CURRENT PERTURBATIONS OF THE NORTH PATAGONIAN CHILEAN FOREST DERIVED OF THE EFFECTS OF LARGE FOREST FIRES OCCURRED HALF A CENTURY AGO. PRELIMINARY STUDY IN THE ANDEAN BASIN OF THE FIGUEROA RIVER

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We present the case of an Andean basin located in the North Patagonian sector of the Aysen region whose main river (Figueroa River) rises near Lago Verde and flows into the Rosselot Lake (Figure 1).

The temperate or boreal Patagonian region owns peculiar physical characteristics. From a geomorphic viewpoint, it comprises the main Andean mountain chain and its western Subandean mountain ranges, which are the result of intense and prolonged glacial erosion. The materials and sediments generated in such glacial process were displaced by ice and water into low regions in different directions. Thus, it is frequent to find aprons formed at the base of slopes due to the fall or tumbling of loose fragments from high parts and alluvial cones. We can distinguish levels of alluvial terraces composed by strata of sand and pebbles with scarce or null slope and fluvioglacial deposits of short extension. A series of volcanic cones has replenished the near-by valleys through mud and lava flows and wind-blown sediments.

The region has a rainy and cold temperate climate, especially in its eastern region. Data from the nearest meteorological station point out an average annual rainfall of 1.348 mm, great part of which are of snowy nature during the winter season. Regarding temperatures, the maximum average temperature oscillates around 14 ºC in summer and the minimum average temperature is around 0 ºC in July —its annual average temperature ranges between 7 and 8 ºC. For comparison purposes, we include two ombrothermic diagrams corresponding to two near-by meteorological stations located at the east and south of the studied region (Figure 3).

Its soils have been originated from volcanic fly ashes, especially in the lowest regions. But they are not enriched enough due to the slow process of weathering of forest wastes gathering around calcined trunks entering into rot, and to the high quantity of rainfall. The culminant regions of the Andean mountain ranges of this boreal sector —which do not exceed 1.950 m. of height— are uncovered by forest vegetation, and soils are thin and are located on igneous, sedimentary, metamorphic and some intrusive rocks. In the lower regions, volcanic material was deposited on alluvial cones, moraines or alluvial or fluvioglacial plains.

I. METHODOLOGY

The bibliography we managed to look up is relatively exiguous, being scarce the studies of ecological and botanic nature. Regarding cartographic documents on relief and vegetal coverage, we turned to several works by Hueck (1969), UNESCO (1975), the Institute for Natural Resources (IREN, 1979), Quintanilla (1989) and Roig (1998), which include maps at different scales. As support material for photointerpretation we disposed of panchromatic aerial photographs at scale 1:60.000 and orthophotos at scale 1:20.000. The use of Landsat satellite images has also been very helpful, especially Thematic Mapper, with which we have used several band combinations (RGB 4-3-2/4-5-3) for its analysis. We attempted the application of a valuation methodology (Meaza, 2000), which turned out to be much limited by the deficit of knowledge base and the concrete atmospheric circumstances of the studied region.

Field work was carried out at the beginning of the spring season of 2007 (October) and made us move to the basin during 6 days. We surveyed census and five phytogeographic profiles of linear transects, also carrying out recognitions of sample plots. Due to adverse climatic conditions, it was not possible to carry out a more intensive and exhaustive field work. Likewise, we carried out 16 interviews, mainly to aged informants, in order to obtain direct testimonies of the ravages caused by forest fire and know the current degree of dependence of the population regarding forest exploitation.

II. DISCUSSION AND RESULTS

Census, profiles and sample forest plots

Census, profiles and sample plots were carried out in several forest sectors of the valley and slopes of the Figueroa River, in its high and medium course and 3.5 km. from the river mouth, located in the Rosselot Lake (Figures 4 and 5).

The covered sectors show important contrasts regarding the presence of dominant woody plants and the structure of the communities, which are mainly product of rainfall variations and lower oscillation of monthly temperatures. Towards the higher regions, the soil also influences vegetation typology. Such variation of ecological factors is somewhat more noticeable towards the east side of the valley, in an ecotonal situation regarding the neighbouring biogeographical province of the Patagonian steppe.

In the field, we carried out 5 linear transects of 30 m. of length and recognised 16 sample plots of 20 × 20 m. As a first approximation, we put forward in Table 1 the floristic structure

of those plant groupings more constantly detected in the basin of the Figueroa River, followed by a brief analysis of such forest and pre-forest communities.

In the low-medium course predominates the formation of evergreen *Nothofagus* (coigue), together with other trees of rain forest. Undergrowth is dense and noticeable forest stratification can be observed in spite of anthropic intervention. In the herbaceous stratum, the list of species is wide, standing out some species of high size. In places of held-back water (*mallines*) one can observe scattered and scarce remains of buds of *Pilgerodendron uviferum* (ciprés de las Guaitecas), a very much exploited conifer due to the excellent quality of its timber (Figure 6).

Towards the medium course, and also in the direction of the Figueroa River source, the composition of forest grouping presents certain changes. The structure is simpler and the dominant trees change, predominating deciduous *Nothofagus*, which is the case of *Nothofagus pumilio* (lenga) and *Nothofagus Antarctica* (ñirre); the latter species shows a marked tendency to appear in high parts of slopes, as well as in the eastern area neighbouring to the ecotone with the steppe, a sector in which it shows a smaller size.

In slopes and valley bottoms *N. pumilio* forms girdles of post-fire areas of young trees which are relatively dense in the borders of water courses and low hill slopes, while *N. antarctica* occupies less moist soils in mid-height mountains and even in abrupt slopes. This community is much altered by livestock in other sectors.

Disturbing agents for native-forest regeneration

Lamentably, human mark on the region has caused important ravages on its forest ecosystems, especially due to the extensive forest fires generated between 1928 and 1952 by pioneers and colonizers who settled with their livestock in these fiscal lands to have meadows at their disposal. In somewhat more than half a century forest fires have approximately devastated 3.500.000 forest hectares. Even when forests were only partially consumed, the structure and composition of its high stratum varied considerably.

In few years, diminution of nemoral density has lead to the increase of the activity of biotic agents, both in the periphery of the plant resource and in the inside of the soil. On the other hand, changes induced by forest fires entailed a slight increase of soil temperature, relative humidity, light, etc. and generated alterations of the affected flora and its associated fauna. Otherwise, we should not forget the impact on the loss of productivity of the forest mass. A good example of it can be found in the valley of the Figueroa River, where we could find large calcined trunks of *N. pumilio* —also affected by rot— originated by wounds located in the base shafts. Likewise, it is frequent to detect in spring-summer an intense activity of insects colonizing most of the wounds provoked by fire, which often contributes to a total loss of dead trunks regarding their possible use as firewood.

Another important agent in the alteration of native forest in this basin is forest exploitation for timber and firewood. Such activity is the most destructive and active agent, since energetic consumption of native trees is daily and lasts during the whole year (Figure 7). Trees are selectively cut down to provide firewood and satisfy other necessities of the rural or urban localities of the region, and especially those of the cities of Coyhaique and Aysen.

Mass-removal proceedings are quite common in the basin, obviously constituting another important, active and disturbing agent regarding its effect against forest regeneration, a phenomenon which is otherwise quite common in the whole Andean-Patagonian system. Slopes higher than 35 % are very vulnerable to landslides, dragging along forest groupings often constituted by young-tree groupings (Figure 8).

The opening, nine years ago, of a lateral road connecting the small locality of Lago Verde, located in the source of the studied basin, with the austral road connecting the south of the country down to the ice fields, provoked serious ravages on the rain forest. Subsequently, two and a half years ago, the electrical installation —which carries energy to the afore-mentioned locality— was implemented through this lateral road (33 km.) On a strip of 6 m. on each side of such road, the heavy machinery used destroyed the lush forest (Figure 9).

III. PROVISIONAL CONCLUSIONS

The forest ecosystems of the North Patagonian valley of the Figueroa River clearly show evidences common to the whole region: human settlement was carried out through forest fires; such forest, lamentably, still remain nowadays. This harmful technique was directed by colonization fiscal policies. Considering the need of inhabiting the territory of Aysen, a colonization act was passed in 1928 with the aim of reaffirming the sovereignty of Chile over certain areas disputed against Argentina after the arbitration award carried out by the English crown in 1902. Numerous Chileans living in Argentina were repatriated with their livestock, which impelled them to set fire to large extensions of lenga forests for livestock shepherding. The base of economic sustainability was extensive livestock in deforested soils. As in other Chilean regions, to take over a hundred of hectares, colonizers should “clean” it and, consequently, set fire to forests.

The ignorance of the capacities of the soils —mainly of forest and not livestock use— has generated irreversible erosion processes, which can be observed in the degraded landscape of the medium basin of the Figueroa River.