

FOREST FIRE RISK ASSESSMENT IN CIEGO DE AVILA, CUBA: THE ROLE OF ANTHROPIC AND METEOROLOGICAL FACTORS

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An accurate evaluation of forests fire risks was performed for the province of Ciego de Ávila, which is located in the central part of Cuba (Fig. 1). This province highlights because of socioeconomic activities like agriculture, but also for having an important natural protected area named “*Gran Humedal del Norte*”; one of the most important ecosystems in the country. A government authority’s instruction is to planning and preparing the country against natural disasters; hence, the aim of this study is to identify the risk of forest fire in each one of the ten municipalities of the province. To do it was implemented the methodological guidelines proposed by the Risk Assessment Group of the Ministry of Science, Technology and Environmental Sciences (CITMA). This methodology is based on the calculus of two variables: hazard and vulnerability, to finally obtain the risk. The hazard level is calculated based on the susceptibility and the frequency of forest fires. The frequency is obtained like the number of times a box (depends on the map scale) is affected by a fire, while the susceptibility depends on the type of vegetation, the slope of the terrain, a water stress index, the human factor and storms lightning. In the other hand, the total vulnerability is a function of the kind of factors exposed to forest fires. The following vulnerability classifications were considered in this



study: Structural (evaluates the degree of exposure of homes, facilities and technical networks); Non Structural (evaluates the degree of exposure of the vegetation cover according to the surface covered and the dangerousness of the combustible material); Functional (evaluates the preparation of

Fig. 1.- The province and municipalities of Ciego de Ávila, Cuba

the territory and the capacity of response of the professional firefighters and of other entities or organisms, in case of occurrence of fires in rural areas); Social (evaluates the exposed population and their perception about this disaster); Economic (evaluates the economic losses in the forestry sector, beekeeping, livestock, and the implementation of the disaster reduction budget) and Ecological (evaluates the protection and conservation of biodiversity in exposed areas).

The work was performed at seasonal scale, for the dry (November – April) and rainy season (May – October) along the period 2008 – 2014. This range of years was selected because of the major information regarding forest fires occurrence. The methodology here utilized considered the climatological water stress conditions and wind direction for every season. Taking into account that dry conditions and drought episodes may increase the occurrence of forest fires we also decided to utilize the Standardized Precipitation & Evapotranspiration Index (SPEI) to diagnose the state of the drought every month during the period of study. This index has the ability to diagnose at different temporal scales the water balance conditions but also considers the role of temperature through its influence on potential evapotranspiration. A precise analysis was also performed to investigate the direction and velocity of the predominant wind and the sea breeze regime; in order to support the mitigation plans.

To do this work was necessary to collect information about the goods exposed, the social, economic and ecological values of the territory such as forest heritage, elements of the agricultural sector, tourism, protected areas and especially the population. The Ranger Corps and the Sugar Group (AZCUBA) freely provided the records of forest fires. The geographic information systems ARGIS and MAPINFO were used effectively to apply the methodology and to finally obtain the forest fire susceptibility, hazard, and risk maps.

The results show a total of 418 forest fires. The 93% of them occurred from November to April with the greatest number in March. The SPEI at six months' temporal scale revealed the major influence of accumulated water balance deficit at seasonal scale on forest fire occurrence. In the rainy (dry) season the 52.6% (71.5%) of forest fires are registered between 12:00 m and 6:00 pm respectively. The 66% of the total forest fires occurred at less than 1 kilometer from the roads; a fact that suggests the importance of human activities (cigar butts, vehicle sparks, bonfires and coal ovens, etc.). The intentional due to negligence (32%); thunder and electric cables (23%) and because of the fire passes (27%). These three causes add up to 82%; other causes are less frequent. The predominant wind is from the northeast and east, however, in the rainy season, the 12% of cases are from the south during the afternoon. The breeze regime plays a key role; it is typically from the south and north directions in the south and northern coasts of the province. Both breezes tend to converge in the south-central region of the province and play a key role in the propagation of forest fires.

We obtained that 32.7% of the vegetation in the province is very dangerous to catch fire, 21.0% dangerous, 31.5% is not dangerous, and the rest little and very little. Areas without susceptibility and low susceptibility are observed during the rainy season in almost all the province; but several areas are with susceptibility and medium susceptibility

(e.g. Florencia, Cunagua) in the dry season. In fact, in the dry season, areas of medium hazard increase markedly and a small area of high hazard is detected to the south of Baraguá municipality. Finally, for the rainy season, it was obtained that the municipalities of Chambas, Morón, Bolivia and Primero de Enero have a medium risk, while in the rest the risk is low (Fig. 2). In the dry season, Ciego de Ávila, Baraguá and Primero de Enero are under medium risk and the risk of forest fire in Bolivia and Morón increased to high (Fig. 2). In both municipalities, (Morón and Bolivia) the type of vegetation and the water stress conditions played a key role in obtaining this result. Nevertheless, these results may be attenuated in the cays to the north of the province, which are often affected by the cold fronts during November – April. Considering multiple factors to assess the forest fire risks; in particular, the anthropic and meteorological factors at the same time strengthens the veracity of the exposed results, which are a tool for taking measures and decisions in order to prevent and mitigate the occurrence of forest fires and associated human and economic harms. We consider this approach can be widely and effectively used to assess the forest fire risks, but also considering more the own climate variability in each region.

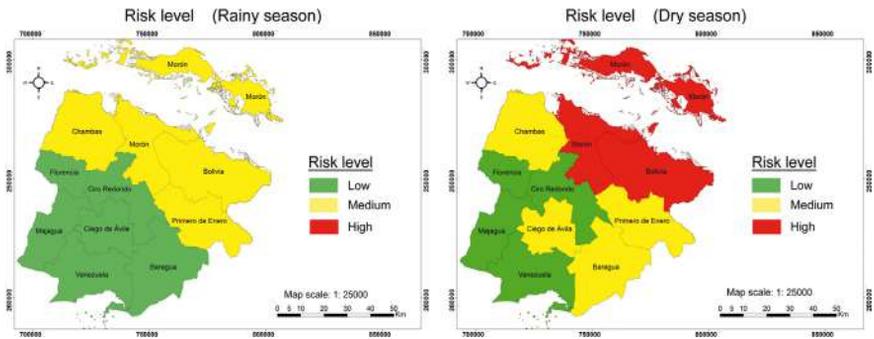


Fig. 2.- Risk of forest fires in the rainy (left) and dry (right) season.