Eco.Fire

O valor económico dos incêndios florestais como suporte ao comportamento preventivo

PCIF/AGT/0153/2018

FCT Fundação para a Ciência e a Tecnologia

NIPE Núcleo de Investigação em Políticas Económicas e Empresariais

CECS centro de estudos de comunicação e sociedade

Centro de Computação Gráfica
Investigação & Desenvolvimento Tecnológico
Research & Technological Development

Two dimensions to measure forest fires values and one application for communication.

University of Minho, March 2023

The ECOFIRE project was developed between 2019 and 2023 by three research centres based at the University of Minho - the Centre for Research in Economics and Management (NIPE), the Communication and Society Research Centre (CECS), and the Computer Graphics Centre (CCG), the latter of a private nature.

The work developed was applied to the Municipality of Baião, specifically to the 2019 large forest fire that occurred in this region.

This document reflects the main ECOFIRE outputs available for future development in this work area.

Project website:
https://nipe.eeg.uminho.pt/project/eco-fire-o-valor-economico-dos-incendios-florestais-como-suporte-ao-comportamento-preventivo/

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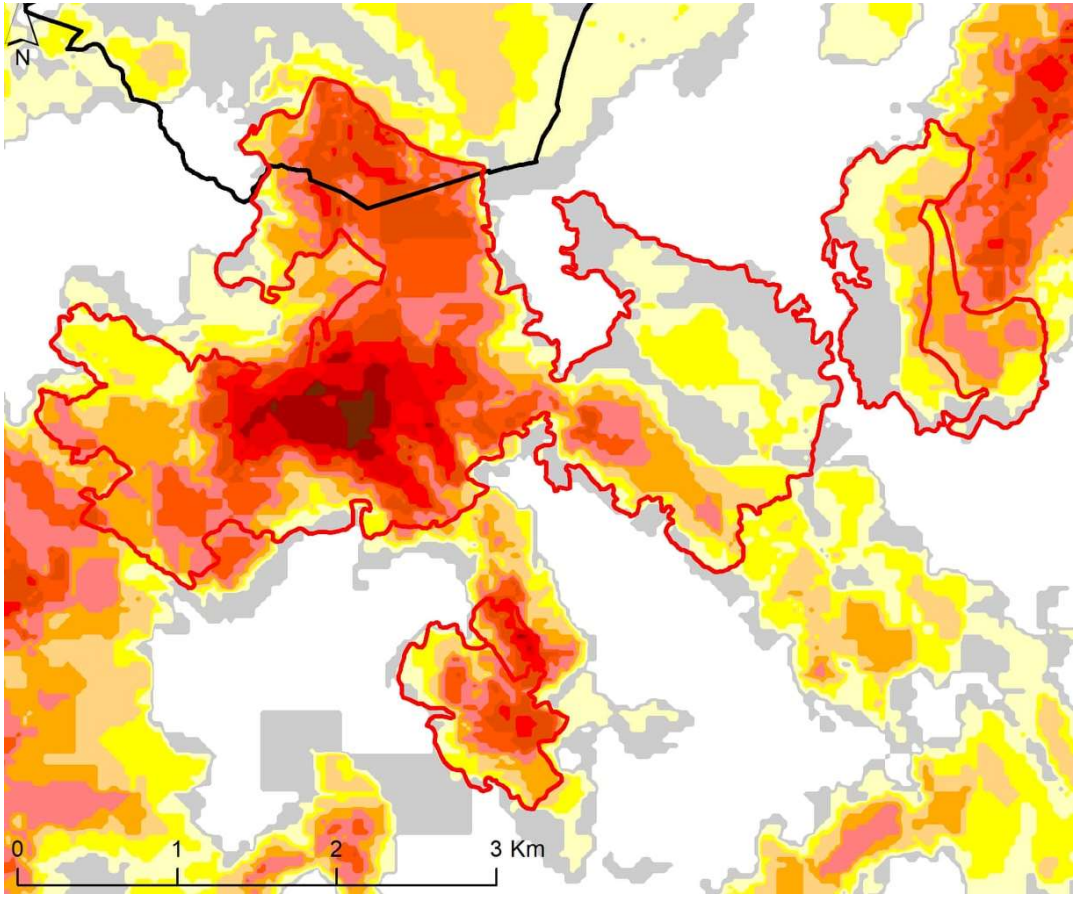
1 ECOFIRE

The economic value of forest fires as support for prevention behaviour.

Forest fires have been considered one of the major environmental problems. However, their economic impact, considering direct and indirect economic losses, is currently not well measured. In addition to the loss of human lives and injuries and loss of properties and infrastructures, the extent of the consequences of fire from the forestry perspective can be assessed largely by the social cost of such fires, which is the most negative of the forests-related externalities.

Figure 1 – Extract from the 2019 Baião Wildfire analysis. Source: Geography outputs.



The possibility of estimating in advance the predictable cost of a forest fire in a certain location may support the decision process of landowners, managers or administration entities in what concerns decisions such as the choice of species to explore, forest strips management, land use changes or even to balance costs of land clearing taking into consideration the several scenarios of cost in advance.

The research team, combining both high-level pieces of knowledge of environmental, and economic valuation methods, forest fire impacts, and computational tools, aimed to look at several dimensions of the evaluation and communication of forest fire impacts involving the local population, which could serve as a tool to support forestry planning and fire prevention policies. These dimensions include economics, geography, and app and computing, presented in the sections of this document as the outputs of the project.

The multidisciplinary team composed of environmental economists, experimental economists, geographers, experts in land-use planning and forest fires, and computation experts provide all the necessary knowledge to develop work in such cross-cutting areas and successfully tackle the recognised challenges.

2 ECONOMICS

GOAL

Elicitation of preferences for engagement in prevention and associated values.

HIGHLIGHTS

. Focus groups identified population perceptions as to causes, risks and value.

. Primary data collected on preferences for direct involvement with forest fire prevention (e.g. crowdsourcing).

. Choice experiments on fire prevention were carried out, resulting in a ranking of forest attributes and value estimates for the app.

Figure 2 – ECOFIRE social media cover photo.

DESCRIPTION

Outputs of this research line mostly relate to the valuation of preferences for engagement in forest fires prevention. A complementary study was developed on forest fires impacts in tourism.

Perceptions of the population about forest fires. Both local and non local residents participated in focus groups, which allowed the team to systematize perceptions about causes and risks of forest fires, losses and value of forest fire prevention.

Support and involvement with forest fire prevention. We collected data from focus groups and questionnaires about means to participate in forest fire prevention directly or indirectly. In general participants were willing to take part in forest conservation and monitoring tasks or subsidize them. Additionally, we focused on a specific form of making forest conservation financially sustainable through the valorisation of forest biomass as an energy source. Participants acknowledged the several advantages of forest bioenergy and revealed a willingness to support financially this energy source.

Choice experiments on fire prevention. After selecting the forest attributes, more valued by participants in this study in previous stages of research, the choice

experiment methodology was applied to elicit estimates of value of forest attributes. These estimates were then used as inputs in the app. The app asks users for information about certain characteristics in real time in the field, which combined with information from existing databases, informs users of estimates of value of the terrain they are located in. Providing this information of non-market values of forests acts as an incentive for users to be involved with the app and help crowdsource information in the field through the app.

Tourism impact. Fire intensity and size incite visitation decrease and recreational losses. Using a spatial econometric model to analyze the relationship between total burned areas and overnight stays, our results show that tourism demand of the forest fires neighbouring municipalities is also negatively impacted by them. In fact, tourists use weather data such as local fire occurrences to determine their next visit, changing their one-year intentions to visit burned sites and nearby locations. These results are another reason for developing climate adaptation measures to fight forest fires.

OUTPUTS

MSc Thesis 2023 – U.Minho, Lídia Novais "Citizens and forest fire prevention: an exploratory study with scouts from northern Portugal", supervisors Lígia Pinto e Marieta Valente.

MSc Thesis 2022 – U.Porto, Mariana Bonacelli Montelatto "Social perception regarding wildfires in northern Portugal", co-supervisor Lígia Pinto.

MSc Thesis 2022 – I.P. Leiria, Ema Pedrosa "Estudo exploratório das perceções de fatores de risco e do potencial envolvimento da população na prevenção de incêndios rurais.", co-supervisor Marieta Valente.

Published articles

Pinto, L. C., Sousa, S., & Valente, M. (2022). Forest bioenergy as a land and wildfire management tool: Economic valuation under different informational contexts. Energy Policy, 161, 112765, https://doi.org/10.1016/j.enpol.2021.112765

Other publications

Cerejeira, J., Sousa, R., Bernardo, C. T. S., & Bento-Gonçalves, A. (2023). Do wildfires burn tourism intentions? The case of Portugal. NIPE Working Paper No. 1

Presentations in national and international conferences

Cerejeira, J., Sousa, R., & Bernardo, C. (2022). Do wildfires burn tourism intentions? The case of Portugal. IX International Conference on Forest Fire Research. Coimbra, Portugal, 11-18.11.2022.

Pinto, L., Valente, M., Ferreira, C. (2022) Participatory integrated assessment of wildfire risk: a qualitative approach to the case of Portugal. 27th IAPS conference 2022. 07.2022

Pinto, L., Montelatto, M. (2022) Social perceptions regarding wildfire prevention in northern Portugal. 27th IAPS conference 2022. 07.2022.

Valente, M., Fernandes, E., Pedrosa, E. (2022) Exploring the willingness to help prevent forest fires: your time or your money? 27th IAPS conference 2022. 07.2022.

Pinto, L. (2022) ECO.Fire - The economic value of forest fires as support for prevention behavior, 10th IAERE and 1st MED-IAERE conference. Cagliary, Italy. 21-23.04.2022.

Pinto, L., Valente, M., Ferreira, C., Mesquita, R., (2021) Understanding individual perceptions about Forest Fires through qualitative methods: Impacts, Causes and Prevention. ICEP 2021 3rd International conference on environmental psychology. Syracuse, Italy. 05-08.10.2021.

Pinto, L., Valente, M., Sousa, S. (2021) Forest bioenergy as a land and Wildfire management tool: Economic valuation under different Informational contexts. AERNA Conference of the Spanish Portuguese Association of resources and environmental economics. 02-03.09.2021

Pinto, L., Valente, M., Ferreira, C., Mesquita, R. (2021) Forest bioenergy as a land and Wildfire management tool: Economic valuation under different Informational contexts. AERNA Conference of the Spanish Portuguese Association of resources and environmental economics.02-03.09.2021.

Pinto, L., Valente, M., Sousa, S. (2020) Forest bioenergy as a land and wildfire management tool: economic valuation under different informational contexts. INFER Symposium

on Circular Economy and Sustainability 03.07.2020 https://infer2020.gr/

Pinto, L., Valente, M., Ferreira, C., Mesquita, R. (2021) Exploring perceptions of the value of preventing forest fires through focus groups. ME3 Meeting on Energy and Environmental Economics. 07.03.2021.

Pinto, L. (2019) Eco.Fire - o valor económico dos incêndios florestais como suporte ao comportamento preventivo, no âmbito do Encontro Incêndios Rurais: gestão com base em evidência científica. FCT, Lisboa, 27.11.2019

3 GEOGRAPHY

GOAL

Analyse the 2019 Large Wildfire of Baião, using Remote Sensing and GIS.

HIGHLIGHTS

. Characterization of the 2019 Baião large wildfire and analysis of its severity on vegetation recovery.

. Knowledge of the dendrocaustological reality and comprehension of the consequences of fire recurrence.

. Understanding of the dynamics of forest fires and their relationship with the wildland-urban interfaces.

Figure 3 – Field work in the Baião region. Source: Geography team.

DESCRIPTION

Outputs of this research line are divided in two parts: Part I reviews relevant work, and Part II focuses on application and mapping of large forest fires.

Part I. The work concludes that research trends in this field have undergone a significant evolution in the last decades, explained by the strong relationship between the technological evolution of detection methods and the acquisition of data by remote sensing.

Part II. A methodology for mapping large forest fires is developed, using a machine learning algorithm and time series of Landsat images. The case-study is in the Northwest of continental Portugal.

The results show that the mask definition process with the outliers considerably reduced the universe of pixels to be classified within each image. This leaves the classifier training focused on separating the set of pixels into two groups with very similar spectral characteristics. Thus, contributing to the separation of groups with similar spectral behaviour to be performed automatically and without great sampling effort.

The method presented satisfactory accuracy results with little omission of burnt areas

OUTPUTS

PhD Thesis 2023 – U.Minho: Sarah Moura Batista dos Santos: "Os Grandes Incêndios Florestais no Noroeste de Portugal Continental (2001 – 2020) - A deteção remota como ferramenta de apoio ao seu estudo", supervised by Prof. António Bento-Gonçalves

Published articles:

Santos, S., Duverger, S. G., Bento-Gonçalves, A., Franca-Rocha, W., Vieira, A., Teixeira, G. (2023) Remote Sensing Applications for Mapping Large Wildfires Based on Machine Learning and Time Series in Northwestern Portugal, Fire 6(2): 43. https://doi.org/10.3390/fire6020043

Santos, S., Bento-Gonçalves, A., Vieira, A. (2021) Research on Wildfires and Remote Sensing in the Last Three Decades: A Bibliometric Analysis, Forests 12 (5): 604. https://doi.org/10.3390/f12050604

Other publications

Santos, S., Bento-Gonçalves, A., Vieira, A. (2021) Análise da regeneração da vegetação um ano após o grande incêndio de Baião (2019). In Adélia Nunes, António Bento-Gonçalves, Carlos Ferreira, Luca Dimuccio, Lúcio Cunha, Paulo Nossa, Pedro Chamusca (Eds) O compromisso da Geografia para Territórios em mudança , Livro de resumos do XIII Congresso da Geografia Portuguesa. FLUC, Coimbra, 192-193. apgeo.pt/sites/default/files/xiiicgp_livro_resumos.pdf

Santos, S.; Bento-Gonçalves, A., Vieira, A. (2021) Analysis of vegetation regeneration after a wildfire in Portugal using the google earth engine (GEE) platform. In Artemi Cerdà and Ioannis Daliakopoulos (Eds) Book of abstracts of the 1st International Congress on Fire in the Earth System: Humans and Nature (Fes2021). Valencia, Spain (Online), pp. 148-149. (Anexo FES2021)

Santos, S., Bento-Gonçalves, A., Vieira, A. (2021) The 2019 Large Wildfire of Baião (Northwestern Portugal) - evaluation of severity and regrowth of vegetation after 1 year. Book of abstracts of the FESP8 (8th International Conference on Fire Effects on Soil Properties). Guarapuava, Paraná, Brazil. pp. 17-18. (anexo FESP8)

Santos, S., Bento-Gonçalves, A., Vieira, A. (2020). A recorrência como manifestação do risco de incêndio – o caso do grande incêndio florestal de Baião em 2019. Livro de Resumos do V International Congress on Risks - "Contribution of the Science for Disaster Risk Management. Acting today, protecting tomorrow". Coimbra. pp. 151. https://vcir.riscos.pt/wp-content/uploads/2020/10/eBook_Resumos_VCIR_v2.pdf

Presentations in national and international conferences

Santos, S., Bento-Gonçalves, A., Vieira, A., Duverger, S. G. (2022) Os grandes incêndios florestais em Portugal continental nos últimos 20 anos. XVII Coloquio Ibérico de Geografía, Faculdade de Geografia e História da Universidade de Salamanca, Salamanca, Espanha, 4-6.07.2022.

Santos, S., Bento-Gonçalves, A., Vieira, A., Duverger, S. G. (2022) Cartografia de áreas ardidas no noroeste de Portugal, utilizando processamento em nuvem na plataforma Google Earth Engine. XVII Coloquio Ibérico de Geografía, Faculdade de Geografia e História da Universidade de Salamanca, Salamanca, Espanha, 4-6.07.2022.

Santos, S., Bento-Gonçalves, A., Vieira, A. (2021) Análise da regeneração da vegetação um ano após o grande incêndio de Baião (2019). XIII Congresso da Geografia Portuguesa. FLUC, Coimbra, 18-20.11.2021

Santos, S., Bento-Gonçalves, A., Vieira, A. (2021) Analysis of vegetation regeneration after a wildfire in Portugal using the Google Earth Engine (GEE) platform. FES2021 (1st International Congress on Fire in the Earth System: Humans and Nature). University of Valencia, Facultad de Geografía i Història, Department of Geography (Online), 2-6.11.2021.

Santos, S., Bento-Gonçalves, A., Vieira, A. (2021) The 2019 Large Wildfire of Baião (Northwestern Portugal) - evaluation of severity and regrowth of vegetation after 1 year. FESP8 (8th International Conference on Fire Effects on Soil Properties). Guarapuava, Paraná, Brazil (Online), 26-28.07.2021.

Santos, S., Bento-Gonçalves, A., Vieira, A. (2020) A recorrência como manifestação do risco de incêndio – o caso do grande incêndio florestal de Baião em 2019. V International Congress on Risks - "Contribution of the Science for Disaster Risk Management. Acting today, protecting tomorrow". Coimbra, 12-16.10.2020.

4 APP AND COMPUTING

GOAL

To calculate values that may be lost with a forest fire for a given terrain.

HIGHLIGHTS

. Download the app at the project website https://tinyurl.com/ecofirePT .

. A user can better obtain a notion of the terrain value in a very easy way – using the mobile phone.

. The database stores several data relating to the vegetation in Portugal, to be used in future analysis.

Figure 4 – Initial, intermediate, and final screenshots of the simulation app. Source: ECOFIRE app.

DESCRIPTION

The ECOFIRE application calculates values that may be lost with a fire for a given terrain. The application is divided into four parts: Terrain | Vegetation | Landscape | Results.

Part I – Terrain – The application opens the *OpenstreetMap* on the user location. The user can then drag the map to the centre and proceed to the next page (coordinates are stored). The following step asks the user about the terrain size and the number of forest fires in the last century. 1hectar is the default.

Part II – Vegetation – The application reports the terrain size and coordinates to the server, from which it obtains data from the COS database (Land Use Chart). The user may then correct the data, namely by removing vegetation and/or adding new. After confirming, the next page regards specificities, including: Age, Health, DAP, Height, and Size.

Part II – Landscape – Next step is related to the cleansing, where the user will choose from a few radio buttons, moving on to a page where it will indicate which of the presented components he values most in his terrain.

Part IV – Results – The final page is where the user is informed of the final estimation of the terrain value (visible in the third part of Figure 4, above)

5 FINAL REMARKS

ECOFIRE contributes to the assessment of the economic losses caused by forest fires, a complex and important task due to the number of related socieconomic and environmental effects, as well as due to the difficulty of allocating market value to natural resources.

Under two dimensions – economics and geography – the work builds on current land market value, featuring other non-market values, to support the assessment of forest fire losses. Additionally, the population is a key ingredient for making better decisions about mitigating future occurrences.

The ECOFIRE case study regards the Baião Municipality, although the project outcomes are now relevant and available for other regions via the website https://tinyurl.com/ecofirePT. Our purpose is to make the knowledge fully available, to reach the final goal of making the territory more resilient to fires and allow for more effective firefighting.

Special thanks

To Câmara Municipal de Baião, Bombeiros Voluntários de Baião, and Bombeiros Voluntários de Santa Marinha do Zêzere, for all their most valuable support for the project.