FIRE RISK CARTOGRAPHY IN A SECTOR OF THE VENTANA CHAIN. A CASE OF TECHNOLOGICAL TRANSFERENCE TO THE ENVIRONMENT

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ABSTRACT

The fires that break out in seminatural areas often cause enormous damage to the natural resources and the scenery as well as to the various habitats of the animal and plant species living in those areas.

The aim of this work is to develop a methodology to draw maps of the areas with a potential fire risk, based on the implementation of a quantitative risk index wich combines and correlates the variables having a major influence on the ocurrence of these problems, such as human action, the fuel properties of the vegetation, and the slope.

The results provide a very useful tool for the authorities and regional bodies in charge of planning and prevention of natural disasters that may affect this kind of ecosystem.

INTRODUCTION

Although the problems considered in this work are not frequent, they may cause great, irreparable damage and enormous expense for the recovery of the affected areas. Such is the phenomenon of a fire in seminatural area. Two are the main causes . One of them is natural and is the consequence of lightning during a thunder storm. The other is human and has become the main cause of fire in places, grasslands and other environments.

From the above, it can be inferred that any kind of scenery consists of elements integrated in their morphology, which can be affected by fire. Consequently, the concept of risk is latent and it is possible to draw maps which allow us to prevent phenomena of this magnitude.

LOCATION OF THE AREA UNDER STUDY

Although the area under study is within the mountain scenery of the Ventania system, situated in the southwest of Buenos Aires Province, it lies in an area of about 13 km², corresponding to the town of Villa Ventana and the surrounding land.

Its geographic position spreads between 61° 53'and 62° 00' west of Greenwich and between 38° 04' and 38° 07' south latitude. The reduced extension is due to the fact that the sector is a pilot area on which the work will be done in an experimental way (figure 1).

METHODOLOGY

Hypothesis and objective of the work

The hypothesis of the work is the following:

The fast growth of Villa Ventana and its surroundings as a result of two natural features, i.e. its climate and its typical vegetation, which have made it a potentially significant tourist resort, has converted it in a fire risk area.

Once the hypothesis has been presented, the objective of the work is:

To design a fire risk cartography by using an index of quantitative risk.

The methodology of the work basically consist in the drawing of thematic cartography from the analysis and cartographic representation of the variables that contribute to the development and spreading of fires in natural areas. These have been classified according to their potential risk and then the most relevant ones have been selected in order to correlate them from the working-out of a quantitative risk index.

The chart from the Instituto Geográfico Militar to scale 1:50,000 was used as basic cartography, while the land use units, plant fuels and linear elements in the scenery, such as rivers, streams, main roads and secondary roads were defined from the interpretation of aerial photomosaics to scale 1: 20,000, which were supervised by field control on the spot (supervised classification).

The various thematic coverings were digitalized and equalized on a scale using a GIS.

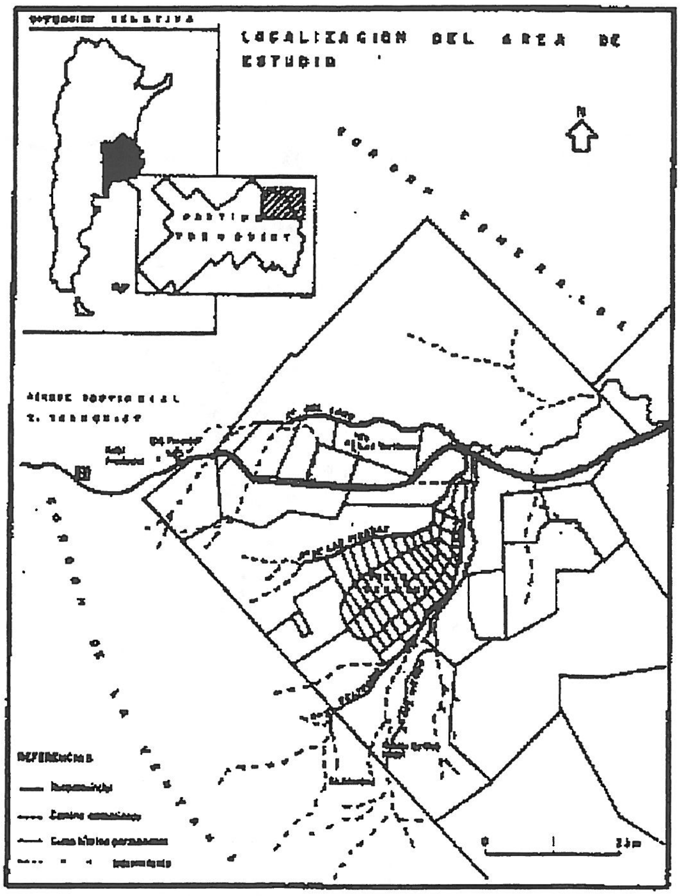


Figure 1. Study Area.

HISTORICAL ACCOUNT OF FIRE OCCURRENCES AND THEIR CONSEQUENCES

The occurrence of fires in the area is significant, mainly in springs and summer. The local fire brigade is called every day.

The following map showing the historical occurrence of fires was made from information given by the Villa Ventana and Sierra de la Ventana fire brigade. It shows the places where the most important fires broke out (figure 2).

RESULTS AND DISCUSSION

Interacting factors in the process of a fire

For a fire to break out there must be a series of interacting natural factors linked to climatic and topographic conditions, which define the environmental features and influence the fuel properties of the vegetation.

Another fundamental factor which is interrelated and contributes directly with the others is human behaviour. This is the main starter of the process.

From the numerous contributing factors, three have been selected: human intervention, slope, and fuel properties of the vegetation. These factors have been chosen because on the one hand, they have been decisive in the fires that occurred in the past, and on the other hand, reliable data are available.

Another important aspect is the climate. However, as the climatic data available so far correspond to the Sierra de la Ventana weather station (about 17 km. from the area under study), and they are useless for this work, the climatic aspect has not been considered.

Drawing the fire risk cartography for thr area under study

The cartography arises from the application of a risk index. This consists of the variables mentioned above, which in turn are quantified as a function of the risk of each of them.

A) Human Intervention: The values given to each element are obtained by the frequency of break out and spreading of fires in such places (Table 1).

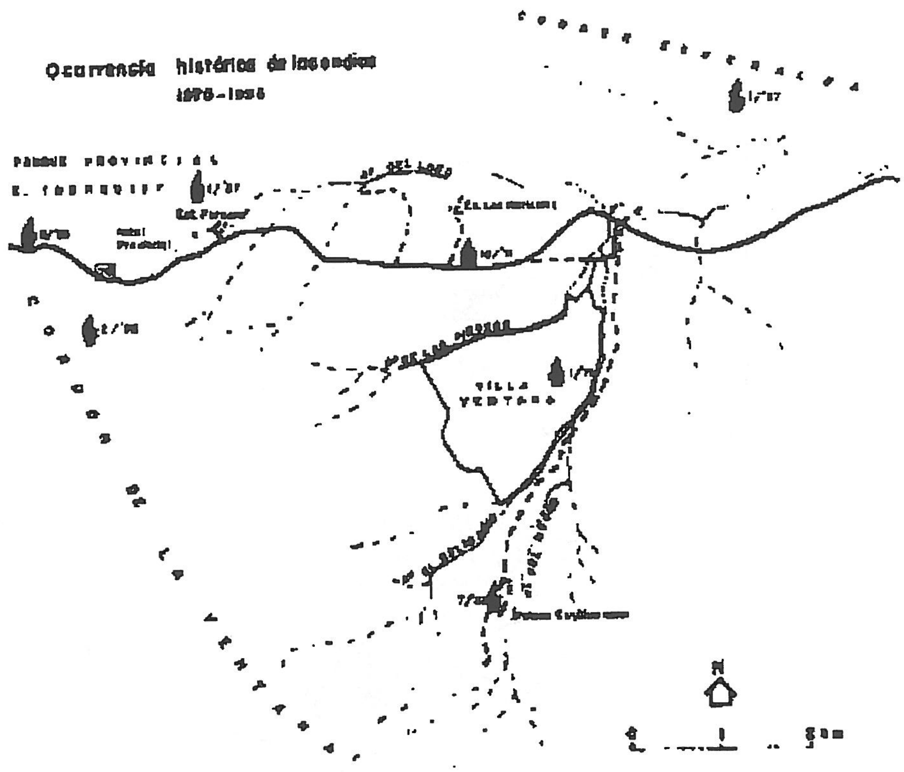


Figure 2.

Elements	Risk	Percentage
Roads and surrounding areas	**Very high**	**43.3**
Recreational	**High**	**26.2**
Isolated sectors	**Medium**	**17.4**
Secondary roads	**Low**	**13**

Table 1. Human Intervention.

B) Vegetation: The classification is obtained from the flammability of its components and the occurrence of fires affecting each plant group. The values for each class are defined according to the following ratio:

% fires/leaf index

The term fuel means everything that can burn, i.e. matter whose combustion produces calorific energy (Castro Ríos 1994).

For the case under study we trated as fuel the individual plants placed in rural and natural (pristine) spaces liable to ignition and flammability.

To determine this, it is basic to draw maps of the areas occupied by the different plant groups and estimate their area as a ratio of the total area under study. Whit that purpose, the leaf index, considered as a measure of plant cover, became useful. As there is a great variety and abundance of natural and exotic herbs in the region, they were put together in six categories so that they could be charted (figure 3).

The definition of the plant fuels categories was achieved through an adaptation of the classification proposed by Anderson to the area under study (Anderson,1992) (Table 2).

CATEGORIES	LEAF INDEX	% OF FIRES
I- Tall grass and scrub	**3%**	**31.57**
II- Low grass and scrub	**35%**	**21.05**
III- Scrub and bushes	**5%**	**5.26**
IV- Low bushes and herbs	**25%**	**15.78**
V- Trees and grass	**10%**	**16.02**
VI- Crops	**19%**	**10.52**

Table 2. Plant fuels categories. Adaptation of the Anderson Classification.

In order to include the categories in the risk index it is necessary to create new categories in a scale from 1 to 4 where:

4————————————————very high risk
3————————————————high risk
2————————————————medium risk
1————————————————low risk

This way the categories can be grouped as a function of their risk an assessment (Table 3).

CATEGORIES	RISK	ASSESSMENT
I	Very high	4
III and V	Medium	2
II,IV and VI	Low	1

Table 3.

FUEL PROPERTIES OF THE VEGETATION. VILLA VENTANA 1995

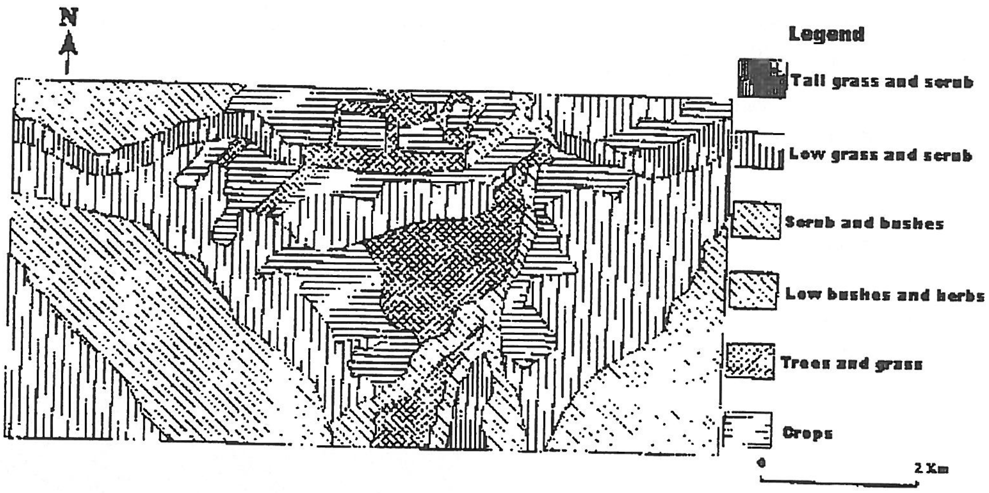


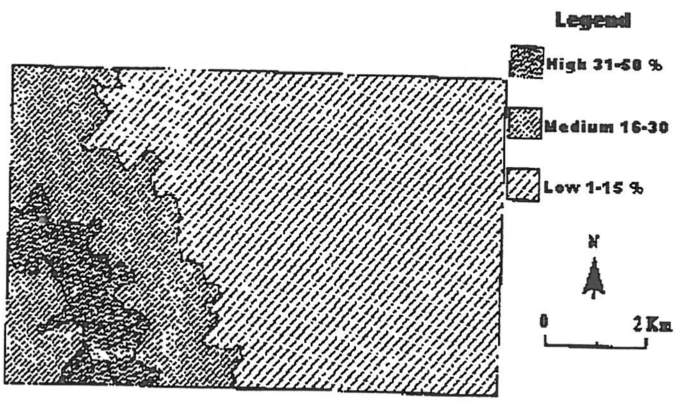
Figure 3.

C) Slopes: The slope was divided into four risk categories following the criteria of other authors (Chuvieco et al,1993) (Table 4), (figure 4).

SLOPE %	RISK	RANGE
+ 50	Very high	4
31 to 50	High	3
16 to 30	Medium	2
0 to 15	Low	1

Table 4.

SLOPE AREAS. VILLA VENTANA 1995



By adapting the risk index designed by E. Chuvieco in 1993 to the sector under study we obtained the following equation:

$$Ir = 4 \times H + 3 \times V + 2 \times P$$

Where:

H = Human intervention
V = Plant fuel
P = Slope

For practicality it is necessary to define potential fire risk areas on which the index will be applied to determine their actual risk.

This zoning arises from the relationship between the land uses and covers and the linear elements of the scenery. The latter generally have a close relationship with the break out of fires. This way ten sectors of potential fire risk are differentiated (figure 5).

A_ Recreational near a road (RnR)
B_ Crops next to road (CnR)
C_ Natural related to road (NrR)
D_ Crops next to secondary roads (CnSR)
E_ Populated and recreational (P&R)
F_ Crops near recreational areas (CnR)
G_ Natural isolated (NI)

H_ Recreational near secondary roads (RnSR)
I_ Natural near recreational use (NnR)
J_ Natural distant (ND)

The risk index is applied to each of these areas considering the slope, the plants fuel properties and human intervention for each of them. It will be noticed that some areas present more than one kind of slope, more than one category of plant fuel, or more than one element associated to human intervention. For example, there are two areas crossed by the main road and at the same time they have a recreational use; others show two or more kinds of plant fuels, etc.

In order to simplify the application of the risk index (Ir) for each potential risk area, we have determined all the plant fuels it contains, all the kinds of slopes it presents and all the elements linked to human intervention it possesses. After defining these for each sector, the average value was obtained for each variable under consideration and then the index (Ir) was applied.

Considering a maximum Ir equal to 158 and minimum Ir equal to 57, we can define 4 kinds of risk.

Very high.........................158 to 133
High................................132 to 108
Medium............................107 to 83
Low....................................82 to 57

The Ir for each potential risk sector is the following:

A = 152.2
B = 122.8
C = 86.4
D = 77.6
E = 87.4
F = 120.8
G = 68.3
H = 84.4
I = 86.4
J = 74.6

From the analysis of variables and the results of the risk index the following thematic map has been drawn with the various land covers and the corresponding fire risk (Figure 6).

CONCLUSIONS

On the map it can be noticed that the greatest risk is in a sector dominated by the Parque Provincial E. Tornquist, which is the centre of attraction for numerous tourist who go camping or make excursions in the area. Then the crops next to the road present a lower risk, as they have been generally affected by fires started by travellers who go along the area. The tourist-recreational village of Villa Ventana presents a lower risk because there is greater control in the place and it also has a fire brigade. Finally, the lowest risk is perceived in the agriecosystem located farther from the roads and tourist-recreational centres.

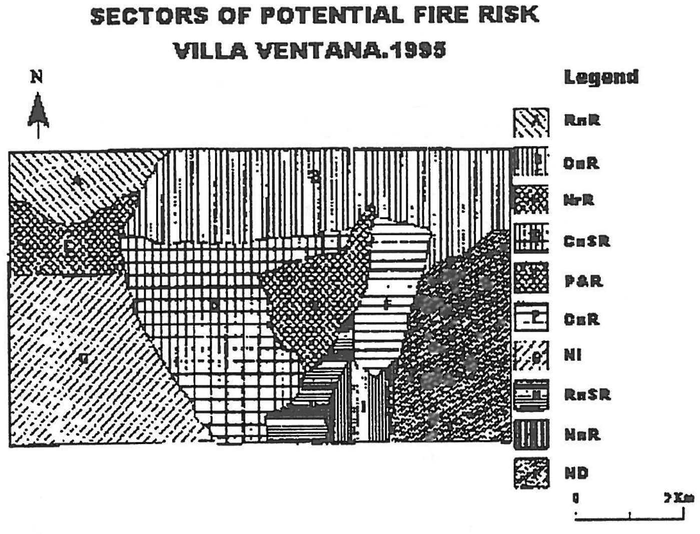


Figure 5

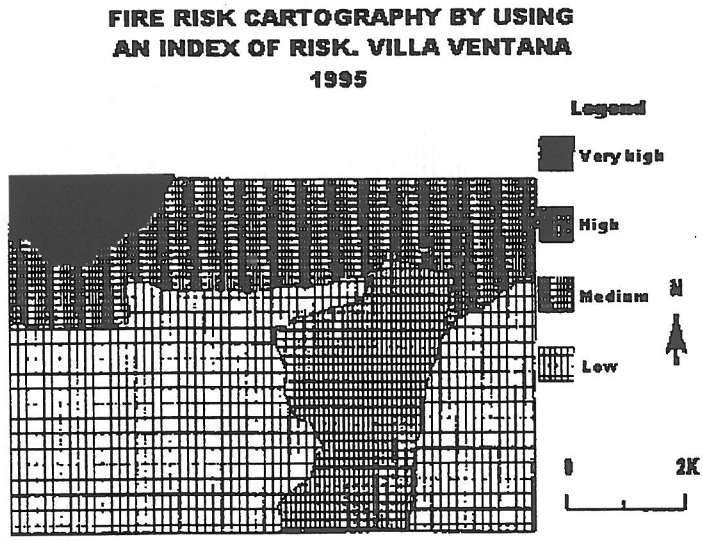


Figure 6

It can be seen that the results obtained from the application of the risk index are highly positive, as the areas of greatest risk are precisely those where most fires have broken out.

The importance and frecuency of fires in the area under study shows that it is necessary to prevent this kind of accidents to avoid the loss of natural resources.

The development of appropriate management of the vegetation, the design of awareness compaigns for the population and the implementation of preventive management, like controlled fires, are some of the proposals which may contribute to reduce the occurrence of this phenomenon.

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