BEAUDOU (A.G.), DENIS (B.)

THE UTILIZATION OF PEDOLOGICAL DOCUMENTS FOR THE RESEARCH OF LAND SUITABLE TO COCO-NUT PALMS

Second South Pacific Island Regional Meeting for Research Development, Extension and Training in Coconut - Saraouton Coconut Research Station
SANTO - VANUATU
23-27 Avril 1984.

THE UTILIZATION OF PEDOLOGICAL DOCUMENTS FOR THE RESEARCH OF LAND SUITABLE TO COCO-NUT PALMS

BEAUDOU (A.G.) DENIS (B)*

Let us quickly go over the principal requirements of the coco-nut palm. It is plant which prefers light, rather deep and well-drained soils, in the upper-most 80 cm. The pH values of the most favourable soils are situated between 6 and 7. However, the coco-nut palm can endure less deep soils, on limestone (coastal coral reefs), on the condition that they are cracked and that an underground water is accessible. It is, therefore, a plant which can equally accept more basic pH values, but however, less than 8. Its requirements in nitrogen and potassium are high. Nevertheless, the sodium coming from the spindrift or the underground water can, to a certain extent, compensate for a deficiency in potassium.

For that which concerns climatic conditions, the requirements of the coco-nut palm are very precise. The climate must be hot and regulary humid, the average temperature above 20 C, the pluviometry between 1,600 and 4,000 mm/year,and a dry season of not more than 2 or 3 months. The amount of sunshine must be considerable and superior to, or equal to 1,800 H Campbell insolation (nebulosity less than 6/8).

All these conditions permit us to define the most favourable zones for the coco-nut palm - low altitude zones (less than 200-300 m) situated in an equatorial climatic zone (windward coast) and in the tropical zone called "transition zone". In the leeward zones, the coco-nut palm plantations are limited to alluvial terraces near to an underground water.

This partial inventory of the edaphic restraints of the coco-nut palm, therefore poses the problem of the quest for suitable soils to sustain coco-nut palm cultivation. To resolve this problem, pedologists possess several types of documents :

1) Pedological maps on an everage scale (1/100.000, 1/50,000) and agricultural potentiality or cultural aptitude maps on the same scale.

2) Morpho-pedological maps on a large scale (1/25,000, 1/10,000) with morpho-pedological legends and an edaphic restraint legend.

* Soil scientists from ORSTOM - NOUMEA - BP A5 NEW CALEDONIA

- **Agricultural potentiality and cultural aptitude maps of the soils of Vanuatu.**

These maps are directly derived from pedological and morphological maps from the atlas of soils of Vanuatu (Quantin - 1982) on scales of 1/100,000 and 1/50,000.

The aptitude maps are on a scale of 1/100,000 for the Malabula, Espirito-Santo, Tanna, and Efatè Islands. For the whole of the archipelago, one map on a scale of 1/500,000 has been drawn up. On all these maps, 7 classes of different potentialities were represented. For that which concerns the coco-nut palm, only the classes I, II, III and possibly IV can be considered.

1 - **Class I : Optimum potentiality**

It gathers together high fertility soils with a high pH (6 to 7.5) and which are firm, well-drained and quite deep. The relief is flat or on a slight slope. Traces of erosion are few. There is, therefore, a possibility of mechanized agriculture without risks of erosion, nor the need of anti-erosive adjustment. The climate is sunny and quite humid. The chemical fertility is good, except for acidiphile plants . The need for fertilizing elements is restricted.

In this class I, Quantin distinguishes 3 sub-classes, depending on the type of climate.

1.1. **"Equatorial" climatic zones of low altitude (300 m)**

They regroup different types of soils :

- Eutrophic and andic brown soil (VII - 4)

- Saturated "chromic" andosol (IV - 2)

These zones correspond to the needs of the neutrophile plants, adapted to a hot, regularly humid climate. There are no risks of hydrous deficiency. The insolation is good.

1.2. **"Transition" climatic zone with a dry season of 1 to 2 months**

Soils :

- Weakly unsaturated humic ferrallitic soils (X.1)

- Rubefied saturated fersiallitic soils (IX.21)

Regions favourable to neutrophile plants adapted to a hot, regularly humid climate. There may be a risk of an exceptional dry season of more then 2 months.

1.3. Tropical climatic zones with a short dry season of 2 to 4 months

Soils :

- Saturated "melanic" andosol (IV.2)

- Saturated "brownified" fersiallitic soils (IX.21)

Favourable to neutrophile plants adapted to a hot climate with a well-marked dry season. There may be a need for irrigation or umbrage.

2 - Class II : Good potentiality

In this class we find soils of good fertility with a high pH (6 to 7.5) and often well-drained. The restraints for utilization are reduced - little depth of soil and a quite large number of traces of erosion (erosion risks). Still depending on the climate, Quantin distinguishes several sub-classes.

2.1. Variable climatic zones

The soils are situated on recent coastal terasses :

- Weakly developed alluvial soils (II.42)

Adapted to neutrophile plants in a hot and humid climate.

2.2. "Equatorial" climatic zones of low altitude

Soils :

- Eutrophic brown soils (VII-4)

- Highly rejuvenated eutrophic brown andic soils (VII-4)

- "chromic" saturated andosols (IV-2)

- weakly unsaturated andic ferrallitic soils (X-1)

Suited to neutrophile plants in a hot and regularly humid climate, with no risks of hydrous deficiency. Good insolation.

2.3. "Tropical" climatic zones with a short dry season of 2 to 4 months

Soils :

- "Melanized" calcic soils (V-1)

- Vertic eutrophic brown soils (VII-4)

Suited to neutrophile plants in a hot climate with a well-marked dry seaon. Umbrage and irrigation may be necessary.

3 - Class III : Average potentiality

It represents the whole of the good fertility soils w[illegible]h moderate restraints of utilization and/or the soils of [illegible]rage fertility having limited capacities, requiring [illegible]ilization.

3.1. Variable climatic zones

Soils :

- Humic reudzinas (V.1)
- Weakly developed alluvial sandy or sandy clay soils (II.42)

Suitable for neutrophile plants in a hot and humid climate.

3.2. Equatorial climatic zones of low altitude

Soils :

- Partly rejuvenated andic eutrophic soil. (VII.4)
- Modal, Vertic, Partly rejuvenated) eutrophic brown soil (VII.4)
- Modal vitric andasols (IV.1)
- Moderately unsaturated ferrallitc soils (B). (X.2)

Zones which accept neutrophile plants of a hot and regularly humid climate, without hydrous deficiency and with good insolation.

4 - Class IV : Mediocre potentiality

This class in only pointed out for memory, for these zones can only suit very small plantations. The restraints of utilization are numerous for soils with a rather good fertility. For soils with a mediocre fertility, the capacities are very limited and necessitate very costly fertilization. This class is equally characterized by zones where the climate is a big limiting factor.

Soils :

- Ferrallitic soils moderately unsaturated (B) horizon. (X.2)

Here is the data which can be obtained from the reading of these agricultural aptitude maps on these scales. If next, we refer to the pedological map from which these maps are derived, we will have complementary information concerning the soil. There again, this information remains general - concerned, is an "average profile".

From this data, we can thus fix the boundaries of large regions where it is possible to foresee coco-nut palm cultivation. But, for the final choice of areas to be planted, more precise data is required. At first, this data will be furnished by more detailed pedological and edaphic restraint maps. At the present time, in Noumea, documents of this sort are worked out. The morpho-pedological maps are on a scale of between 50,000 and 10,000, depending on the complexity of the area studied.

II - Morpho-pedological and edaphic restraint maps on a large scale

The method used in Noumea, therefore allows the drawing up of morpho-pedological maps which are accompanied by two legends.

1 - A morphological legend

It takes into account relief, vegetation and soil, and is based upon the notion of landscape.

- A longitudinal diagrammatic profile or a diagram block gives an image of the landscape. In this landscape, thus represented, are placed the cartographic unities with their extension and the soils which constitute them. This allows us to bring to light soil - landscape relations : presence of toposequences, fragments of toposequences (segments) and soil mosaics (juxtaposed soils without obvious relations between them). The vegetation of each cartographic unity is equally characterized. A little table completes the data concerning the morphology. It indicates slope characteristics, risks of flooding, erosion, stoniness of the surface, depth of soil... All this landscape data is accompanied by a synthetic description of the soils (identification of the horizons with the aid of typological diagnosis). Finally, the soils are placed in the French classification system C.P.C.S.

2 - An edaphic restraint legend

On this legend, in the form of a table, are gathered together :

a) The restraints of the "landscape"

- Risks of flooding
- Slope
- Propensity of erosion
- Stoniness of the surface
- External drainage
- Depth of soil

b) The physico-chemical restraints of the soil

- Thickness
- Percentage of coarse elements
- Texture
- Structure
- External drainage
- Water reserve (difference between pH 2.5 humidity and pH 4.2 humidity
- pH
- Percentage of organic matter
- Percentage of nitrogen
- C/N
- Percentage of exchangeable Ca
- Percentage of exchangeable Mg
- Percentage of exchangeable K
- Percentage of exchangeable Na
- Percentage of exchangeable Al
- Capacity of exchange
- Saturation rates
- "Total" P205
- Assimilable P205
- Soluble salts

c) Fertility ratios

- Ca/T
- Ca/Mg
- Ca + Mg/K
- Mg/K
- A/AL + S
- N/P205
- Na/T

All these values are given for each type of horizon existing in each cartographic unity.

3 - The utilization of documents (Example of the Tiwaka map)

An example of a study of a coco-nut palm plantation. The climatic conditions are presumed satisfactory (pluviometry and sunshine). We know that the coco-nut palm presents several requirements :

- Flat regions or on a gentle slope
- Deep soils
- Well-drained soils
- Loose soils
- A pH of between 6 and 8
- High percentages of potassium
- High percentages of nitrogen

a) First stage :

The quest for flat regions or regions on a gentle slope. For that, we use the morpho-pedological legend on which is placed the cartographic unities in the landscape and the indications of slope. In this manner, we can note a certain number of cartographic unities present in practically all the landscapes.

Concerned :

Landscape	1	U3	U4			U8	
	2		U4	U6	U7		
	2'		U4	U6	U7		
	3		U4	U6	U7		
	4		U4	U6	U7		
	4'		U4	U6	U7		
	5		U4	U6	U7		
	6			U6		U13	U14

Whether - U3, U4, U6, U7, U8, U13, U14, - the U4 and U6 largely predominate. U7 is often uncertain.

b) Second stage :

In these unities, the search for the deepest soils. This characteristic is indicated in the morpho-pedological legend ; one must look for the presence of brachy-apexols (60-120 cm) and ortho-apexols (>120 m). Lepto-apexols are to be eliminitated.

Thus we have :

U3 : Lepto-apexols over-lying on reductons
U4 : - Lepto-apexols over-lying on reductons
- Brachy-apexols
(If this unity is to be noted, the presence of the two types of soils will necessitate a detailed prospection to differentiate the zones where they are located).
U6 : Two types of soils : but still ortho-apexols
U7 : - Ortho-apexols
- No apexols
(Two easily differentiated soil types).
U8 : Brachy-apexols
U13 : Brachy-apexols
U14 : Ortho-apexols

Thus we can eliminate the cartographic unity 3. Unities 4 and 7 present two types of apexols. By using the edaphic restraint legend we can state precisely the true thickness of brachy-apexols (thickness of horizon column). The ortho-apexols are at least 120 cm thick.

U4 : Thickness varies from between 85 to 105 cm.

- Humite : 15 to 35 cm
- Humo-entaferon : 35 cm
- Entaferon-oxydon : 35 cm

From 85 cm : presence of the hydrophyse (under ground water)

U8 : Thickness : 120 cm

- Humite : 10 cm
- Entahumite : 40 cm
- Entaferon : 70 cm

At 120 cm : hydrophyse (underground water)

U13 : Thickness : 55 cm

- Humite 20 cm
- Humic entaferon : 25 cm
- Hypohumite : 10 cm

From 55 cm : Reducton

Unity 13 seems little favourable. It must be eliminated. Therefore, following this analysis, we can note :.

U4 : (1 pedon) - U6 - U7 (1 pedon) - U8 - U14

c) Third stage :

Drainage conditions : It is possible to answer this question in several ways :

- In the morpho-pedological legend : In the soil description column, look for the words "Reducton" or "Oxydo-Reducton". The presence of the hydrophyse and its depth of appearance (underground water).

- In the edaphic restraint legend : Read the "Internal Drainage" column. A table allows us to summarize :

Restraints / Pedon Cartographic Unit	Internal Drainage	Hydrophyse Depth	Reducton	
			Presence Estimate	Depth
U4	Slow at Zero	85/105 cm	/	/
U6 Pedon 1 Pedon 2	Fast at Medium	/	/	/
U7	Fast at Medium	/	/	/
U8	Fast	120 cm	/	/
U14	Fast	/	/	/

Unity 6 is the last favourable, but mustn't be eliminated

d) **Fourth stage** :

Mellowing : This characteristic can be deducted from the observation of the texture and structure.

Restraints / Pedon Cartographic Unit	Texture	Structure	Mellowing
U6	L.A.S. a S.A.	Grumoanguclode Pauciclode	Sufficiently Mellow
U7	L.A.S. a S.	Anguclode Psammoclode	Mellow
U8	S.a. a S.	Grumoclode Psammoclode	Very Mellow
U14	L.A.S. a A.1.s.	Grumoclode Pauciclode	Mellow

Unity 6 is the least favourable, but mustn't be eliminated.

e) **Fifth stage** :

The search for chemical restraints.

Restraints / Pedon Cartographic Unit	pH eau	Nitrium	Exchangeable Potassium
U6	< 6	Good	Very Low
U7	6.3	Weak	Very Low
U8	6.2 (< 50 cm) ⩽ 6.0 (> 50 cm)	Weak	Very Low
U14	⩽ 5	Good	Very Low

Unities 6 and 14 have a too acid pH and must be eliminated.

Therefore, the result of this analyse leads us to note unities 7 and 8, with the obligation to rectify the percentages of potassium and nitrogen by fertilizing.

The way to use these maps has been explained here, in order to solve a precise problem. The same procedure is possible for whatever other type of culture, if we are aware of the edaphic restraints.

B I B L I O G R A P H I E

BEAUDOU Al - 1983 - :

Typological soils mapping - Methodology - ORSTOM Noumea, 31 p. multigr.

PODWOJEWSKI (P) - BOURDON (E) - 1984 :

Carte morpho-pedolologique - Vallée de la Tiwaka - Carte à l'échelle 1/25 000 ORSTOM Nouméa - 44 p. multigr.

QUANTIN (P) - 1972-1978 - :

Archipel des Nouvelles-Hébrides. Atlas des sols et de quelques données du milieu naturel. 7 fascicules avec cartes pédologiques, géologiques, des formes du relief et de la végétation : Iles Banks et Torres, Espiritu Santo, Mala-kula, Ambrym - Aoba - Maewo - Pentecôte, Epi-Shepherd, Vate, Erromango - Tanna Anatom - ORSTOM, Paris.

QUANTIN (P) - 1982 - :

Vanuatu - Agronomic potential and land use map. Explanatory Notes. 7 Maps ORSTOM Paris - Ministry of Land and Natural resources Republic of Vanuatu.