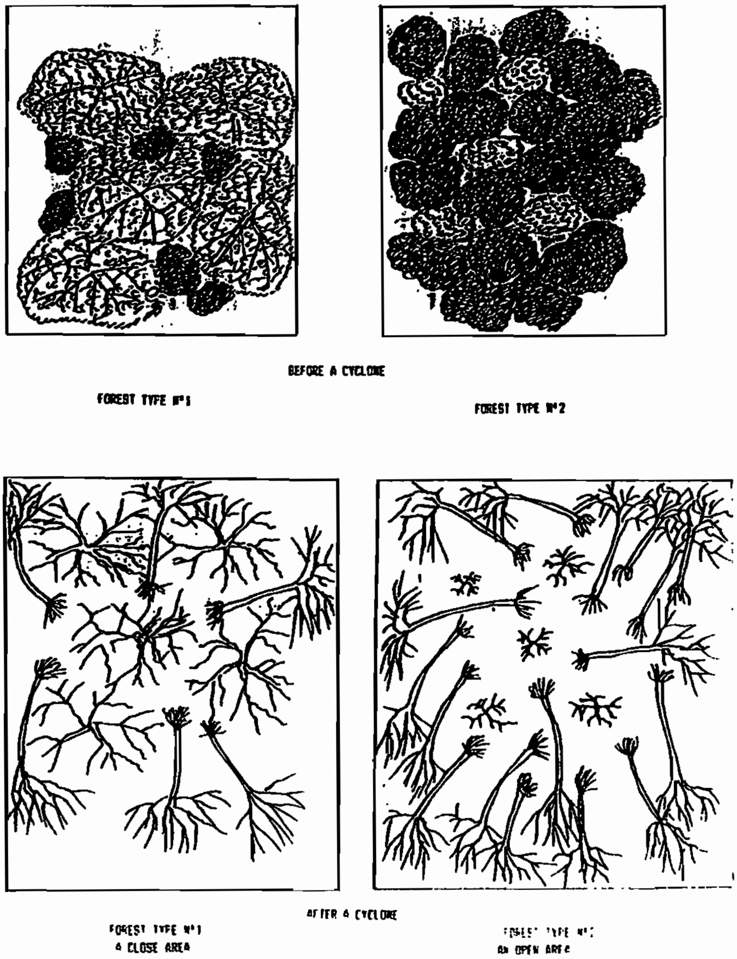
Cyclones are a disaster for food crops, especially fruit trees such as bananas, citrus and mango, but also for the forest, especially if the deeper horizon of the soil is too compact. In this case, the three roots are concentrated on the solum and this constraint cause a heavy selection among the trees. Trees which grow faster with superficial roots are advantaged but these trees are very sensitive to wind blow. Figure 48 shows the relationships between the structure of the soil, the resistance of the trees to cyclones and the composition of the vegetation.

Two cases are presented, a soft soil with deeper horizons which allow the growth of tall trees and a shallow soil where fast-growing trees with superficial roots, a small canopy and low resistance to cyclones effect are in the majority. The combination of superficial roots, quick growth and low resistance to cyclones could explain the low density of big trees in Efate and the low economical value of the forest which is mainly composed of small trees.



a) Lateral side view

Figure 47. Relatations between the depth of the soil, the forest vegetation's composition and the resistance of the trees to cyclones



b) aerial view

Figure 47. Relatations between the depth of the soil, the forest vegetation's composition and the resistance of the trees to cyclones

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