Climatology, Car Accidents and Road Security
Case Study: IP4 (Portugal)

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Introduction

The regional atmospheric dynamics, assumes a fundamental importance in planning because the success of the spatial human occupation reflects the opportunities and constraints of each place..

This study considers the climate and weather influence over the structures designed for the terrestrial mobility, namely roads.

Objectives

Our main purpose is to understand the threats caused by adverse meteorological situations over road mobility and road safety. We want to evaluate how and in which way the different weather types play a role with the specificities of the road to affect the drivers security.

Parameters Affecting the Road Security

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- At a Regional Level by Meteorological Factors
  - Solar Radiation
  - Terrestrial Radiation
  - Air Temperature
  - Nebulosity
  - Wind Speed and Direction
  - Humidity
  - Precipitation
- At a Local Level by the Geographical Specificities
  - Latitude
  - Altitude
  - Topography
  - Screening
  - Sky-View Factor
  - Land Use
  - Traffic Volume and Construction

- the risk of accident increases from 50% up to 100% during rainfall;
- exists a strait parallelism between the precipitation intensity and the risk of collision;
- the risk of accident seems to be higher during the first annual rains or snowfalls;
- the snowfall as a bigger impact than the rain in the occurrence of road accidents, although they tend to be less serious for the reason that the velocities are usually more moderated in this circumstances;
- the higher risk of collision during precipitation is due to the lost of visibility, as after the occurrence of rain the number of accidents decreases despite the pavement still is wet (except in the case of snow or ice);
- strong winds (that can drag snow, sand and other debris) and fog increase exponentially the risk of accident.

Methodology

1) Direct Acquisition of Data:

- Registration, *in situ*, of the temperature (Celsius) and the relative humidity (percentage) values with five seconds interval using the Thermohygrometer Digital Delta OHM-HD-8501.

Measurements realized on 17th May 2008 at 8h30m, 16h18m and 20h15m.

2) Adopted Model to the Treatment of Data:

- Definition of measurement points, 1204 in total (catalogued with 65 meters equidistance).
- Statistical analysis using "Non-Parametric One-Sample Kolmogorov-Smirnov Test", using the "SPSS 15.0" statistical software.
- Information and results processed and presented in graphics and in maps created in the ESRI "ArcGIS 9.2" software.

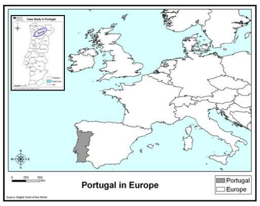
Bivariate Correlations with Spearman Correlation Coefficient for Altimetrical Variability

		1st Measurement	2nd Measurement	3rd Measurement
Air Temperature	Flat	-0,087	-0,037	0,008
	North	-0,069	0,1	-0,013
	East	0,088	0,16	-0,097
	South	0,026	-0,001	-0,04
	West	-0,055	0,043	-0,03
	Slope	-0,293	-0,39	0,358

Bivariate Correlations with Spearman Correlation Coefficient for Altimetrical Variability

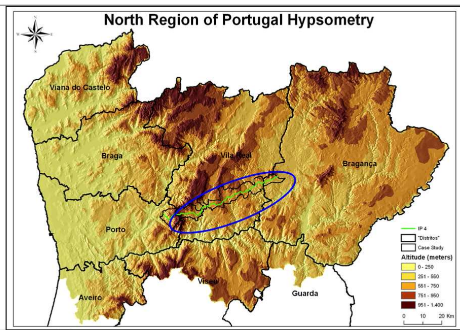
		1st Measurement	2nd Measurement	3rd Measurement
Relative Humidity	Flat	0,11	0,009	-
	North	-0,45	0,12	-
	East	0,01	-0,66	-
	South	-0,07	0,038	-
	West	0,06	0,023	-
	Slope	0,276	0,055	-
	Altimetry	0,252	-0,287	-

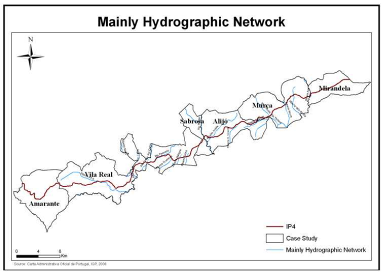
Case Study Area

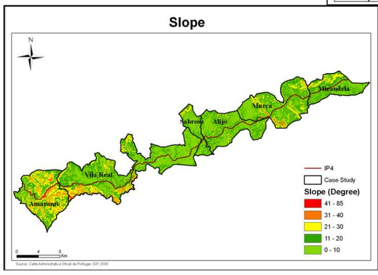


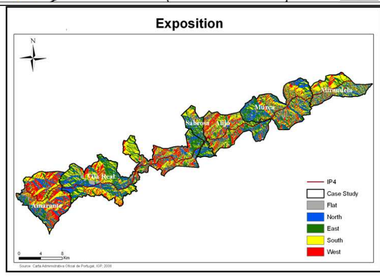
The "Itinerário Principal 4" (IP4) is an important Portuguese road concluded in 1993, connecting the *distritos* of Porto, Vila Real and Bragança.

Since than it accumulated W road accidents with X deaths and Y injuries



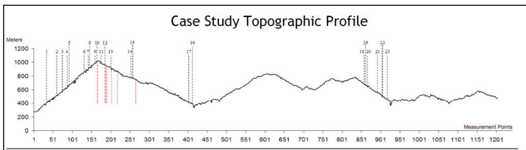


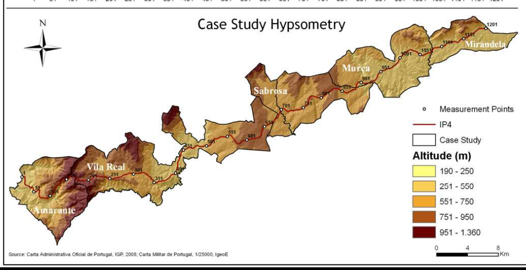




Results

1)





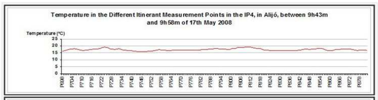
Signalization Existent in the IP4 Case Study Area

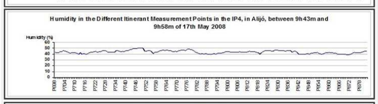
1	2,2km	Fog and Wind
2	3,9 Km	Lateral Wind
3	4,9 Km	Lateral Wind and Fog Zone in the Next 12 Km
4	5,7 Km	Rockfall Risk
5	6 Km	Lateral Wind
6	8,5 Km	Lateral Wind
7	9,1 Km	Lateral Wind
8	9,5 Km	Lateral Wind Zone in the Next 2,2 Km
9	10,4 Km	6% Slope in the Next 500 m
10	10,7 Km	6% Slope in the Next 4000 m
11	11,4 Km	Slippery Pavement
12	12 Km	Accident Zone and Slippery Pavement in the Next 4 Km
13	13 Km	6% Slope in the Next 12,3 Km
14	16,4 Km	6% Slope
15	16,7 Km	Accident Zone in the Next 1 Km
16	26,2 Km	6% Slope
17	26,9 Km	Rockfall Risk
18	55,7 Km	6% Slope
19	55,9 Km	Keep the Vehicle in a Low Gear
20	56,3 Km	6% Slope in the Next 17,39 Km
21	58 Km	6% Slope
22	58,8 Km	6% Slope
23	59,6 Km	6% Slope

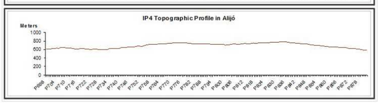
Note – Counting realized from Aboadela

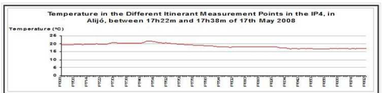
[redacted]

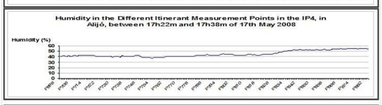
2)

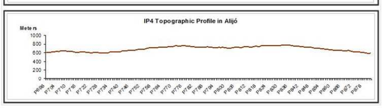


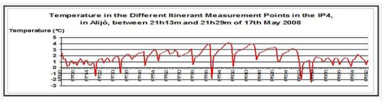




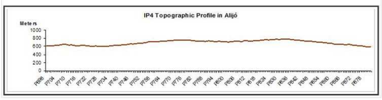






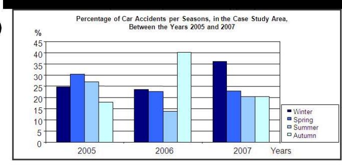


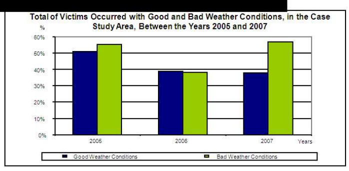
Humidity values superior to 100%

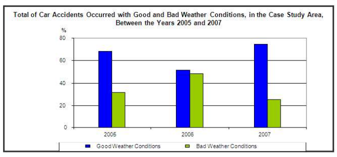


Remarkable parallelism between the altimetrical variation and the temperature and relative humidity differences. In general, as the altitude rises, the temperature is lower and relative humidity increase..

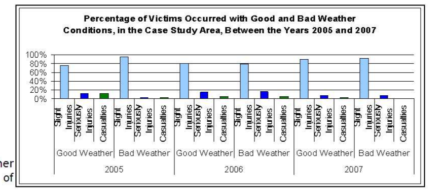
3)







Souce: *Guarda Nacional Republicana*



Despite the occurrence of more accidents during good weather conditions, the percentage of injuries and deads resultant of vehicle accidents is higher in adverse weather situations.

However, good weather conditions are more frequent than adverse climatological situations.

In the year 2005 was during Spring that occurred more collisions, in the year 2006 the Autumn was the principal season for vehicle crashes and in 2007 the season when happened more car accidents was the Winter.

The percentage of injuries and deads as result of accidents is higher in adverse weather situations.

Conclusions

- The knowledge of the climatic characteristics of each region is fundamental to an efficient and sustainable spatial organization i.e. road design and routing...
- Doesn't exist a unique season whith more car accidents. However the foggy, the frost and the rainfall conditions coincide with more injuries in car accidents.
- During the analysed years the largest number of car accidents happened in good weather conditions which correspond to the majority of the days in our area.
- The road studied presents some construction deficiencies that promote an accumulation of vulnerabity factors (slope, shade ou bad solar exposition, and altitude) that contribute to a high number of severe accidents

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