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Relationships between land degradation forms and historical development of malaria in Calabria (Southern Italy)

Introduction

The present paper deals with the correlation between the malaria diffusion in Calabria during the past centuries and the different forms of land degradation on slopes and alongside the river network. It also describes the regional distribution of land degradation processes within the altimetric limits in which environmental conditions are suitable for the development of Anopheles mosquitoes (0 to 500 m).

Calabria, the southernmost region of the Italian peninsula, has an area of about 15,000 km^2: more than 60% of its surface lies at an elevation greater than 500 m.a.s.l. A great deal of such territory, composed of weathered and tectonized rocks, is involved in active geodynamic processes.

Land degradation on slopes occurs mostly as mass movement and badland erosion: they both contribute to continuosly model the Earth's relief. Such processes are very common throughout the region, except on alluvial plains and flat areas at the top of major mountain ranges. In many cases, rock types cropping out in the hilly areas are both prone to instability and intensive erosion.

Small lakes and ephemeral ponds can form on the surface and flanks of landslide bodies, or as a result of river blockage, or, to a lesser extent, in the badland areas (Figure 1). These impoundments can be long lasting and be colonised by several forms of life such as reeds, sphagnum, frogs and, above all, mosquitoes.

Because of the short distance between mountain chains and sea, the size of many catchment basins ranges between 50 and 200 km^2. The drainage network is composed of short branches with steep mountain reaches and a wide terminal braided branch characterised by coarse debris (Figure 2). The fluvial regime of these rivers, called *fiumare* (Fairbridge, 1979), is tied to the Mediterranean climate of Calabria, characterized by hot dry summers and rainy winters. During the dry season the stream flow is mainly base flow, but occasionally, in autumn and winter

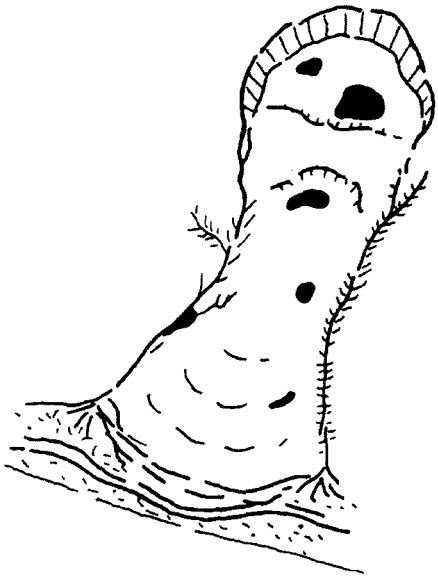

Figure 1 - Example of landslide (slide-flow type). In black the small lakes and ephemeral ponds that can form on the surface and flanks of the landslide body.

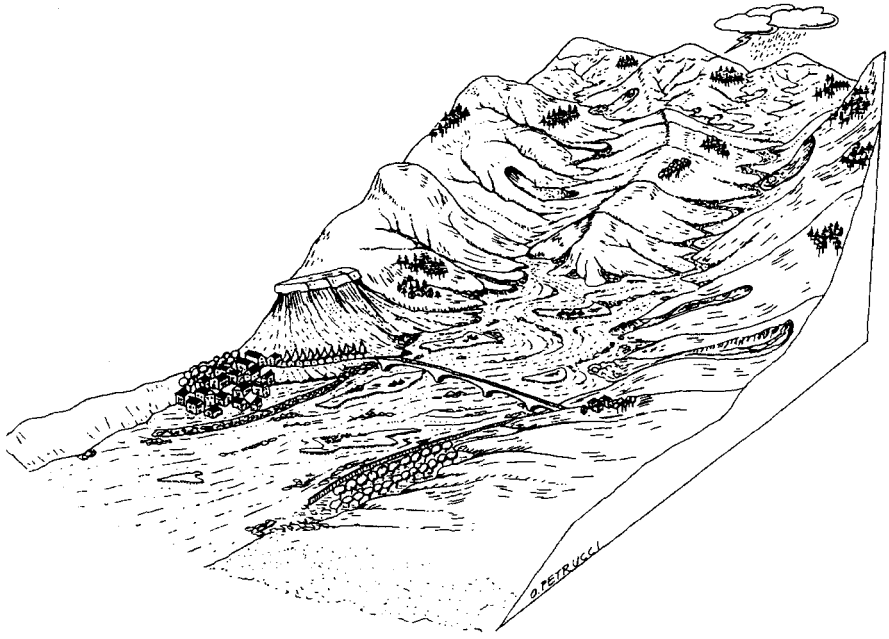

Figure 2 – Tipical features of fiumare basins.

disastrous floods can occur. The spreading of debris transported by water causes the greatest part of damage for settlements located on flood plains. After the flood peak, along the irregular braided channels, water can locally form swampy areas.

Historical notes on land reclamation in Calabria

At the end of the XIX century, physiographic setting of Calabria was very suitable to the formation of large swampy areas and malaria diffusion, due to the conformation of drainage network, as well as to the development of slope instability processes. Then, large areas of regional territory were not usable for urban or agricultural purposes and was very dangerous also travel across it.

In flood plain, at the end of flood season (from October to April), remained a superficial muddy layer that transformed all the depressions in potential swamps.

National and local administration began to realise that environmental problems of river plains were directly tied to slope instability of mountain basins. For these reasons Calabria has a long history of engineering works aimed at reducing both flood damages and swampy malarial areas alongside river plains.

During this century, two kinds of actions were performed in order to reclaim river plains and wipe out malaria:

a) the construction of continuous embankments along terminal reach of *fiumare*, undertaken before the Second World War in order to easily convey the stream flow to the sea;
b) a wide reforestation program started after the War and finished in the '70s, when work was suspended or locally limited to maintenance operations. In the '50s, within this program, many lands, dispossessed by local governments, were reforested and a great number of check-dams were built along main rivers and tributary valleys.

Reforestation, engineering works in the mountain basins, as well as check-dams and embankments along the river network, were all responsible for a slow modification of landscape. Nowadays, the main characteristics of *fiumare* are unchanged but the conditions suitable for the formation of swampy areas are very limited.

Historical research on swampy areas

The historical research on past distribution of swampy areas in Calabria has been performed in order to find out swamps caused by two kinds of processes:

a) Swampy areas tied to landslides or erosion processes

A zoning of the areas with moderate or severe landslide and badland incidence has been carried out on the basis of photo-interpretation. These landforms are usually due to processes active at present. A noteworthy exception is the southern part of the Gioia Tauro Plain, where in February 1783, a great number of landslides (never more mobilised since then) were triggered and 215 landslide-dammed lakes were generated (De Dolomieu, 1784; Vivenzio, 1788).

Alluvial fans and consequent river blockages can also be formed by debris-flows (a kind of landslide where "considerable amounts of loose material are suddenly moved by an excessive amount of water and transported through a valley" (Soeters et al., 1996). The alluvial fan near the village of Aiello Calabro is a typical example. There, the Civil Corps of Engineers reported an intensive debris-flows activity in 1863 tied to clear-cutting and landuse changes which both increased slope instability. The alluvial fan, fed by debris flows, dammed the Oliva river, creating a lake of about 6,6 ha (Figure 3). It is referred that during the summer such lake "become a pond whose exhalations killed the people". It is now clear that this *killer exhalation* was the malaria.

b) Swampy areas alongside the stream courses

This part of historical research has been performed analysing two kinds of documents:

1) topographic maps of different epochs, in order to find out local place-names tied to malaria. The oldest map we used is the *Atlante terrestre delle due Sicilie* (Rizzi Zannoni, 1788); after this we analysed the subsequent topographic maps published by IGMI (*Istituto Geografico Militare Italiano*) respectively in the period 1870-1875 and between 1957 and 1959.

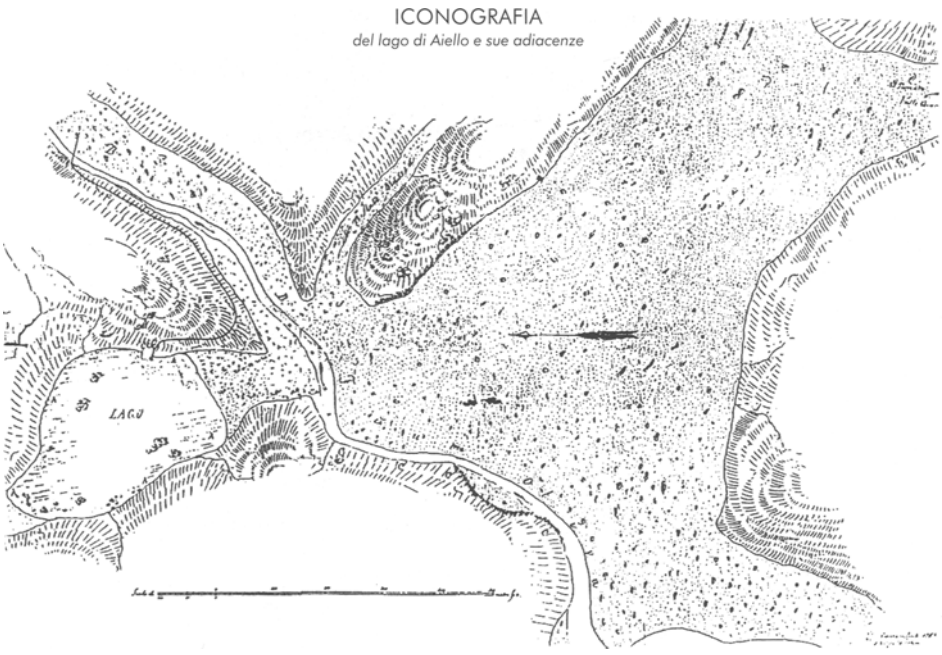

Figure 3 - Reproduction of the drawing enclosed in the document written by an engineer of Italian Civil Corps of Engineers, on 1863.

2) different kind of historical books, mainly popular literature and travel journal of old travellers who visited south Italy in the XVIII and XIX centuries.

A final map, representing the past distribution of swampy areas in Calabria has been prepared (Figure 4). Swampy areas have been classified followings their cause (mass movement, badland erosion and fluvial processes).

Figure 4 – Historical distribution of swampy areas in Calabria tied to landslide, erosion or fluvial processes.

Concluding remarks

The comparison between the map showing the distribution of swampy areas obtained as above said and the map of malaria prevalence (Figure 5) allows finding out a considerable similarity. This is more evident for some coastal areas along the Ionian and Tyrrhenian seas, and, inland, in the north-central part of the region. In these zones, slope instability phenomena and swamps along the river courses show a very high frequency (the latter until the Second World War).

Lakes and ephemeral ponds, that can form on the surface and flanks of the landslide bodies or as result of river blockages, together with swampy areas in the drainage network represent the zones where mosquitoes proliferate. From these zones the mosquitoes can rapidly spread over a long distance compared to the origin areas, and this can explain why malaria prevalence is more widespread than suitable physical conditions for its development.

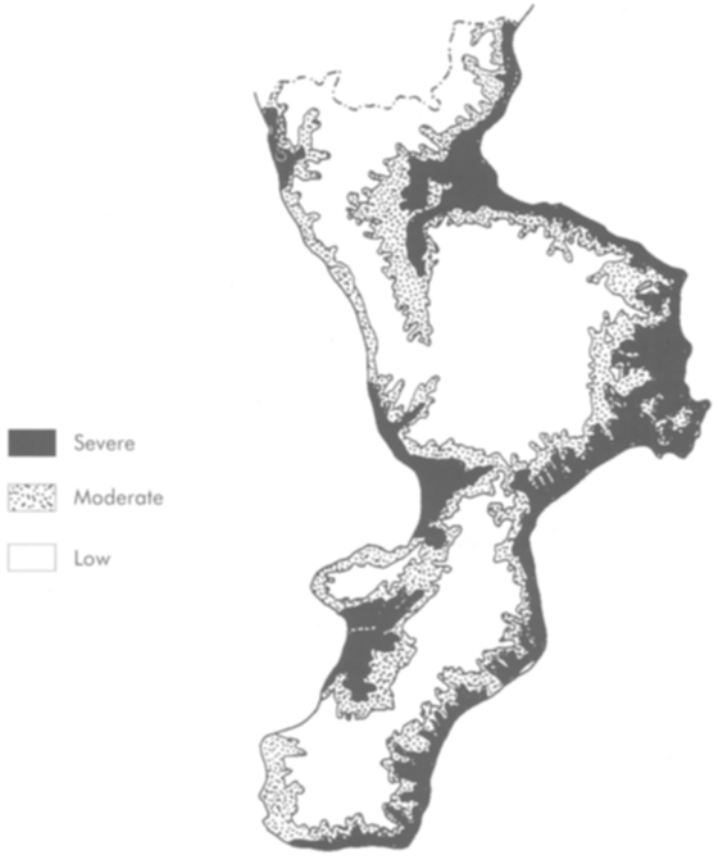

Figure 5 - Map of malaria prevalence in Calabria (fromTagarelli, 1997).

Last, but not least, mosquitoes are able to colonise even the smallest ponds, as it can be a horse footprint.

Luckily, the long-dry season is not favourable to the permanence of such small pods, thus distribution of wet zones, such as landslide bodies, and layer swamps, ultimately remain the most important causative factors of spreading of malaria.

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