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HISTORY OF VEGETATION MAPPING IN TUNISIA METHODOLOGY AND CRITICISM

by

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HISTORY OF VEGETATION MAPPING IN TUNISIA METHODOLOGY AND CRITICISM

Here is a brief survey of the scientific and technical conditions existing in Tunisia when started vegetation mapping. Since 1943, functioned at the Department of Hydraulique and Equipments Ruraux a soil survey section whose surveyors mapped soils for the purposes of land and water management.

In 1947, after visits of Prof. Emberger in Tunisia, microclimatologists and agronomists became interested in plant sociology studies, and in the future, vegetation mapping studies followed closely the phytosociological studies in the country.

In a first section, will be mentioned how the occurrence of plant associations was established in Tunisia, how the first vegetation map of H. Gaussen and A. Vernet was established (1/100.000th scale), followed later by the vegetation map at 1/100.000th scale of Central Tunisia, which was established for integrated rural planning more especially grazing management for sheepbreeding purposes.

In a second section, and because have been gathered all the favourable conditions for mapping at small scale (and especially planning) will be outlined the 1/200.000th mapping of the north and 1/500.000th scale mapping of the south.

In a third section, will be included some remarks, comments, and criticism.

1. Occurrence of plant associations, vegetation map of Tunisia at 1/1.000.000th scale, and 1/200.000th map of Central Tunisia.

1.1. SHOWING THE OCCURRENCE OF PLANT ASSOCIATIONS IN TUNISIA AND THEIR RELATIONSHIP WITH SOILS

In 1947, G. Long studied the vegetation of sandstone plateaux and that of sandy plains located at high elevations in Central Tunisia (G. Long, 1954). After several years of study, he showed:

1.1.1. The occurrence in the Center of Tunisia of plant associations as defined by Braun-Blanquet.

1.1.2. Within the same climatic subunit (subaride) the close relationship between vegetation as indicator of environment (specially soil) and land management.

1.1.3. To illustrate his research, he mapped out at a 1/200.000th scale, the plant associations of Sbeitla sheet map.

1.1.3.1. Each colour was given to a defined plant association and according to Gaussen's principles: the more humid associations would be marked in blue, whereas the more xeric in red or yellow.

1.1.3.2. Climax was not shown on the map, but was established according a regressive sere (Gaussen's principles). Only degradations as indicated by vegetation, were outlined as horizontal stripes of the same colour as the actual undegrated plant association.

1.1.3.3. He separated very close floristically associations because they grew under different soil conditions.

1.1.4. Another map at 12/500th scale showed narrow relationships between soil and vegetation.

1.2. PHYTOSOCIOLOGICAL STUDIES OF THE WHOLE TUNISIA AND TUNIS-SFAX VEGETATION MAP AT 1/1.000.000th SCALE

1.2.1. History

Following the interest rised by these studies, the Ministry of Agriculture and CNRS decided to fund the work of 5 plant sociologists who would study the whole Tunisia, each of them working in one field: Mr. Gounot (native vegetation on annual fallow), H.N. Le Houerou (vegetation of the south of Tunisia), G. Novikoff (halophytic vegetation), M. Thiault (grazed lands of the Northern Tunisia). These topics were studied until 1954, and meanwhile, the 5 plant sociologists participated to Tunis-Sfax vegetation map at 1/1.000.000th scale, from H. Gaussen and A. Vernet.

1.2.2. Methodology

1. This map separates the big vegetal types: land cultivated in cereals, orchards, native vegetation including forests, maquis, garrigues, steppes.

2. Within which, differences are made according to the degree of xericity, shown by a ranking of colours, ranging from blue (more humid climate) to yellow (dry climate).

3. Forests and their degraded aspects are combined into the same regressive succession departing from climax: Quercus suber (cork oak), Pinus Halepensis (Aleppo Pine), Phoenician juniper (Juniperus Phoenicea).

4. The amounts of olive-trees or palm-trees in areas cultivated with these species and fields are indicated with appropriate symbols.

1.3. INTEGRATED RURAL PLANNING OF CENTRAL TUNISIA

1.3.1. History

In 1964, for purposes of rural planning in arid Mediterranean area of Central Tunisia, a team in which there was 2 plant sociologists (D. Froment, van Schwinderen) specialized in range management and one photo interpreter (D. Schwaar), who through aerial interpretation and field control, mapped vegetation of Central Tunisia ("Ecologie pastorale, Déc. 1966") to evaluate their agronomic as well as their grazing possibilities by sheep.

1.3.2. Methodology

1.3.2.1. The principles used in establishing the physionomic maps of vegetation. As indicated by

Froment, 1964, and to establish a clear difference with phytosociologic maps, those maps established for the integrated rural planning were named physionomic maps: they are based upon features easy to distinguish on the aerial picture, on the whole, it is a quick survey, orientated towards establishing the nutritive value of vegetation for sheepbreeding purposes. To establish a phytosociologic map would have required the gathering of many floristic lists, called releves phytosociologiques, into phytosociologic tables, and their control in the field; it would have resulted in a much longer work, than physionomic map of vegetation.

1.3.2.2. The mapping

In arid zone, the location of a given plant community (and more precisely the dominance of a plant species which interests more precisely the mapper) is related to geomorphology, soil texture, drainage conditions, anthropic factor; from these 3 factors, geomorphology is the most important for vegetation mapping at a small scale. The mapping occurred in several steps:

1. Splitting central Tunisia into natural regions. Central Tunisia was divided into several natural regions, each region corresponding to one stage bioclimatique, such as it is defined in Emberger classification; on the map, they are named I, II, III, IV, V & VI.

2. Splitting each natural region into several study areas. The natural region is too big to be easily "jandled" by the aerial photo interpreter (too many pictures to be displayed and studied) and that is why it is splitted into several study areas.

3. Within each study area, all the aerial pictures are examined, and also the topographic, geologic, soil maps, according to the degree of heterogeneity of the land, the aerial photointerpreter chooses several control plots which are representative of the totality of the study area.

4. Detailed outline of all the differences appearing on the aerial pictures. The aerial photographer outlines all the differences appearing on these 1/22.700 scale pictures: geomorphology, very cultivated areas, forests, gulliers, dark or light spots. Until now, the vegetation cover was not yet defined.

5. Field work to identify all the vegetation and land units (trip to the field).

6. Final interpretation of the control plots: establishment of key symbols in relation with the goals of rural planning.

7. Extension of the land units identified in control plots to the whole study area and drawing a map.

2. BIG SCALE MAPPING BASED UPON THE DETAILED PHYTOSOCIOLOGICAL STUDIES OF THE WHOLE TUNISIA

The phytosociological studies of the 5 plant sociologists were finished, a new concept of plant association was developed, based upon Duvigneau and Ellenberg observations on ecological groups as the basis of plant association, and through this, a new tool was made available for vegetation analysis (Duvigneaud, 1946).

The Secretariat of Economy and Plan in Tunisia asked M. Gounot and A. Schoenenberger to do the mapping at 1/200.000th of the Northern part of Tunisia, its Southern limit being the Southern pediment of Tunisian Dorsale. Meanwhile, H.N. Le Houerou mapped at 1/500.000th scale Southern Tunisia. With these 2 maps, Tunisia had the ecological back-ground covering the whole country.

2.1. NORTHERN TUNISIA

2.1.1. This mapping as said by M. Gounot (p. 14, 1967) gives schematic representative of different environments, and their location. At the same time, their agronomic, grazing, forestry potentialities are also indicated, which permits and optimal allocation of the resources, that is, decides for which best use is allocated such land (grains, olives, forage crops, crops row). Such mapping may help to the planning of resources at the country level, but must not be used to establish an agronomic development project.

Several teams participated to the study, including a team of agronomists who evaluated the agronomic potentialities.

2.1.2. Vegetation from cultivated lands.

2.1.2.1. Reasons for the separate study of forests from that of cultivated lands: the study of forest vegetation was separated from cultivated lands, due to the old cultivation, forest was eliminated and it is very difficult to establish series linking forest to cultivated lands. What was studied, is the vegetation of the one year fallow.

2.1.2.2. Classification of plant groupements by vegetation stage (Emberger, classification) and also by climatic variant of vegetation.

- "étages bioclimatiques": the stages values can be computed from meteorological stations and several bioclimates can be evaluated.

- "étages de végétation": within one stage bioclimatic, there can be different climaxes, and the influence of microclimate and soil conditions (in Northern Tunisia) may modify the Q values. To the "étage bioclimatique" corresponds in this map one "étage de végétation"; vegetation being the reflect of bioclimate. The "étage de végétation" is named after the name of "étage bioclimatique".

In the mapping of Northern Tunisia and at the scale used are taken account the differences of Q due to soil and microclimate:

2.1.2.3. Regionality concept.

In the absence of defined climax, in order to classify the vegetation of cultivated lands, the different environments in which grows one plant species are studies in relation with the different climates: it may develop on a maximum of different medias in one bio-climate and in a far smaller number of media in another bio-climate: the plant species is said to be regional when its species are all regional under the same bioclimate.

2.1.2.4. Example of description and evaluation of one groupement: AMF Groupement with Ammd visnage, Picris echioides, Mentha puleigium, Salvia argentea, ssp patulo.

- Geographic location: on sheet V in Merja, South of the Kef.

- Floristic composition: several ecological groups: Mentha pulegium, picris echioides, phalaris truncata

+ indicator plant species: Bupleurum lancifolium, Silybum marianum, Ammi visnage, Capnophyllum peregrinum.

- Ecological features: this groupement is regional in "sous-étage bioclimatique semi-aride supérieur, variant, aux hivers frais." The soils are fine textured hydromorphous, with

a quick drying out of the superficial layer. It is a groupement which is close to the one growing on "white soils" of high Medjerda valley, especially in Jendouba area.

- Actual and potential use. These soils are now cultivated in cereals, and they are too finely textured to be planted with fruit trees or olives. Their good fertility allows high wheat yields. Because they easily get soaked with water, winter row crops grow poorly. Summer row crops which tolerate heavy soils can be grown; because of the climate and soil quality, annual native forage provide high yields.

2.1.3. Vegetation from forest lands:

The vegetation of the forest was mapped by A. Schoenenberger according to his studies (p. 151, 1967).

2.1.3.1. Climax - Groupements

It is admitted in this study that climax is the state of equilibrium that can be reached by vegetation when the influence of man is excluded. The vegetation will reach this equilibrium passing ghrough a succession of different groupements; the totality of these consecutive states is called series in the Gqussen concept of vegetation succession.

Several series may converge to the same climax, but within the limits of the study, was considered only one sery for each climax; such are among others the climaxes of the cork oak (Quercus suber), Aleppo pine (Pinus Halepensis), Phenician juniper (Juniperus phoenicea).

Each groupement which is described, results from a combination of ecological groups. The name of the groupement comes from the dominant forest plant species and the ecological group indicating the stage of vegetation.

2.1.3.2. Classification of forest vegetation. Example of description of one forest unit.

The first splitting is done according to different "étages" and "sous-étages". Example: "étage de végétation semi-aride, sous-étage supérieur".

The second splitting is according to the serie: Aleppo Pine.

The third is done according to groupement for instance Pinus halepensis and Rosemarinus officinalis. In each groupement are described:

- The geographic location: sheet V on djebels WE, NM of Le Kef.
- Physionomy and structure:
  - dominant strata: rather loose with Aleppo pine (8 - 10 m. height)
  - shrubby strata in the open parts: Lontisks, rosemary, cists (Montpellier).
    Very often, this groupement is degraded and only remains rosemary.
- Floristic composition.

The ecologic group of Aleppo pine is abundant: Pinus halepensis, Rosemarinus officinalis, Globularia alypum, Fumana thymifolia, Genista cineroa, Ebenus pinnata.

This groupement has several facies (one dominant plant species): with Ampelodesma mauritanica goriw growing on shale, with Lygaeum spartum on gypsu.

Potentialities.

The part of the oforest which is in good condition must be protected.

Degrated facies can be reforested using Aleppo pine and Cypres; on low slopes can be planted Eucalyptus astringens, Gomphocephala and they product good yields. Other plant species can be planted for honey production: E. melliodora, polyanthemos.

- A few forage species exist and could be developed Oryzopsis miliacea, Ebenus pinnata, Hedysarum coronarium, Dactylis glomerata. Some experiments in dj. Mansour showed that after a few years, Medicago sativa, Sanguisorba minor cover completely the soil. S.Ceratonia siliqua can be planted on terraces and gives good results.

2.2. VEGETATION MAPPING OF SOUTHERN TUNISIA

2.2.1. Setting up the map. The map of Southern Tunisia at 1/500.000th scale (Le Houerou, 1969) is a synthesis of the studies of different authors and can be only schematic; as mentioned Le Houerou, its accuracy is unequal.

The first units to be mapped are those resulting from man's action, forests and matorrals, the steppes, cultivated lands. As it is impossible to delineate all the plant communities existing in the field, was used the Gqussen's concept to sery: To explain this concept, for instance in the case of plant communities resulting from the cultivation of an Artemisia herba alba (or chih) steppe, they have a floristic composition differing from the original steppe, but they grow in an environment which is similar to the steppe, and the experience shows that if the cultivation effect disappears, these communities tend to change their floristic composition towards that of the original "chih" steppe.

2.2.2. Vegetation classification; its description.

The south of Tunisia was divided into "étages" and "sous-étages" according to Emberger classification; in each "sous-étage" are mapped the plant communities (or groupements).

2.2.2.1. The plant community

Each plant community or groupement* is an association of ecological groups**: some groups are related to defined soil type, others to the climate, others are anthropozoogenic; some are characteristic of a soil under one given climate, others are related to one soil under different climates; this leads to the concept of zonality and regionality.

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* phytosociological unit of undefined ranking level.

** an ecological group is an ensemble of indicator species related to one ecologic factor.

2.2.2.2. *Zonality and regionality*

Plant species and ecological groups can be:

- Zonal: that is occupying in one area average topographic and soil conditions.

- Extrazonal: growing under special ecological conditions due to an increase of humidity in soil because of peculiar topographic conditions, like the olive tree in South of Tunisia growing in channels catching extra moisture run off in Matmata mountains.

- Azonal: some plant species have a wide ecological span.

2.2.2.3. Describing each plant community.

For each plant community are described the following.

- Generalities

  A. Area of extension
  B. Climate: including P, Q2, m of Emberger's classification
  C. Altitude, topography, morphology
  D. Geology, soils, geomorphology
  E. Human action.

- Vegetation

  A. Physionomy, structure
  B. Diagnosis: list of ecological groups and plant species for each group
  C. Interpretation
  D. Biological spectrum, degree of cover.

- Land use.

2.2.3. Evaluation of productivity

This productivity was computed from a small amount of data (P. 418, Le Houerou, 1964), and statistical informations on stocking rate, cattle density (expressed both in amounts of animals per unit surface), and some assumptions on cattle energetic requirements (expressed in F.U.) and also the energetic value (in F.U. per hectare) per kilogram of dry matter. The surface of each plant community was measured and the data grouped in a table.

Reference number on the map	Production in kgs of dry matter per hectare	Surface in hectares	Total production in tons dry matter	Remarks
79	600	46,960	28.176	

From the production of dry matter per hectare was computed the amount of F.U. per hectare (1 kg dry matter = 0.30 F.U.).

In another study, Le Houerou established a relationship between plant communities and yields of olives trees in olives.

3. COMMENTS - CRITICISM

These maps reflect the purposes for which they were established, but they have also limits of validity in relation with these goals.

3.1. DELINEATION OF THE SOIL - VEGETATION UNITS THE CROPS OPTIMIZATION

Because of the integrated approach using soil and vegetation studies for the delineation of mapping units, the accuracy of these limits is good for the proposed scales (1/200.000th or 1/500.000th). Through the studies of the team of agronomists, the soil properties are related to factors limiting the growth of the crops; therefore it provides, within a regional units, a ranking of the crops yields, and suggests the most appropriate crop to be cultivated, in terms of maximum production. Now, with the population increase, this optimization problem becomes less important, what is more urgent, is to keep on covering the basic human nutritional requirements (mostly cereals) of families where they are settled; this is the most difficult in areas where erosion is the critical problem (desert encroachment, watershed management).

3.2. LIMITS OF VALIDITY

3.2.1. Overestimation nutritive value of grazing lands. It is well understood that such small scale maps can only be of general use (Le Houerou, p. 424, 1969) giving a schematic

outline of the different soil vegetation mapping units (Gounot, p. 14, 1967). Despite all these warnings, in some cases, the evaluation of the productivity of the grazing lands was used in regional planning: such is the case of a SCET SEDES. Study of Medenine SCET SEDES p. 104, 1963, the planner multiplied the F.U. values per hectare by the total surface, and hoped to obtain a forage balance between the flocks requirements and grazing lands nutritive value. But

- F.U. values for each land were calculated for a year with average rainfall whereas for a 120 mms. area, it is better to calculate the F.U. values for a sery of years with different values of rainfall.

- It was assumed the rainfall evenly throughout the whole Medenine region, whereas it is falling in a scattered way throughout the presaharan zone,

- the F.U. values were expressed on the basis of an entire year which is scarcely noticed in the field.

3.2.2. Vegetation dynamics

In his studies of the forest vegetation of the Northern Tunisia, Schoenenberger A. (p. 151, 1967), assumes that several series in the Gaussen meaning may converge towards the same climax, but within the limits of this study, it is considered one sery by climax. The same principle was applied by Le Houerou (p. 358, 1969) for areas with rainfall above 150 millimeters. In his study

of the vegetation of fallow fields, Gounot admits that it is very difficult to establish series linking vegetation of cultivated lands and forests.

There is an absence in these studies* of the research of a climax in the clementsian meaning; it is probably due to the descriptive orientation of the studies, focusing on the soil-vegetation relationship: when vegetation had similar (or very close) floristic composition, but growing on different soils, purposedly it was separated in two different mapping units.

This would also have required long-time consuming studies which were not within the scope of the mapping.

It is suggested to use different possible approaches to study the climax of the vegetation in the clementsian type.

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* to explain it in a very simple way, adopting this approach, on two different soils can grow vegetation of very close floristic composition when it is rear climax.

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