Examiner’s commentary

This is an excellent essay that includes a strong spatial element and determines patterns and trends over a specific location; such approach often achieves good results in the subject as it enhances geographical analysis. The research is appropriate in scale – a small province with strong internal contrasts – because sufficient sources and data are used to answer the question and they represent 100% coverage of the area. There is an abstract (not mandatory under the current specification) that outlines the key features of the research and an introduction that communicates the topic and the academic context in greater detail. There are references to existing literature about the region under study and links to current knowledge about the topic (rural decline, wildfires). The area is introduced through a detailed locational context that thoroughly accounts for the physical and human factors that may affect the magnitude and number of wildfires in a region that should not naturally be prone to them. The main sources of information consist of a compilation of secondary data that are treated in the form of indices (index of rurality, flammability), graphs and choropleth maps. The sample size is strongly reliable as it represents 100% of the population studied and it comes from the official sources available. The communication of the methodology is excellent, it refers to other similar studies and the research process could possibly be repeated by others. The analysis incorporates strong spatial emphasis, and the data is represented on maps and graphs made by the student allowing them to determine trends and patterns in the spread of wildfires. The factors affecting the presence and magnitude of wildfires are scrutinized and the findings are supported by data, maps and graphs, plus secondary information. The conclusion gives an account of the results and clearly reflects the findings.

Does a relation exist between rural decline and the increasing magnitude of wildfires in Asturias, Spain?

[redacted]

Source: El Pais, "Dos detenidos y 12 imputados por la oleada de incendios de Asturias", 26 Feb 2016.

International Baccalaureate Diploma

Extended Essay

Geography

Word Count: 3739

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ABSTRACT

This essay sets out to find a relation between rural decline and the increasing magnitude of wildfires in Asturias. After defining the concept of "rural decline" and starting from the hypothesis that rural decline has a direct relation with the increasing magnitude of wildfires, it has been investigated whether rural decline in a region can directly affect the number and magnitude of wildfires, isolating as many variables as possible to verify this hypothesis.

This investigation has been carried out with the use of secondary data, from official Spanish statistical institutions such as INE (Instituto Nacional de Estadistica) or SADEI (Sociedad Asturiana de Estudios Economicos e Industriales). This has been done with the aim of finding precise data for every municipality, to be capable of simplifying down to the area of study concerning this essay, being rural areas with decline. From the same sources, wildfire data were acquired.

The conclusions obtained in this study sustain the hypothesis: Municipalities with rural decline suffer a lesser number of wildfires, yet their magnitude increase, burning a larger extension of surface.

I infer this increase in magnitude of wildfires can be due to the rarer presence of rural activity, meaning there are less preventive rural activities and less vigilance. This very same fact would explain the decrease in the number of wildfires, as many traditional rural activities that use fire as a management tool being progressively abandoned in rural areas in decline.

INTRODUCTION

Wildfires burn wide sections of land, from grasslands to forested areas, and many times affecting populated zones. These natural disasters can be terribly complicated to control and neutralize. Despite this, wildfires are a vital component of the cycle of certain ecosystems, such as the Mediterranean, where after wildfires occur the nutrients in the soil increase.[1] This ecosystem is an example of ecosystems using wildfires for their regeneration.

Wildfires are increasingly important issues nations and conservationists attempt to tackle. They have a massive ecological impact, affecting biodiversity, diminishing soil water holding capacity and favoring erosive processes. They also have a considerable effect on people and settlements, affecting local economy and putting human lives at risk. Virulent wildfires can affect hectares of rural and agricultural areas. For example, in the summer of 2018, Greece suffered from the Attica wildfires, which affected large sections of populated zones, with more than 1000 structures affected and summing up a death toll of approximately 90 casualties.[2]

It is widely accepted that the majority of causes of wildfires are human. Whether voluntary or not, the most usual human causes for wildfires include unattended campfires, burning of debris and agrarian activities such as burning of pastures and agricultural debris. At times wildfires are the cause of arson, which is the deliberate act of burning land to later receive

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[1] "Effects of Wildfire on Soil Nutrients in Mediterranean Ecosystems." *NeuroImage*, Academic Press, 16 Sept. 2014, www.sciencedirect.com/science/article/pii/S0012825214001585.
[2] CBS/AP. "Death Toll Rises to 91 in Deadly Greece Wildfire." *CBS News*, CBS Interactive, 29 July 2018, www.cbsnews.com/news/death-toll-rises-deadly-greece-wildfires-today-2018-07-29/.

compensation.[3] This crime is persecuted and punished in practically all MEDCs, with jail time and with fines of over $50.000.

However, there are plenty of traditional rural activities that in fact contribute to reducing the amount of wildfire-fuel, thus lowering the probability of ignition. Activities such as these include logging[4], forest cleaning, and grazing by local livestock, such as sheep or goats. The ongoing presence of locals and their activities also mean the swift detection of fire outbreaks and their rapid extinction. These traditional methods have been crucial to preventing and neutralizing wildfires for centuries.

These traditional processes of prevention are altered by rural depopulation, being the consequence of increasing rates of urban concentration. The term 'depopulation' is understood as the reduction of inhabitants in a nucleus of population in a defined time period.[5] As of today 55% of the world's population lives in urban areas, and the UN claims that a projected 68% will reside within urban nuclei by 2050.[6]

In the whole Iberian peninsula there are 1,300 municipalities with less than 100 inhabitants registered and, according to the Spanish National Institute of Statistics (INE), in 2016 there

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[3] "Causes, Effects and Solutions to Wildfires." *Conserve Energy Future*, 25 Dec. 2016, www.conserve-energy-future.com/causes-effects-and-solutions-of-wildfires.php.

[4] Logging is the process of cutting down trees and vegetation either to collect timber or to reduce fire-fuel. "Logging." *Dictionary.com*, Dictionary.com, https://www.dictionary.com/browse/logging

[5] "1.2. La despoblación ruraL en España: génesis y características" *INFORME EL MEDIO RURAL Y SU VERTEBRACIÓN SOCIAL Y TERRITORIAL 01/2018,* Consejo Economico y Social España, 24 Jan. 2018.

[6] "68% Of the World Population Projected to Live in Urban Areas by 2050, Says UN | UN DESA Department of Economic and Social Affairs." *United Nations*, United Nations, www.un.org/development/desa/en/news/population/2018-revision-of-world-urbanization-prospects.html.

were 3225 nuclei of population that were completely uninhabited.[7] Galicia and Asturias are the regions with most abandoned locations on record, summing 71% of the total figure. Spain's ageing population also affects this issue, as this increases the dependency ratio of the population. This causes a decrease in productive population in rural areas, meaning traditional activities and processes which once helped prevent the outbreak of wildfires slowly fade away, until they are eventually lost.

Like every Mediterranean country, Spain is incredibly prone to wildfires. In 2018 alone, 200.000 hectares of land were burnt in wildfires – 125.000 more than in 2017 . Moreover, wildfires are increasing in their magnitude; while in the period between 1970-1979 the average surface burnt per wildfire amounted to 1,81 hectares, that figure increased to 1,96 in the period between 1990-1999.

Despite having been widely studied, rural decline has yet to been given a holistic definition. Following the work of Drudy and Wallace (1972) [8], in the framework of this study rural decline will be considered as the process characterized by progressive and persistent population loss due to emigration and ageing of population, resulting in the reduction of economic activity and in a decreasing in the provision of services essential for wellbeing.

[7] "1.2. La despoblación ruraL en España: génesis y características" *INFORME EL MEDIO RURAL Y SU VERTEBRACIÓN SOCIAL Y TERRITORIAL 01/2018,* Consejo Economico y Social España, 24 Jan. 2018.
[8] Drudy, P.J, Wallace, D.B "The Causes and Consequences of Rural Depopulation: Case Studies of Declining Communities." *ERIC - Education Resources Information Center*, 31 July 1972, eric.ed.gov/?id=ED066250.

There is currently an on-going debate in Spain **whether rural decline has a relation with the increasing magnitude of wildfires.** However, not many investigations on this relation have been done. By selecting a region in Spain that should not be specially prone to wildfires due to its natural conditions, this Extended Essay is focused on assessing the hypothesis that **rural decline has a relation with the increasing magnitudes of wildfires in Asturias.**

AREA OF STUDY

Asturias is a region of northern Spain, facing the Atlantic Ocean, characterized by its oceanic mild climate despite its proximity to Mediterranean zones. Asturias is neighboured by other northern Spanish autonomous communities such as Galicia to the west (1), Castilla-Leon to the south (2), and Cantabria to the east (3).

Figure 1 Map of Spain. Asturias highlighted in red

Map obtained from comersis.com, edited with Adobe Photoshop CC 2015.

Asturias has an extension of 10,600km2 and a population of 1.034 million inhabitants, of which approximately 200,000 reside within Oviedo, the capital of the region[9].

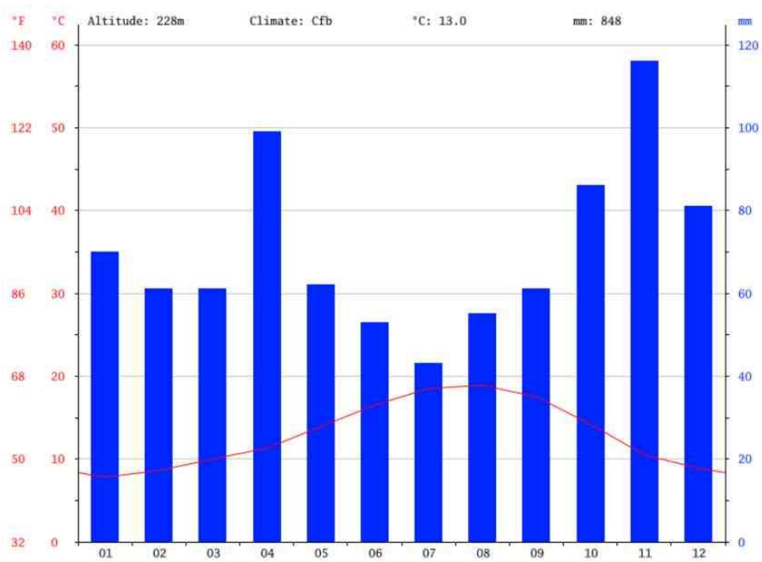
According to the Köppen classification[10], Asturias has a Cfb–Oceanic climate with a slight influence from Csb warm-summer Mediterranean climate[11].

[9] "SADEI - Sociedad Asturiana De Estudios Económicos e Industriales / Información Estadística / Índice Temático." */ Información Estadística / Índice Temático*, www.sadei.es/es/portal.do?IDM=22&NM=1

[10] "Arnfield, A. John. "Köppen Climate Classification." *Encyclopædia Britannica*, Encyclopædia Britannica, Inc., 28 Dec. 2017, www.britannica.com/science/Koppen-climate-classification.

Asturias is characterized by warm summers and cool winters, with its warmest month reaching 24°C and its coldest 5°C. Annual precipitation in Asturias is relatively high, reaching 1000mm per year. Maximum precipitation occurs in April with a secondary maximum in November. Minimum precipitation occurs in June and July although rainfall is evenly spaced out throughout the year.

Figure 2 Climograph of Oviedo, Asturias (Spain)



Source: Climate-Data.org

As can be observed from this Climograph of Oviedo the average precipitation is always higher than the average temperature, meaning there is no strong evotranspiration[12]. This

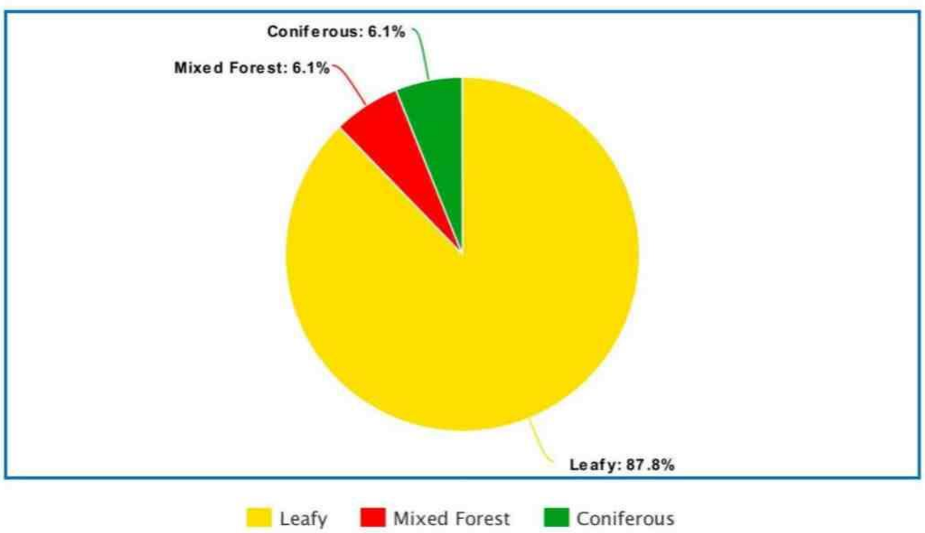
[11] "Climate-Data.org." *Climate Asturias: Temperature, Climograph, Climate Table for Asturias - Climate-Data.org*, 9 Aug. 2015, https://en.climate-data.org/region/255/

[12] Briney, Amanda. "Evapotranspiration Overview - Geography." *ThoughtCo*, ThoughtCo, https://www.thoughtco.com/evapotranspiration-1434432

guarantees a constant presence of humidity in the ecosystem, a reason for which Asturias should not be as fire-prone as it is.

The dominating vegetation of Asturias is deciduous forest[13]. However, human activity has modified this climatic vegetation; for economic reasons, extensions of coniferous vegetation have been planted, especially along the coast.

Figure 3 Distribution of forest vegetation in Asturias



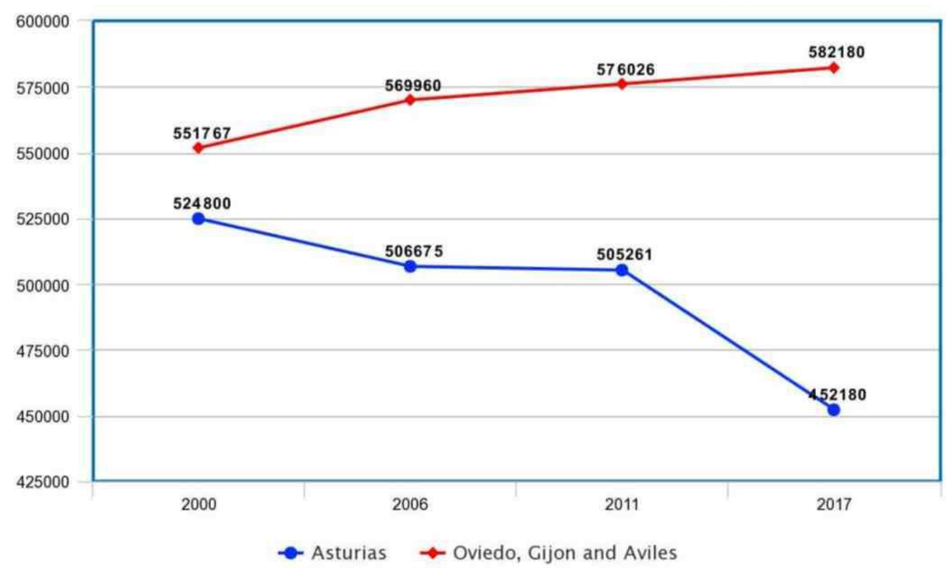
Source: meta-chart.com, data from SADEI. *Author´s work*

87.8% of the vegetation of Asturias is deciduous, meaning trees that shed their leafs during winter. The remaining 12% is formed by coniferous vegetation and mixed forest.

[13] Deciduous vegetation is composed of trees which shed their leaves in one season. Britannica, The Editors of Encyclopaedia. "Deciduous Forest." *Encyclopædia Britannica*, Encyclopædia Britannica, Inc., 31 Aug. 2016, www.britannica.com/science/deciduous-forest.

Asturias has a total population of 1.034 million, from which 580.000 live in the 3 biggest cities, Oviedo, Gijon and Aviles. This high concentration of population in these 3 cities makes the average population density in Asturias 97 people per km2. However, the population density of Asturias is very low in some zones-while in others – such as the ones previously mentioned - it experiences high concentrations of inhabitants, such as the municipalities of Gijon (1598 people per km2), Oviedo (1180 people per km2) and Aviles (2965 people per km2). This distribution of the population of the region supports the hypothesis that people are leaving the countryside for cities, thus causing rural decline.

Figure 4 Evolution of population in the region and in urban areas



Source: *meta-chart.com, data from INE.* *Author´s work*

As previously mentioned, the 3 biggest nuclei of population in Asturias are Oviedo, Aviles and Gijon. This chart compares the evolution of population in these three cities with the rest of Asturias. As can be observed, the rest of Asturias declines in population while the 3 most populated cities grow at a steady pace. This indicates that rural zones are losing population, thus decreasing rural activity in these municipalities.

As it has been presented, Asturias is not a region which should be as fire-prone as it is. A region with such high levels of humidity and rainfall throughout the year, with mild summers and with dominant presence of deciduous forests, should not suffer so heavily from wildfires. Nevertheless, Official data from Spanish institutions concurs that in 2017 alone Asturias suffered 56 major wildfires, where approximately 100.000 hectares of land burnt[14]. At the same time (as we have seen analysing demographic data) the abandonment of rural areas is an important process in the region. For those reasons, Asturias has been selected in order to **analyse if there is a relation between rural decline and the increasing magnitude of wildfires.**

[14] Lavozdeasturias. “Asturias Marca 2017 Como El Segundo Peor a.” *La Voz De Asturias*, La Voz De Asturias, 27 Jan. 2018, www.lavozdeasturias.es/noticia/asturias/2018/01/27/asturias-marca-2017-segundo-peor-ano-incendios-siglo/00031517071688336111627.htm. *last in bibliography

METHODOLOGY

Defining Rurality

The first methodological challenge this study will encounter will be the definition of "rural areas" in Asturias. The term "rurality" cannot be identified with areas where agrarian activity prevails anymore; before the 18th century, defining rural areas was simple; whatever stood beyond city walls was considered rural, as all urban means of production were located within the confinements of the city. However, with city walls being rendered useless, the concept of rurality has gradually changed throughout the years. Nowadays, the concept of "rurality" is often very subjective. For that reason, different attempts of establishing a "rurality index" have been done. The Andalusian School of Public Health (DEMAP) has developed an index of rurality specific for Spain, classifying more than 8000 municipalities taking into account a multivariable approach and defining rural areas as those with low population density, high significance of agrarian activity, low levels of rent and geographic isolation .

Acquisition of data

In order to find a link between rural decline and wildfires, statistics on population, agriculture and wildfires will be collected. This secondary data will be acquired from official sources, such as SADEI (Sociedad Asturiana de Estudios Economicos e Industriales), being the official institution in charge of the statistics of the region. This source has been chosen due to its actuality, its reliability and, of course, due to that it is an official Spanish institution. This source will provide this study with general data of the municipalities at stake such as their total and forest surface, their demographic and socioeconomic statistics and the growth or decline in the number of agricultural exploitations in those regions, as this essay tackles the issue of rural decline.

With one of this study's main objectives being avoiding biases, figures such as the number of fires will be expressed as fires per km2 of the forest surface of the municipality, in order to obtain the most exact and truthful results possible.

The chosen period of time which will be analysed in this study will be the one between the year 2000 and 2017, as it is sufficiently long to clearly observe the evolution of our variables (especially wildfires and their evolving magnitude), as official wildfire data prior to 2000 show inconsistencies which could prove threatening to the exactness of this essay's results. The data which this paper will focus on will be only up until 2017, as 2018 data is yet to be completed at the time of this investigation.

The analytical process of this study will revolve around several steps; first of all, the evolution of the number of wildfires per km2 and the average burnt surface per fire in all of our chosen Municipalities as a whole, will be analysed. The objective of this first analysis will be to concur whether clear tendencies in the evolution of these two variables exist.

To follow with the second step, the evolution of those variables will be compared between rural Municipalities and the global of Asturias. This shall be done with the objective of determining whether our municipalities classified as rural show similar tendencies to the global data of Asturias as a whole. It should be clarified that for all the steps of the analysis the creation of graphs and tables through programs such as Microsoft Excel and self-elaborated figures using Adobe Photoshop will be included in order to find these tendencies.

The third step of the methodology will be to analyse whether there are any existing internal differences among rural municipalities and their wildfire variables. For this, a classification of different levels of rural decline will be applied to the municipalities. To create these 3 classes, three variables will be selected: evolution of population (as population decline is the main factor in rural decline), population density in 2017 (as spare population means less direct control of the territory) and evolution in number of agricultural exploitations (as it indicates the increasing or loss of agrarian activity).

As multiple variables will be considered, a cluster analysis will be used; a cluster analysis is a multivariable process of analysis based on a set of measured variables, with the objective of placing figures and data in separate clusters through an agglomerative process. For this process, IBM's SPSS statistical software will be utilized.

As data of the different variables will be expressed in different units (percentages in the case of evolution of population and evolution of agrarian exploitation and population per km2 in the case of population density) the variables will be previously standardized in order to avoid incoherent results. Lastly, all conclusive data will be visualized as graphs, charts and other figures, using programs such as Microsoft Excel and Adobe Photoshop.

ANALYSIS OF DATA

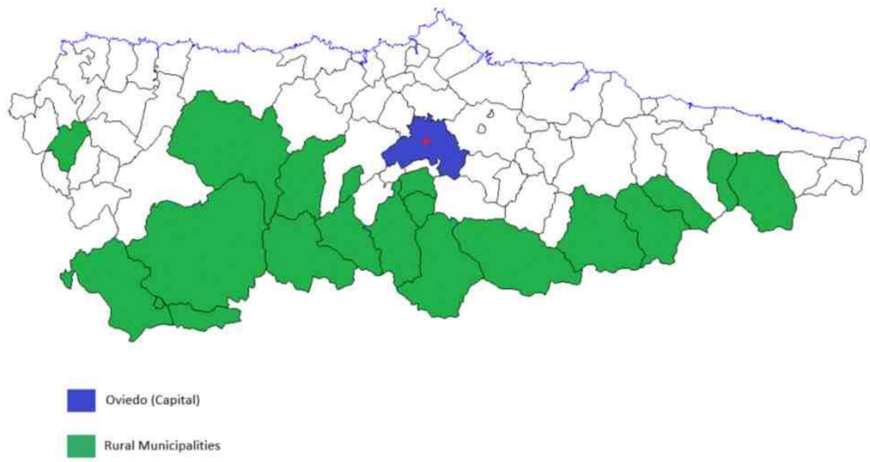
As it has been mentioned in the methodology section, I applied the index of rurality elaborated by DEMAP to the municipalities of Asturias. The index discriminates 4 degrees of rurality (Category I urban, Category II semi-urban, Category III semi-rural, Category IV rural). In Asturias, 19 out of the 78 municipalities existing in the region fall into Category IV (rural). These 19 municipalities are the territorial framework I will use to demonstrate if my hypothesis (that rural decline has a relation in the increasing magnitude of wildfires) is correct.

Table 1 General data of rural municipalities in Asturias

Municipalities	Area (km2)	Forest Area (km2)	Population 2017	Population 2000	Agrarian Exploitations 2017	Agrarian Exploitations 2000
Aller	375.89	249.1	11027	15398	694	1100
Amieva	113.9	56.08	699	905	127	227
Belmonte	208.01	137.17	1554	2304	224	350
Cabrales	238.29	120.18	2008	2371	229	360
Cangas N.	212.75	106.59	12947	17171	1060	1612
Caso	307.99	168.02	1624	1990	218	375
Degana	87.18	57.37	978	1528	45	52
Ibias	333.3	245.46	1362	2190	142	334
Lena	315.51	166.39	11278	13901	610	945
Morcin	50.05	20.69	2666	3066	306	307
Onis	75.42	33.42	743	893	117	179
Ponga	205.98	141.76	623	760	108	163
Quiros	208.79	103.82	1212	1664	182	333
Riosa	46.49	17.48	1991	2578	165	231
Somiedo	291.88	156.8	1142	1621	193	276
Teverga	540.83	93.93	1678	2264	181	325
Tineo	540.83	22.76	9700	12931	1061	1638
V. de oscos	72.98	52.23	303	410	46	82
Yernes	31.63	16.22	140	223	21	42
TOTAL	**4257.7**	**1965.47**	**63675**	**84168**	**5729**	**8931**

Source: Data from SADEI

Figure 5 Rural municipalities in Asturias



Author's work **Not To Scale**

What can be observed from these 19 chosen municipalities is that all of these are in decline, in terms of evolution of population and number of agrarian exploitations. Another clear observation is that the forest surface of each municipality is considerably extensive in relation to their total surface.

Regarding the data on wildfires, in order to avoid any bias in the data as consequence of the varied extension of the chosen municipalities and to make the data comparable, I reflected the number of wildfires per km2 of forest surface in the municipality, instead of only considering the number of fires per municipality. The average surface burnt by wildfire was also considered. The average values of both variables per year in the set of selected municipalities is shown in Table 2. Their evolution is shown in figures 6 and 7.

Table 2 Average number of wildfires and burnt surface per wildfire in rural municipalities

Year	NI	SI
2000	0,258889	22,33472
2001	0,067222	22,32556
2002	0,157222	13,56722
2003	0,143333	3,703333
2004	0,227222	2,058889
2005	0,217222	8,743333
2006	0,249444	5,79
2007	0,200556	12,61278
2008	0,317222	4,367778
2009	0,273889	15,19667
2010	0,268333	6,672222
2011	0,216111	3,558667
2012	0,245556	12,66278
2013	0,089444	14,79556
2014	0,098333	9,863333
2015	0,255556	15,40333
2016	0,1	77,53032

NI: N.fires/km2 of forest land
SI: average surface burnt per fire

Source: Data from SADEI

Figure 6 Rural municipalities. Number of fires/Km2 of forest land (2000-2017)

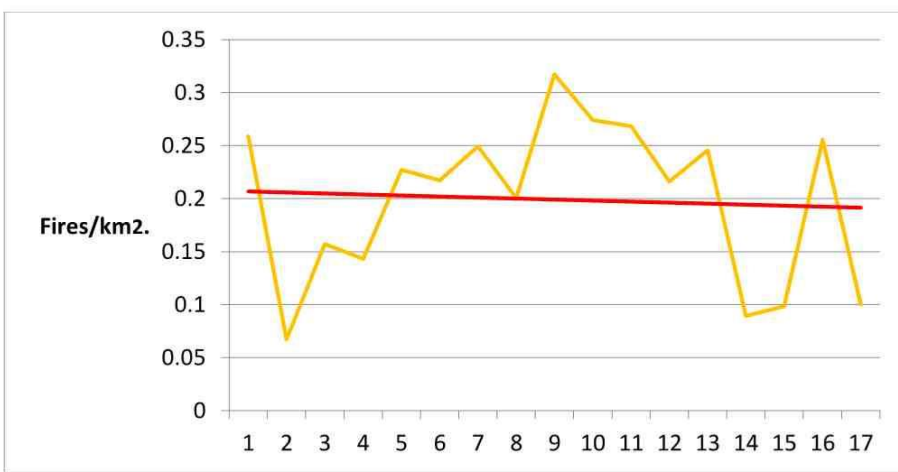
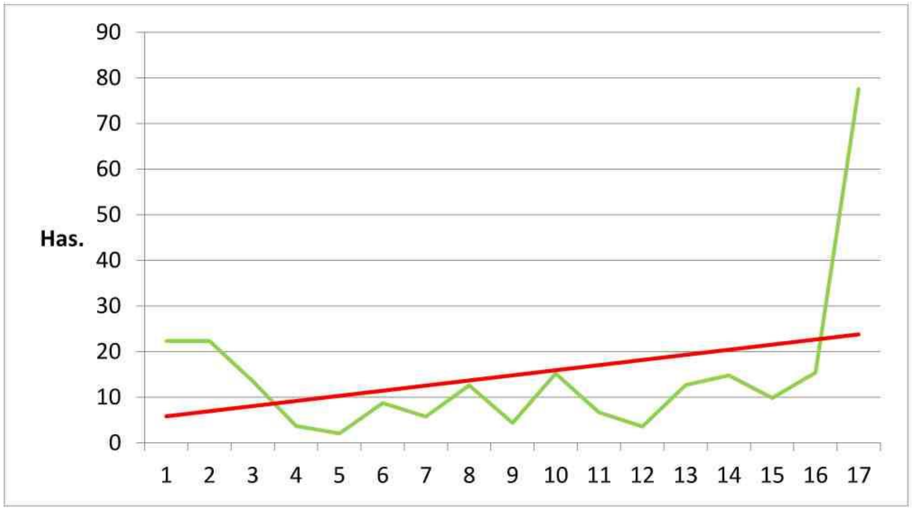


Figure 7 Rural municipalities. Average burnt surface per wildfire (2000-2017)



Source: Data for figures 6 and 7 from SADEI. *Author´s work*

As graphs n. 6 and 7 show, rural municipalities present a growing average of burnt surface per fire while the number of fires per hectare decreases along the time. **That means that in areas in rural decline there are less fires, yet fires now are of a larger magnitude.**

However, in order to reach a definitive conclusion, we need to compare the observed trends in the rural municipalities with the trends of both variables in the region of Asturias. The average data of number of wildfires per km2 of forest surface and average number of has. burnt by wildfire in Asturias are shown in figures 8 and 9.

Figure 8 Number of wildfires/Km2 of forest land in the region of Asturias (2000-2017)

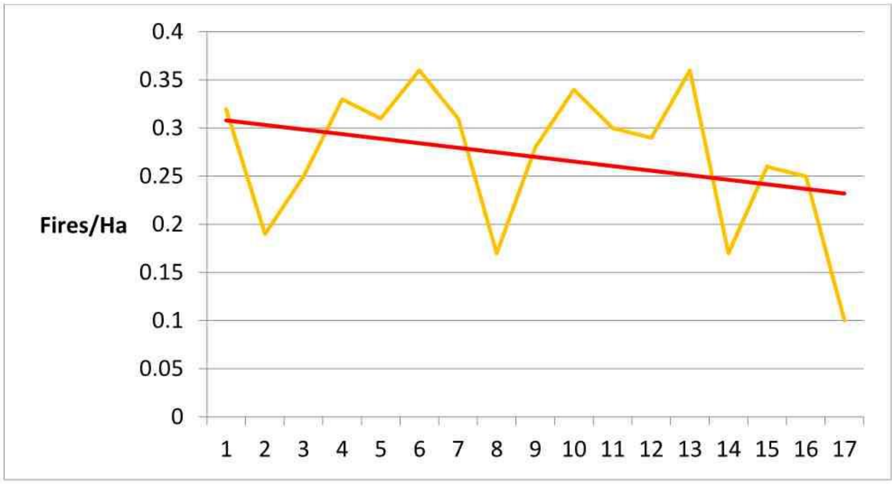
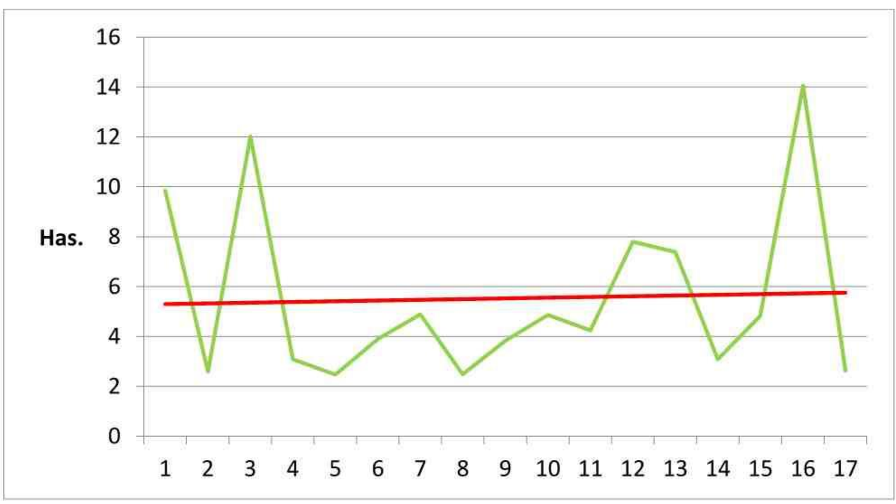


Figure 9 Average burnt surface per wildfire in the region of Asturias (2000-2017)



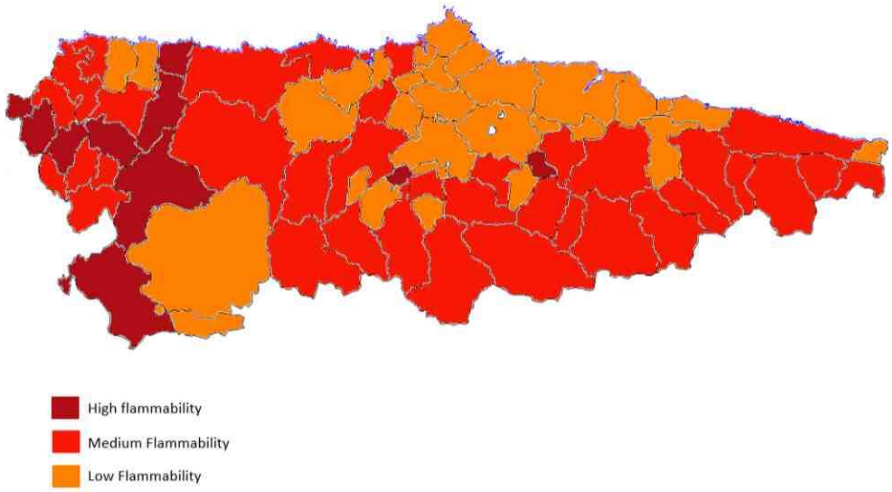
Source: Data for figures 8 and 9 from SADEI. *Author´s work*

As can be observed, the number of fires in Asturias shows a decreasing tendency- similar to our chosen municipalities-, while the burnt surface per fire in the region increases very slightly, contrary to the strong increase experienced by the rural municipalities. This fact aims towards the same direction as this essay's hypothesis, clearly showing that **the increasing magnitude of fires in rural areas has a relation with rural decline.**

Nevertheless, to assess the accuracy of this interpretation of data, it is necessary to evaluate if the natural risk of wildfires is bigger in the rural municipalities than in the rest of Asturias. For this assessment, the flammability map of Asturias created by INDUROT[15] (Instituto de Ordenacion del Territorio del Gobierno de Asturias) was used. This map was produced following a multivariable analysis taking only natural factors into consideration (climatic data, forest vegetation, slope, etc.). As we can observe in figure 10, only 2 of the rural municipalities are located in the section of high flammability, these two being Ibias and Villanueva de Oscos. Most of the rural municipalities fall into the range of "Medium flammability", this range being the most common for the whole region. It can be affirmed that the comparison of the evolution of the variables referring to wildfires between both geographical sets, are not biased by differences in flammability of forest areas.

[15] INDUROT, Centro de Innovación - Universidad de Oviedo. "Instituto De Recursos Naturales y Ordenación Del Territorio." *Instituto De Recursos Naturales y Ordenación Del Territorio - Inicio*, www.indurot.uniovi.es/.

Figure 10 Map of flammability of forest stands in Asturias



Source: data from INDUROT, edited with Adobe Photoshop CC 2015. **Not To Scale**

This analysed data seem to prove this study's hypothesis right, showing that **there is indeed a relation between rural decline and increasing magnitudes of fires, even in those areas that naturally shouldn't be fire-prone.**

Finally, in order to assess these preliminary conclusions, I decided to analyze the behavior of both variables discriminating different ranges of "rurality" in the set of selected municipalities. In order to do that, all the rural municipalities were organized into 3 ranges, from slight rural decline to severe rural decline, following the steps indicated in the methodology section of this Extended Essay. As it was mentioned in the methodology section, the variables taken into account for this classification are population growth 2000-2017 (expressed in percentage over the population in 2000), population density in 2017 (pop./km2) and growth in the number of agrarian exploitations (expressed in % over the number of exploitations in 2000). The variables were standardized to make possible their comparision.

The values of the original variables (EPOP: population evolution, DENS: population density, EEXP: evolution in the number of agrarian exploitations), the standardized variables (ZEPOP, ZDENS, ZEEXP) and the assignation to clusters provided by SPSS Statistics (RANGES), are shown in Table 3.

Table 3 Classification of municipalities in clusters based on degree of rural decline

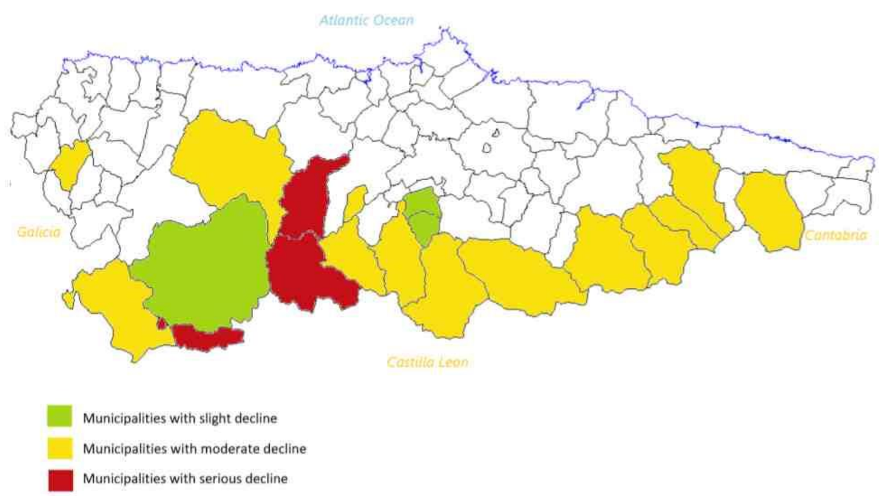
V1	EPOP	DENS	EEXPOP	ZEPOP	ZDENS	ZEEXPLO	RANGES
Cangas N.	-24.59	60.85	-34.24	-0.02804	2.40242	0.13073	1
Morcin	-13.04	53.26	-0.32	1.70038	1.98967	2.82243	1
Riosa	-22.76	42.82	-28.57	0.24581	1.42195	0.58067	1
Aller	-28.30	29.33	-36.90	-0.58323	0.68836	-0.08036	2
Amieva	-22.76	6.13	-44.05	0.24581	-0.57325	-0.64774	2
Cabrales	-15.30	8.42	-36.38	1.36218	-0.44872	-0.03909	2
Caso	-18.39	5.27	-41.86	0.89977	-0.62002	-0.47395	2
Ibias	-25.47	4.08	-57.48	-0.15973	-0.68473	-1.71347	2
Lena	-18.86	35.74	-35.44	0.82944	1.03694	0.03550	2
Onis	-16.76	9.85	-34.63	1.14369	-0.37096	0.09978	2
Ponga	-18.02	3.02	-33.70	0.95514	-0.74237	0.17358	2
Quiros	-27.16	5.80	-45.34	-0.41263	-0.59120	-0.75011	2
Teverga	-25.88	3.10	-44.30	-0.22108	-0.73802	-0.66758	2
Tineo	-24.98	17.93	-35.22	-0.08640	0.06843	0.05296	2
V. de oscos	-26.09	4.15	-43.90	-0.25251	-0.68092	-0.63584	2
Yernes	-37.21	4.42	-50.00	-1.91658	-0.66624	-1.11990	2
Belmonte	-32.55	7.47	-36.00	-1.21923	-0.50038	-0.00894	3
Degana	-35.99	11.21	-13.46	-1.73401	-0.29700	1.77971	3
Somiedo	-29.54	3.91	-30.07	-0.76879	-0.69397	0.46163	3

Source: Data from SADEI, author's work.

This classification of ranges leaves us with these results:

RI – Municipalities in slight rural decline	Cangas del Narcea, Morcin, Riosa
RII – Municipalities in moderate rural decline	Aller, Amieva, Cabrales, Caso, Ibias, Lena, Onis, Ponga, Quiros, Teverga, Tineo, V. de oscos, Yernes
RIII – Municipalities in severe rural decline	Belmonte, Degana, Somiedo

Figure 11 Rural municipalities in Asturias by range of rural decline



Source: data from SADEI, edited with Adobe Photoshop CC 2015. **Not To Scale**

For each of the ranges, the annual average of wildfires per km2 of forest surface was calculated, as well as the annual average of hectares burnt per wildfire. This data is presented in the table below:

Table 4 Annual average of wildfires and burn surface per wildfire, per range of municipalities

	In Slight Decline		In Moderate Decline		In Severe Decline	
Year	NI	SI	NI	SI	NI	SI
2000	0.196667	2.706667	0.24	18.3975	0.34	45.9
2001	0.066667	2.356667	0.065	43.22	0.07	21.4
2002	0.316667	20.58667	0.115	10.435	0.04	9.68
2003	0.26	2.096667	0.14	3.533333	0.03	5.48
2004	0.596667	2.873333	0.075	3.103333	0.01	0.2
2005	0.466667	4.183333	0.085	2.766667	0.1	19.28
2006	0.483333	2.72	0.125	8.32	0.14	6.33
2007	0.466667	2.283333	0.075	5.055	0.06	30.5
2008	0.776667	6.043333	0.075	4.21	0.1	2.85
2009	0.526667	4.163333	0.125	7.886667	0.17	33.54
2010	0.63	5.736667	0.105	3.28	0.07	11
2011	0.423333	6.876	0.105	3.28	0.12	0.52
2012	0.416667	8.863333	0.2	12.755	0.12	16.37
2013	0.203333	6.736667	0.05	3.15	0.015	34.5
2014	0.21	3.203333	0.075	4.496667	0.01	21.89
2015	0.616667	5.675	0.11	25.995	0.04	14.54
2016	0.07	3.436667	0.2	21.6543	0.03	207.5

NI: Number of fires per hectare
SI: Surface burnt per fire

Source: Data from SADEI, author's work.

For each range two graphs were produced, one for the number of fires per km2 of forest surface and another for burnt surface per fire in hectares. The trends of both variables in each range of rural municipalities are shown in figures 12 to 17.

Figure 12 Nr. of wildfires/Km2 of forest land in municipalities in slight rural decline (2000-2017)

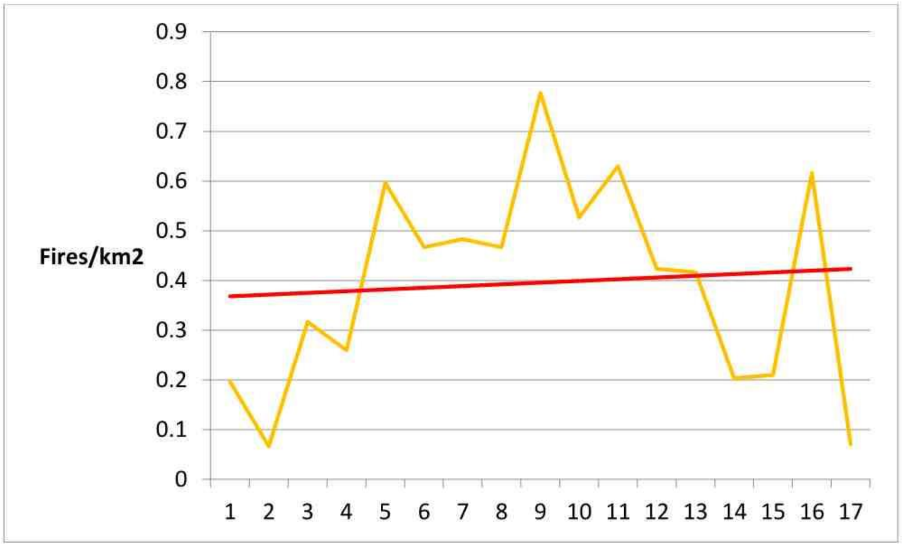
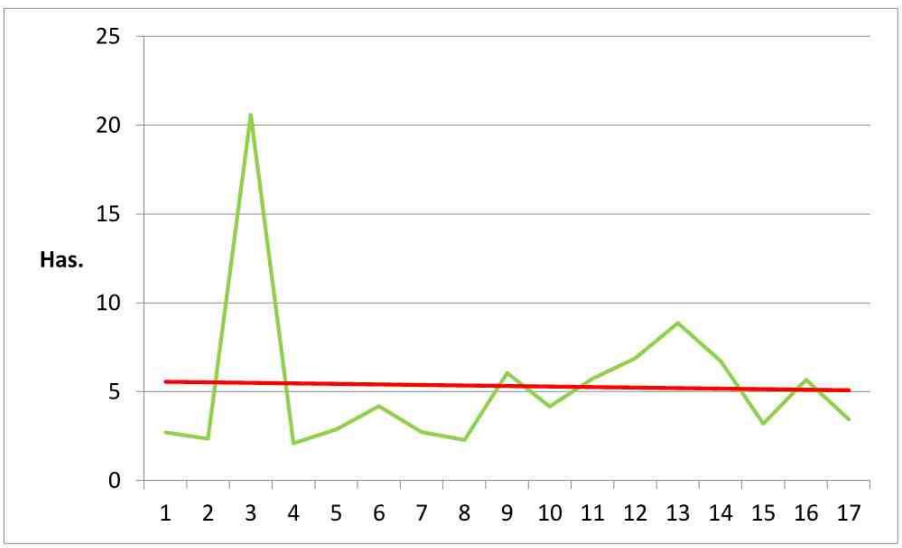


Figure 13 Average burnt surface/ wildfire in municipalities in slight rural decline (2000-2017)



Source: Data for figures 12 and 13 from SADEI. Author´s work

Observing figures 12 and 13 we can see municipalities with a slight rural decline show a clear trend to an increasing number of wildfires, while the average burnt surface per fire tends to decrease.

When we compare the graphics of the municipalities suffering a slight rural decline with the graphics of those suffering a severe rural decline, our hypothesis seems to be confirmed; with a severe rural decline the number of fires dramatically goes down, but the average burnt surface per wildfire grows at a very significant pace. The number of fires per hectare decreases dramatically during the period anayzed. Although this should indicate that less surface is burnt each year, the burnt surface rises dramatically from 2000 to 2017.

Figure 14 Nr. of fires/km2 of forest land in municipalities in severe rural decline (2000-2017)

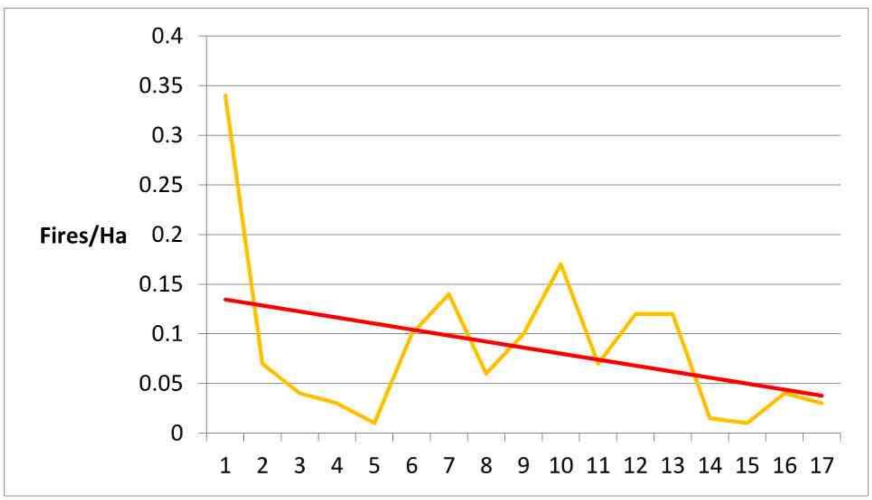
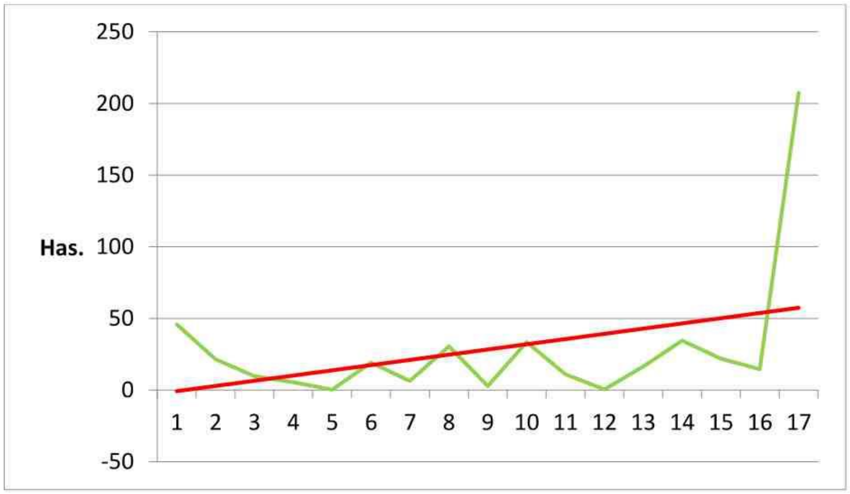


Figure 15 Average burnt surface/wildfire in municipalities in severe rural decline (2000-2017)



Source: Data for figures 16 and 17 from SADEI. Author´s work

That seems to indicate that the less rural activity there is, the less number of fires but the more virulent they are; this is probably due to the fact that there are less or no preventive activities related to traditional rural activities in the area to stop or control these outbreaks.

Finally, for the range of municipalities in the Group II (in moderate rural decline), the data are not conclusive. It can be observed that they haven't experienced much loss of rural activity, therefore the tendency of number of fires experiences only a slight decrease and the burnt surface hasn't varied much since 2000, even having slightly decreased. This is probably due to a higher presence of population – being vigilant, thus noticing outbreaks and neutralizing them quickly – and can also be due to preventive rural activities (such as logging, grazing, etc..). Nevertheless, this cluster group includes a high number of municipalities. These fact could make the trends obtained less reliable.

Figure 16 Nr. of wildfires/km2 of forest land in municipalities in moderate rural decline (2000-2017)

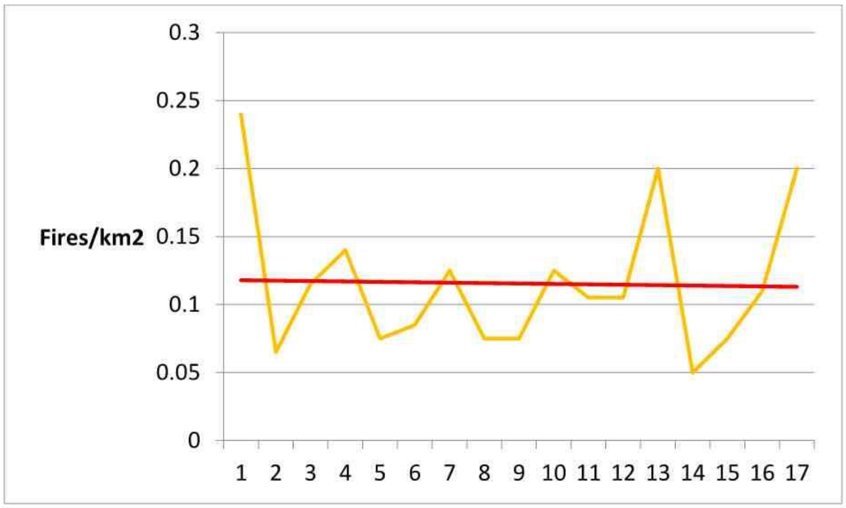
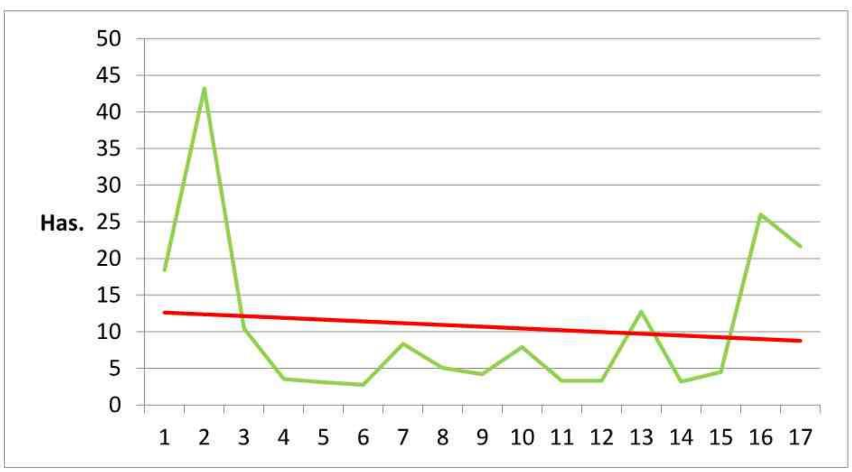


Figure 17 Average burnt surface/ wildfire in municipalities in moderate rural decline (2000-2017)



Source: Data for figures 14 and 15 from SADEI. Author´s work

The analysis differentiating among several ranges of rural decline in our selection of municipalities seems to indicate that **in fact a relation exists between rural decline and**

wildfires; in the areas with rural decline, the number of fires seems to diminish while their magnitude experiences an increment.

CONCLUSION

The hypothesis I started from (that there is a direct relation between rural decline and the increasing magnitude of wildfires in Asturias) seems to be confirmed by the analysis of data.

Firstly, there is a clear positive correlation between the evolution of the average surface burnt per wildfire and the degree of rural decline experienced by municipalities. This correlation is clearly shown when analysing the evolution of the magnitude of fires in the selected set of municipalities (all of them experiencing rural decline) in comparison with the evolution of the variable in the whole region. This positive correlation is also shown when analysing the evolution of the magnitude of wildfires after discriminating the selected set of municipalities in different groups, based on the different degrees of rural decline they experience.

The municipalities experiencing more severe rural decline are the ones where the magnitude of fires increases the most. This fact is probably due to the diminishing of traditional farm activities (especially those related to extensive grazing) that played an important role in the withdrawal of combustible matter from the forest lands while meaning an active vigilance of the territory.

Secondly, rural decline presents a negative correlation with the evolution of the number of wildfires per km2 of forest surface: the more decline rural municipalities present, the less increase in the number of wildfires they experience. This fact could be probably due to the diminishing of traditional rural activities (e. g. burnt of pastures) that used fire as a management tool favouring the outbreak of wildfires.

Although analysing in depth the causes of why rural decline shows a positive correlation with the increasing in the magnitude of wildfires is beyond the scope of this study, this issue deserves further investigation especially in a climate change scenario where the virulence of wildfires is expected to increase.

EVALUATION

After extensive research, both prior and during this study, the hypothesis proposed in this Extended Essay – being that **rural decline has a relation with the increasing magnitude of wildfires** - has been confirmed. However, this study has experienced several shortcomings which should be taken into account.

Rural municipalities in Asturias are mainly located in the mountain, presenting average altitudes of 800 m. and above. The possible difficulties (if any) in the extinction of wildfires in mountain areas in the context of Spain should be consider, in order to qualify the obtained results. In order to isolate this potential problem, it would have been necessary to extend the study to all the rural municipalities in the area of the 'Atlantic Spain' (under very similar climatic conditions and with a variety of reliefs). However that would have gone beyond this essay and its framework.

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Extended essay - Reflections on planning and progress form

Candidate: *This form is to be completed by the candidate during the course and completion of their EE. This document records reflections on your planning and progress, and the nature of your discussions with your supervisor. You must undertake three formal reflection sessions with your supervisor: The first formal reflection session should focus on your initial ideas and how you plan to undertake your research; the interim reflection session is once a significant amount of your research has been completed, and the final session will be in the form of a viva voce once you have completed and handed in your EE. This document acts as a record in supporting the authenticity of your work. The three reflections combined must amount to no more than 500 words.*

The completion of this form is a mandatory requirement of the EE. It must be submitted together with the completed EE for assessment under Criterion E. As per the 'Protocols for completing and submitting the Reflections on planning and progress form' section of the EE guide, a mark of 0 will be awarded by the examiner for criterion E if the RPPF is blank or the comments are written in a language other than that of the accompanying essay.

Supervisor: *You must have three reflection sessions with each candidate, one early on in the process, an interim meeting and then the final viva voce. Other check-in sessions are permitted but do not need to be recorded on this sheet. After each reflection session candidates must record their reflections and as the supervisor you must sign and date this form.*

First reflection session

Candidate comments:

I have chosen the topic of wildfires in Spain and their relation to rural decline, as this is an on-going issue that I have never researched in depth and I'm interested in. The first step of this meeting was to decide the general aim of the study based on the research question: "Does a relation exist between rural decline and increasing magnitudes of wildfires in Asturias, Spain". This region was chosen because it has a climate that should not make it as fire-prone as it is, therefore there must be a human factor involved. Rural decline has been defined as loss of rural activities, rural population and abandonment of land. The first draft of this essay is set to be ready for before June 2018.

Date: 19.12.2018

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Interim reflection

Candidate comments:

During this second meeting a first draft of the essay has been reviewed, during which both the strengths and weaknesses of this essay have been analysed. Terms such as 'rurality' and 'rural decline' have to be further explained and clarified, as they are vital to the investigation of this essay. The structure in itself is well built, despite possible improvements to be made. In terms of the text and layout, a more professional and technical approach needs to be taken. Reflecting on this first draft, I must further immerse myself in this topic in order to familiarize myself with the obtained data, making it easier to write analitically about this subject. During this second meeting it has also been concluded that several maps and labels need editing, in order to properly reference sources and in order to comprehensively present figures and data. The conclusions reached in this meeting have been taken into account and will be worked on until the final draft is due, in November 2018.

Date: 28.05.2018

Final reflection - Viva voce

Candidate comments:

After several months of edits and improvements, the final draft of my Extended Essay has been reviewed in this last meeting with my supervisor. While both my supervisor and I are very proud of the final outcome, there are several things this study could have too analysed; It could have been mentioned and studied more in depth that the magnitude of wildfires in the chosen municipalities with an altitude of more than 800m could also be affected by the difficulty to extinguish fires at such altitudes, or by natural factors such as wind. However, we asserted this would go beyond the scope of this study, as it was analysed whether rural decline had an effect on wildfire magnitudes. Both my supervisor and I agreed that this study is interesting due to the fact that not many investigations have been made on this topic, making it a more unique study. Despite its shortcomings and thanks to its strengths, this Extended Essay is a work that I am personally very proud of, and in my opinion a very interesting investigation.

Date: 26.10.2018