Climatic and pedological features of Sicily

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Introduction

Sicily is essentially characterized by Miocene and Pliocene clayey hills of sea-nature.

The higher relieves are located between Palermo and Messina within the Madonie, Caronie and Peloritani mountainous systems; the Etna complex and the plateau in the surroundings of Ragusa. The mountain region is completed by the Sicani and by other lonely mounts placed in the districts of Trapani and Agrigento. Therefore the alluvial plains are restricted to the wide plain of Catania, which stretches from the Etna to the Iblei Mounts, and to other plains of smaller extent as those of Milazzo, Buonfornello, Carini, Licata and Gela.

The whole Sicilian territory is mainly characterized by the hill (50.11 %) followed by the mountain (37.73 %) and the plain (14.16 %).

Climatic features

Sicily entirely falls under the Mediterranean climate with its mild and rainy winters and warm and dry summers.

The Mediterranean climatic features may generally be found in the coastal belts and in the littoral plains; while, towards the mountainous inland, the thermic and pluviometric conditions undergo change because of the altitude and the always least efficacious influence of the sea.

The annual mean temperature is rather high everywhere, varying from 19°C in the coastal zones to minima nearly below 13°C in the most elevated zones of the inland.

January is usually the coldest month: in fact the recorded mean temperature is higher than 10°C in the coastal which feels the moderating effect of the sea while the temperature goes down to lower values in the inland and in the higher zones far from the sea.

July is the warmest month: the mean temperature value is 25/26°C along the coast while it goes down to lower values (even 18°C) in the inland mountainous system where therefore the daily thermic excursions are much more accentuated. The annual thermic excursion, modest along the coasts and in particular along the Southern and Western ones, exceeds 20°C in some inland areas.

In fact, toward the inland of Sicily and due to change of altitude, climate modifies its

own maritime character chiefly because of the almost complete absence of woody covering. For this reason summers are warmer and winters are harsher compared to the rest of the Island and in particular to the coastal belts.

Furthermore Sicily is characterized by scarce relative air humidity and by a summer days in which temperatures rise over 40°C. That is due to the Scirocco wind coming from Africa which particularly affects the littoral belts of Southern Sicily and the Sicilian inland.

In summer the winds coming from east may sometimes show themselves besides the Scirocco while westerly winds reach wind reach the main intensity as the Scirocco does (Fierotti 1975).

The Northern mountain chain, together with the Eolie insular complex shelter Sicily from the action of Northern cold winds. In winter the North wind coming from north-west is prevalent. Precipitations are not plentiful. They are irregularly distributed during the year and mostly concentrated in few day (about seventy) during the half-year October-March. The precipitations often take a violent character with dangerous consequence particularly on the clay soils of the Sicilian inland. An annual rainfall, often higher than 1300 mm, is checked on the highest mountains constituting the relieves near Palermo, the Madonie, Caronie and Peloritani mountainous systems along the Northern part of the Island. Such values are also reached in the Eastern part of Sicily on the Iblei mountainous system and on Etna Eastern side.

Elsewhere the precipitations rapidly decrease and in large part of the Island the annual mean amount is lower than 700 mm. The annual rainfalls are lower than 600 mm on the Western, Southern and Eastern coastal belts, as well as on the Agrigento, Gela and Catania planes and in the layer valley open to the Sicily Channel and the Ionian Sea. Finally annual mean lower than 500 mm are recorded in large part of the Catania and Gela planes and in wide stretches of the Southern and Western coast.

Sicilian pluviometric situation is made heavy by the strong evaporation caused by the high temperature , the shortage of woody mantle and by the considerable extent of impermeable rocks. Therefore rain waters rapidly flow together in torrential or fluvial river-beds producing sudden and dangerous spates.

With the exception of the Etna Mount, where the snow persists on soil for a long time at an altitude above 2200 m, on the other Sicilian mountain systems snowfalls are scarce and rare below 400 m.

The dry period is variable between three and five months. The longest dry period (May-September) is registered above sea-level while it progressively diminish towards higher altitudes.

An overview of the pedological types from Sicily

The above-mentioned climatic characteristics together with the geologic ones, and in particular those of the parent rock, produce an extremely various soils landscape.

The effects of these two important factors are added with man's action. In fact men have always intensely overworked land influencing the development of the profiles and altering its integrity through tillages, pastures, cutting of woods and fire.

For this reasons the soils of the Island are very different from one another and vary from the least to the most developed (Fierotti 1988).

From a general point of view most of the Sicilian soils are ascribing to the "azonal" order. The youngest soils with a not much developed profile or quite lacking have to be included in this order. The properties of these soils are remarkably influenced by morphologic factors and by the nature of parent rock (lithosols, regosols and alluvial soils).

Also representative of the Sicilian landscape, the "intrazonal" soils (rendzinas, calcic brown soils, red soils) present an highest degree of evolution though they are conditioned by water actions and salts presence.

"Zonal" soils and in particular vertisols, which develop under the preponderating influence of the climate, are also well represented.

Sicilian soils present nearly always clayey granulometry. They are poor of humus and scarcely provided with phosphorus and nitrogen. The reaction is generally sub alkaline but in some cases the pH amount reaches higher values in the case of soils in which sodium and magnesium salts contents are more substantial.

In the hilly environment, morphology have a particular incidence on soils development. Such action is particularly stressed in the case of the so-called "soils chain" of the hilly Sicilian inland. It consists in the making of different type of soils developed on the same substratum starting from different morphologic conditions along the hilly slope. The "soil chain" is typically constituted by regosols, brown soils, alluvial soils and/or vertisols.

Regosols, prevalently of clayey nature, develop on clays or marl clays. The clay rate is rather high (40-45 %) so that regosols often shows vertic characters. Their profile, also because of the intense erosion to which they are submitted, is of A-C type and the thickness varies from few cm to 30-40 cm. In this type of soil the reaction swing between sub alkalinity to alkalinity values and the fertilizing elements, with the exception of potassium are lacking as well as the organic matter.

Because of the extreme variability of the Sicilian hilly environment, regosols can also occur on different substrata. The evolution on loose substrata produce changes in their physical characteristics so that the texture varies from sandy to sandy-loam and the reaction is either neutral or in some cases sub acid.

Regosols, which evolve on gypsum of the gypsum-sulphuric phases, are quite different from the two above-mentioned types. Their greater limitation is due to the presence of soluble salts (mainly chloride and sulphates) that together with the high carbonate contents, remarkably raise the pH values. These soils, already lacking of fertilizing elements, undergo the negative influence of sodium that acting on the exchange complex produces an extremely unstable structure.

The second term that may be found on the sides of the Sicilian hill is constituted by brown soils, generally vertic, with Ap-B-C profile. The vertic character and the grey colour of these soils are exalted by the prevalent presence of montmorillonitic clay (Bellanca & al. 1980). The clay content generally varies between 30-40 % or more. The profile is constituted by a generally worked Ap horizon 40 cm deep and a little thick B profile not always well defined in which a limestone accumulation may often be found. From the fertility point of view the vertic brown soils have a lack of organic matter, nitrogen and assimilable phosphorous while they are provided with total phosphorous and rich in assimilable potassium.

The vertisols have a great importance within the Sicilian clayey soils. They present an A-C profile, their colour may be brown or black and they represent the third term of the "soil chain". Vertisols are mineral soils with a mesic, isomesic or hot temperature regime. The clay content as far as 50 cm or more of deepness, is the same or it's higher than 30 %. In the same period, in different years, vertisols present cracks opened on the surface at least 1 cm wide at 50 cm of deepness. At the same time the characteristic layer of self-mulching appears on the soil surface. Falling, with crop-tailings, into these cracks it contributes to making up a strong homogeneity along the vertisols' profile (Fierotti 1988). The vertisols structure is characterized by the presence of swelling clays and in particular of smectites. The reticulum swells and shrinks respectively corresponds to the alternation of rainy and dry periods. It is shown by the above-mentioned cracks and also by a specific structure in which slickensides make structural wedge-shaped aggregates. Gilgai micro-relieves are present in almost all vertisols; they develop because of the cracks and the soils swelling. The cracks which have formed during the dry season, combine with the moving particles of soils breaking off the surface. The expanding soil mass, unable to occupy the starting volume, pushes towards the upper part creating on the surface rises and depressed zones. Together with these little undulations, vertisols could be characterized by holes appearing where the soil surface is broken and successively sinking. Vertisols have subalkaline reaction (pH 7.5-8.0), high exchange capacity (35 m. e. %) and they always saturate in calcium ions. They often present a content of free carbonates. Water retention is always high and for these reasons they stay moist longer.

If the formation of the pedological types on hilly environment is strongly affected by morphology, on the higher relieves and in particular on the uneven slopes of Sicily, young soils appear at the first stage of development, strongly conditioned by the parent rock and the climate.

In some cases the pedological type is limited to the rock outcrop. Under this term all forms of rock outcropping are included. Rock outcrop is almost barren but sometimes some scarce value pastures and woods are present. We can frequently find together with rock outcrop, some soils at their very early stages of development and which evolved over limestone rocks on the Madonie and Iblei mountainous systems, on the Etna Mount vulcanites, on the Peloritani metamorphic rocks and sometimes also in hilly and flat environments (Fierotti 1988).

This type of soil, named lithosols, is characterized by hard rock very near the surface with A-R profile. The superficial horizon, barely differentiated, never exceed 10-15 cm in depth and is frequently stony. The influence of parent rocks remarkable; only lithosols evolving on vulcanite are provided with fertilizing elements particularly potassium and phosphorous. On the Caronie and Peloritani brown soils appear in association with lithosols while on the Madonie and Sicani lithosols are associated with brown and red soils.

Particularly on the Madonie and Peloritani mountainous systems, pedogenetic types, representing a developed intermediate stage between lithosols and well-developed soils, have been found. Therefore, interned in some limestone environments of the Madonie, the Sicani and the Syracusan plateau develop Protorendzinas, which represents the youthful stage of the more evolved rendzinas on limestone or on dolomitic rocks.

Protorendzinas, with A-C profile, differ from lithosols for their A horizon that is a little

more thick and has a mollic features. The upper horizon is soft with loam texture and clotted structure. The organic matter, partly transformed in humus, contributes to the soil's characteristic very dark brown and sometimes black colour.

Over the same substrata in which protorendzinas evolve, rendzinas are also represented. Rendzinas are more evolved soils in which the A horizon thickness can reach 50 cm. The texture varies from clay-loamy to loamy. Likewise protorendzinas, the rendzinas present a very dark brown characteristic colour because of their richness in organic matter. In these soils the reaction is more subalkaline than protorendzinas because of limestones content. In fact they are in large part concentrated at the base of A horizon in consequence of its partial re-precipitation.

The coarse fragments, generally absent in the first 10-15 cm, are abundant and sometimes very coarse lower down.

On the contrary, on the Peloritani metamorphic rocks, in association with lithosols and brown soils protoranker and ranker sometimes appear. These type of soils can't be easily characterized. They present a A-C profile in which the A horizon is not more than 40 cm thick and has a brown-dark colour due to the presence of moder acid humus. Along the profile, rich in coarse fragments just as rendzinas, the reaction is sub acid.

On the eastern sector of the Island and exactly on Etna Mount and near Lauro Mount (Iblei mountain chain) there are andic brown soils originated on volcanic substrata. They are brown soils and their profile is of A-B-C type. The A horizon, rich of humus, is characterized by the presence of allophane, an amorphous silicate of aluminium. In this soils allophane is strongly connected with the organic matter so that generally their colour is blackish. The andic brown soils have an high water retention and exchange capacity. The granulometry is variable as well as the reaction that generally is attested from sub acid to acid values.

Andic brown soils are associated with lithosols in the case of the vulcanite in the Iblei area of Lauro Mount (986 a. s. l.), around the Etna Mount and in some areas of eastern Sicily as well as in some islets like Pantelleria, Vulcano and Lipari. They are also associated with regosols and leached brown soils on the massif of the Etna (Averna 1954; Fierotti 1988).

Furthermore in south-eastern Sicily on the limestone plateau of Ragusa and Modica and near Siracusa, different type of brown soils have been found. These soils, for their particular morphologic conformation, their profile deepness (sometimes also 1 m) and the excellent characteristics of fertility, structure and texture, are the most well-structured soils of this type that we can find in the Island. The profile is A-B-C type with a brown dark A horizon, generally decarbonated, sometimes it is an Ap type with grumous structure and neutral or subalkaline reaction. In these soils the organic matter is present in fair quantity. The structure is good for the presence of calcium ions in the exchange complex. The fertilizing elements contents vary from average to scarce. The higher rainfall rate and the presence of limestone in the substratum, produce changes in the profile and particularly in the B horizon so that calcic brown soils appear. They are different from the first ones because of the presence of a calcic horizon (Bca), the subalkaline reaction and the presence of carbonates. Their clay content is around 25 % and they are also fairly provided with humus and fertilizing elements. The reaction is subalkaline and the colour is brown. These soils are also present on the Sicani and in other scattered areas of Sicily.

Mainly on the Peloritani and also on the other relieves of Sicily, in the areas characterized by precipitations higher than 800-900 mm, brown soils present an acid character due to the total absence of carbonates and to a deepness which sometimes is more than 60 cm. The A horizon, well provided with organic matter presents a grumous structure which becomes polyedric-sub angular in the B horizon. The fertilizing elements content is fair and the texture is loam or clayey-loam. Lower acidity values (sub acid reaction and exchange complex partially desaturated) are characteristic of the brown soils in the higher altitude of the Nebrodi and the southern Peloritani. When brown soils are subject to an higher rainy, on the main mountainous systems, they undergo an intense leaching. The profile characteristics are modified so that the texture is clayey and the reaction is sub acid or clearly acid because of exchange complex partially desaturated. The good structure of these soils is due to the fertilizing elements content. Their profile is of A-Bt-C type with a well-structured A horizon, rich in organic matter, and of a dark brown or black colour. The superficial rests on an argillic horizon clearly lighter in which the accumulation of illuvial clay is well distinguished.

On the plain we can mainly find red and alluvial soils. Red soils are typically represented on the calcarenitic platform of the western coastal belt but they may also be found, just oases, in the calcareous formations of the main mountain systems. The typical profile is of A-Bt-C type with the A horizon generally less developed and the Bt horizon with presence of illuvial clay.

However, in Sicily, finding integral profiles is very hard least because they are often cut off by the erosion or by the anthropic factors so that they are not much deep (40-50 cm). Texture is generally clayey in the mountain and clayey-sandy on the level areas.

Red soils have an insufficient content of organic matter, the reaction is neutral or sub alkaline and the fertilizing elements may be found in scarce quantity (Averna 1953, Petronici & Averna 1959).

Alluvial soils are present in all the major Island's plains but they are also represented in the inland in relation with the widening of some river beds. A considerable number of their characteristics, i.e. texture, level of weathering and evolution are strongly influenced by the mineralogical composition and by the size of the elements that constitute the same alluviums. Consequently texture can vary from highly permeable sandy to semi-permeable sandy-clayey to impermeable compact clayey (Fierotti 1988). When the texture is clayey it is usual for alluvial soils to have vertic features.

Generally alluvial soils are deep, well structured and with a variable organic matter content and an adequate total and active carbonate endowment. They are characterized by good permeability: sub alkaline reaction and insufficient nutrients. Certain areas are characterized by lacks in soil conditions due to the appearance of the saline phase or to the pronounced clayness of soil texture, that together with a poor drainage can cause a seasonal water table responsible for pseudogley phenomena. Alluvial soils present a very deep A-C profile with changeable physic and chemical characteristics.

Hydromorphic soils are also present in Sicily. They are typical of depressed areas sometimes below the sea level as in the Ispica swamps (district of Ragusa). Their profile is of A-C type, with a depth ranging from average to high and a texture coarse. Their features are strongly influenced by the oscillation of the water-table that in winter period can also reach the surface causing asphyxiation of the soil and reduction phenomena especially on

iron and manganese. For these reasons in the Hydromorphic soils a characteristic "pseudogley" horizon is evident.

At last another pedological type is represented by the dune lands represented by the marine and/or eolic sands that may prevalently be found on the southern coastal area of Sicily (Fierotti 1988). Dune lands don't exceed 50 meters of altitude and are strongly disturbed by the wind.

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