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FIRE AND FLOOD HAZARDS TO PV PARKS

Aggelos Pallikarakis & Flora Konstantopoulou

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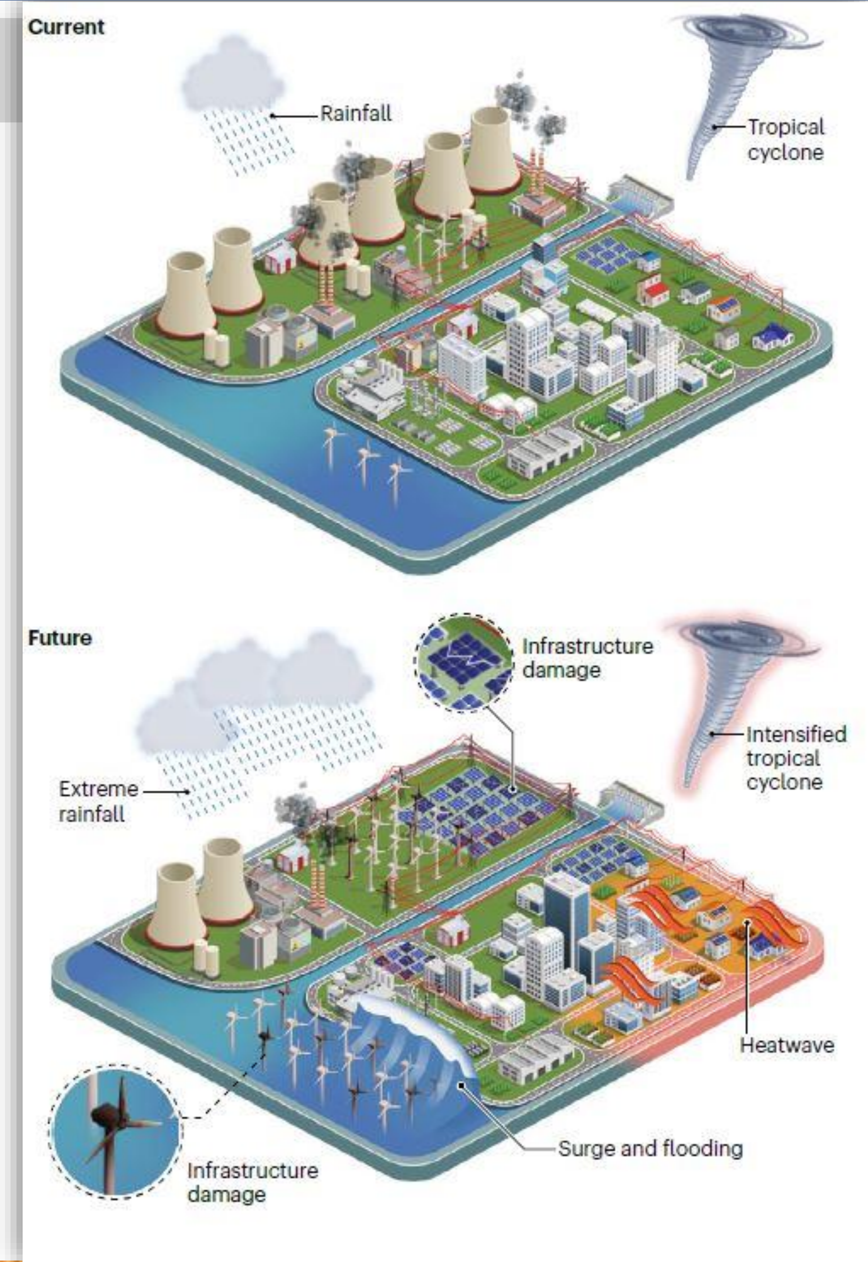
Agenda

- Impact of Climate Change on Renewable Energy
- Natural Disasters Affecting PV Parks in Greece
- Methodology for Assessing Fire and Flood Risks
- Wildfire Risk Estimation and Factors
- Flooding Risk Assessment and Scenarios
- Conclusions and Mitigation Measures

Introduction

It is undeniable that climate change has significantly impacted various sectors of the global economy, including Renewable Energy Sources (RES) projects (e.g., Xu et al., 2024).

Natural disasters such as extreme flooding events, heatwaves, cold waves, and wildfires are not only becoming more frequent worldwide but are also increasing in intensity.



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Xu, L., Feng, K., Lin, N., Perera, A.T.D., Poor, H.V., Xie, L., Ji, C., Sun, X.A., Guo, Q. and O'Malley, M., 2024. Resilience of renewable power systems under climate risks. Nature reviews electrical engineering, 1(1), pp.53-66.

Natural disasters in Greece

In Greece, in particular, significant catastrophic events have occurred in recent years that should alert us

NEWMONEY.gr (2023)«Πνίγηκαν» τα φωτοβολταϊκά στη Θεσσαλία – Πάνω από 1.000 MW η εγκατεστημένη ισχύς στους 4 νομούς του κάμπου
ENERGYPRESS.gr (2023). Στα «χέρια» των ασφαλιστικών οι παραγωγοί φωτοβολταϊκών της Θεσσαλίας – Οι δύο προτάσεις του ΠΣΑΦ για την κάλυψη των αποζημιώσεων που εκτιμώνται έως και εκατοντάδες εκατ. ευρώ.

Notable examples include:

- the major flooding caused by Storm Daniel in September 2023
- the devastating wildfires in the North Evia Island areas (August 2021)
- the devastating wildfires in the Dadia National Park and Rhodes (summer 2023)

Methodology

In this context, two natural disasters—**wildfires** and **floods**—are assessed in a hypothetical photovoltaic (PV) park located in Greece.

Using the ArcGIS Pro software toolbox, the potential impact of these hazards can be visualized, and specific mitigation measures can be proposed to reduce the risk of natural disasters.

Methodology – Wildfires risk estimation

Wildfire risk for this project has been estimated following the methodology proposed by Pallikarakis & Konstantopoulou (2024) which have utilized the multicriteria analysis capabilities of ArcGIS Pro.

Based on this methodology several criteria were considered for the assessment of fire risk, including geomorphological, social, environmental, and climatic factors.

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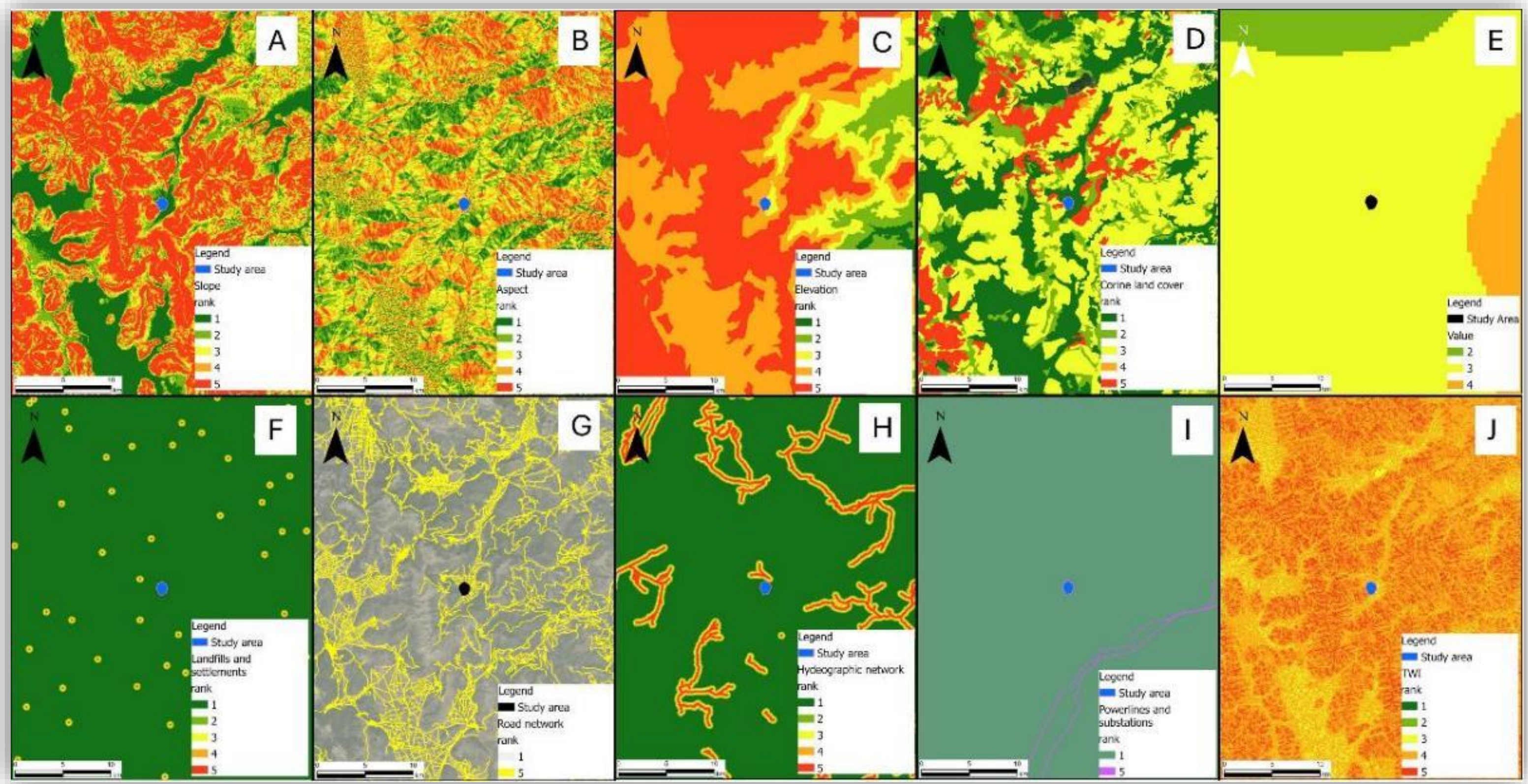
Pallikarakis, A. and Konstantopoulou, F., 2024. Multi-Criteria Wildfire Risk Hazard Assessment in GIS Environment: Projection for the Future and Impact on RES Projects Installation Planning. *Journal of Geoscience and Environment Protection*, *12*(5), pp.242-265.

Methodology – Wildfires risk estimation

Ten factors were considered in the assessment of fire risk, including geomorphological, social, environmental, and climatic elements. Following the methodology proposed by Pallikarakis & Konstantopoulou (2024), each factor has been ranked from 1 (low) to 5 (high), based on on data provided in the international literature.



A) Slopes
B) Aspect
C) Elevation
D) Land Cover
E) Fire Weather Index (FWI)
F) Distance from settlements and landfills
G) Distance from road network
H) Distance from hydrographic network
I) Distance from high voltage OHL/substations
J) Topographic wetness index (TWI)

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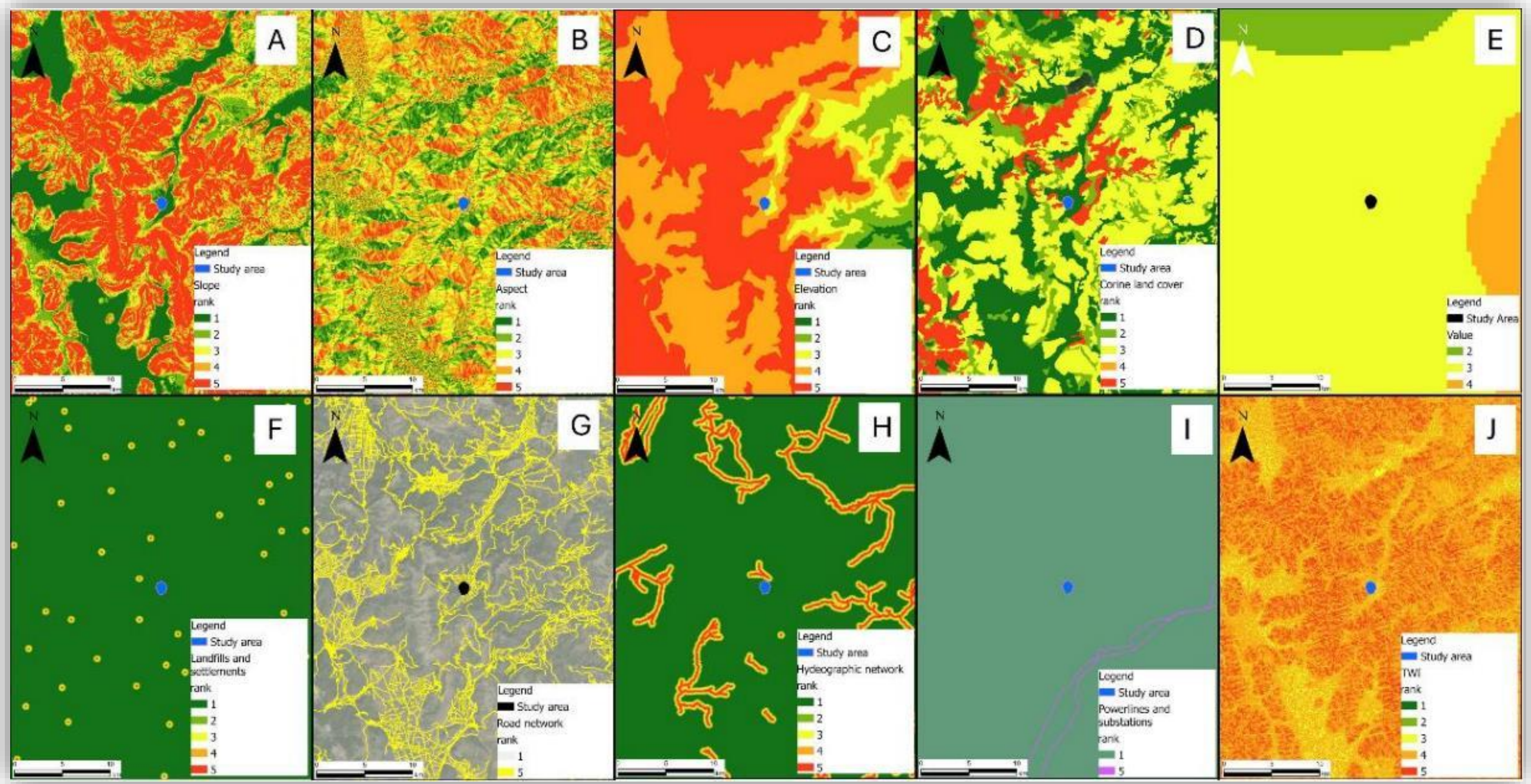
Methodology – Wildfires risk estimation

The next step was to evaluate **the significance of each factor** using the Analytic Hierarchy Process (AHP). Factors such as slope, Fire Weather Index (FWI), and land cover were deemed more significant than others and play a more crucial role. Finally, through Multi-Criteria Decision Analysis (MCDA) and the Analytic Hierarchy Process (AHP), fire risk was assessed for both current and future conditions (2031- 2060).



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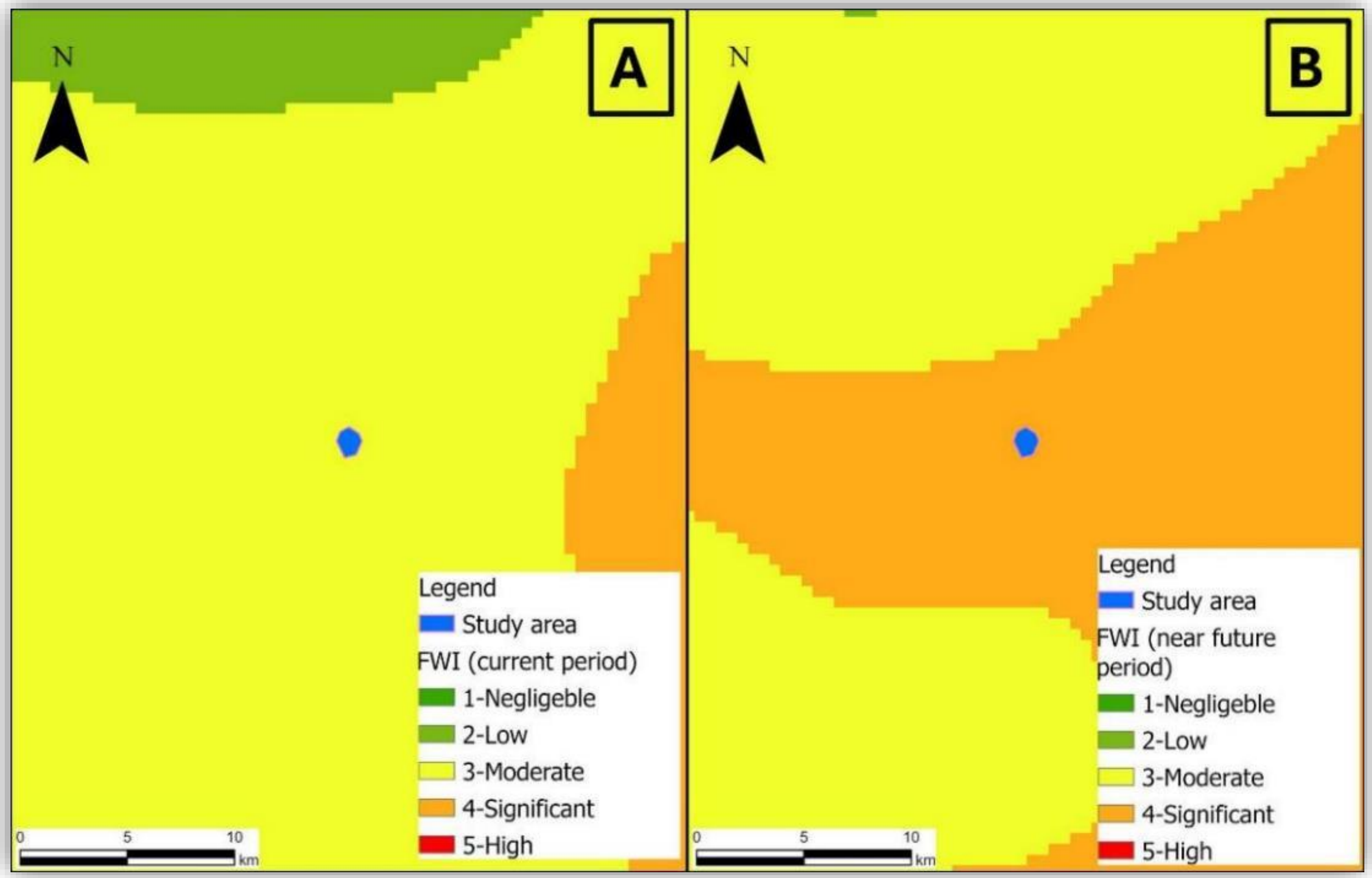
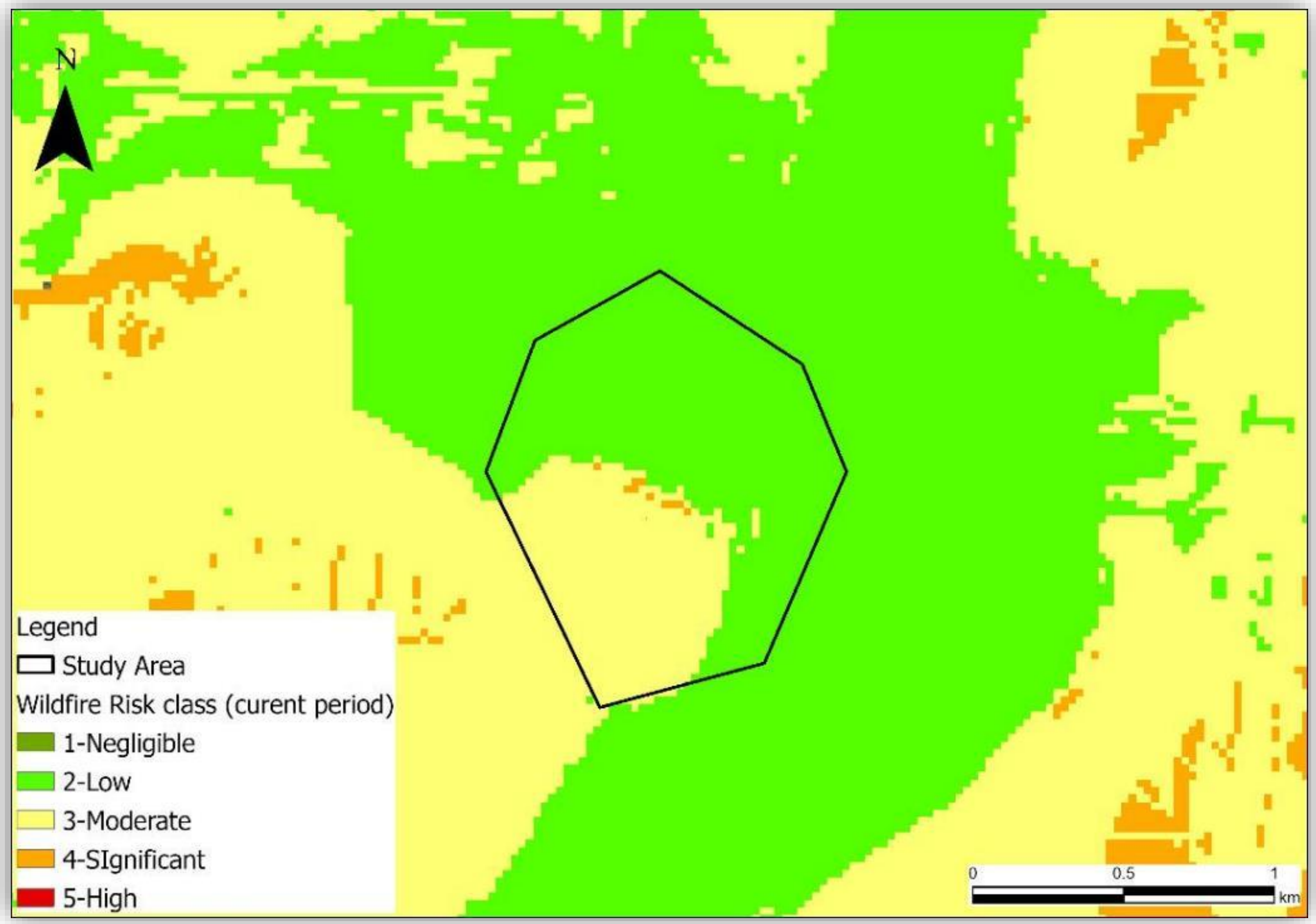
Methodology – Wildfires risk estimation



Based on data provided by the adaptivegreecehub, the Fire Weather Index (FWI) for the current period (A) and the near future period (B) for the area are available.

Notably, climatic conditions are expected to become more favorable for fires in the future. Consequently, fire risk can be assessed for both current and future conditions (2031-2060).

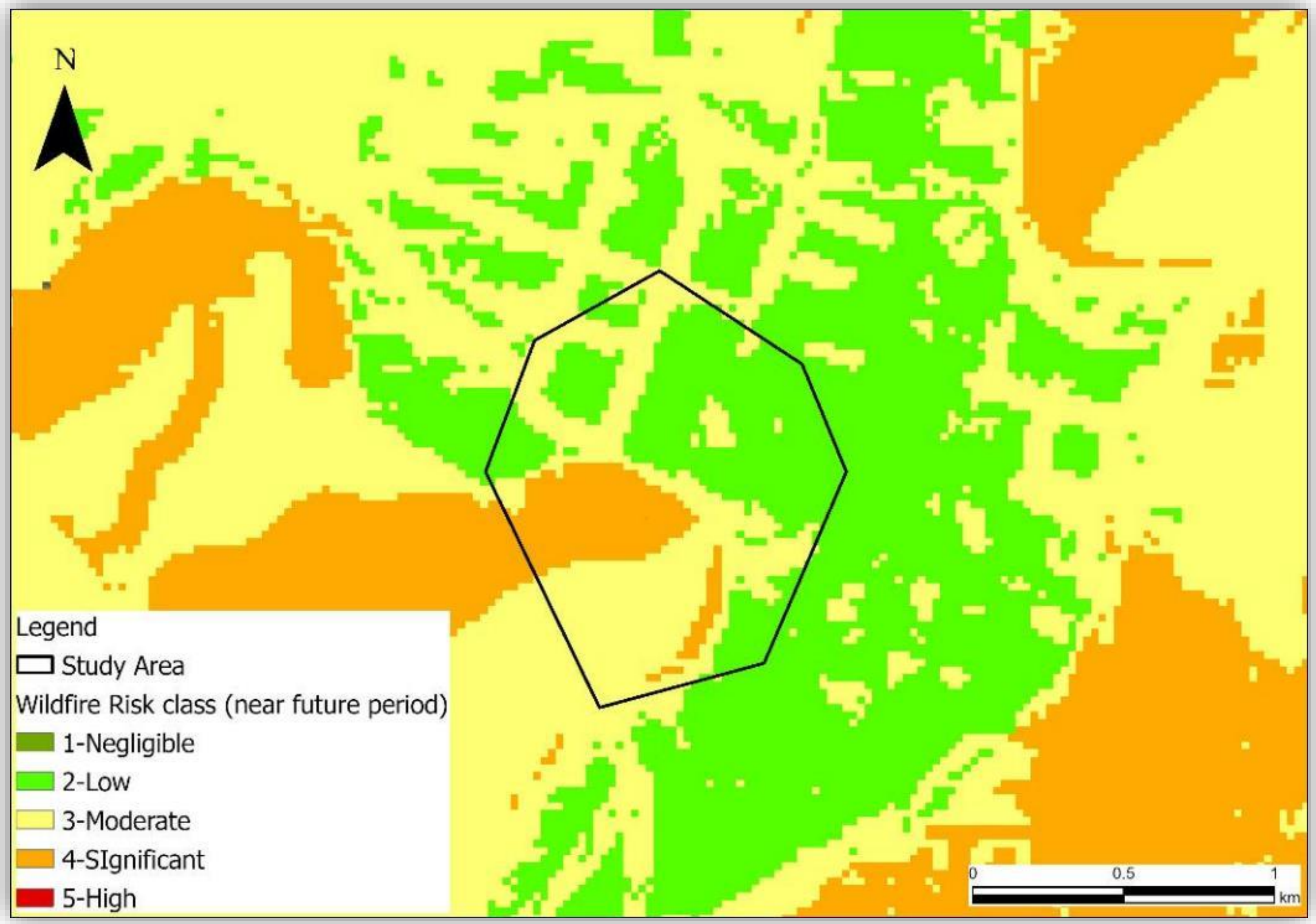
Wildfire Hazard Risk - current



Following the previously described methodology, the Wildfire Hazard Risk of the area has been estimated and categorized into five classes, ranging from Negligible (scale 1) to High (scale 5).

It is evident that, based on this methodology, the wildfire risk in the area is predominantly classified as **Low**.

Wildfire Hazard Risk - future



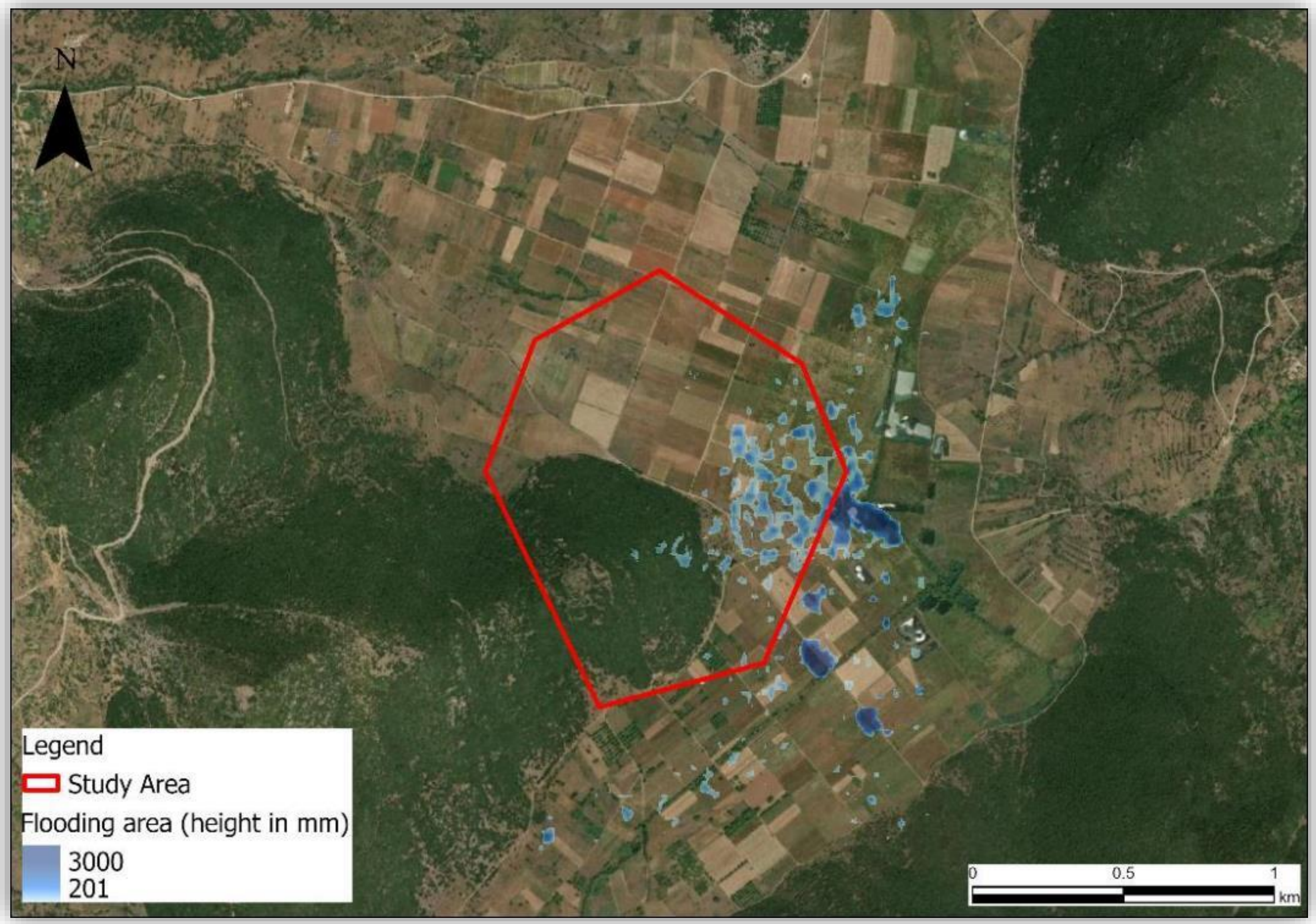
Additionally, the Wildfire Hazard Risk for the future period (2031-2060) can be estimated using the data for the future Fire weather Index (FWI) provided by adaptivegreecehub, as mentioned before.

Based on the above, the wildfire risk in the area is expected to increase and some areas will also face **significant risk**.

Methodology – Flooding risk estimation

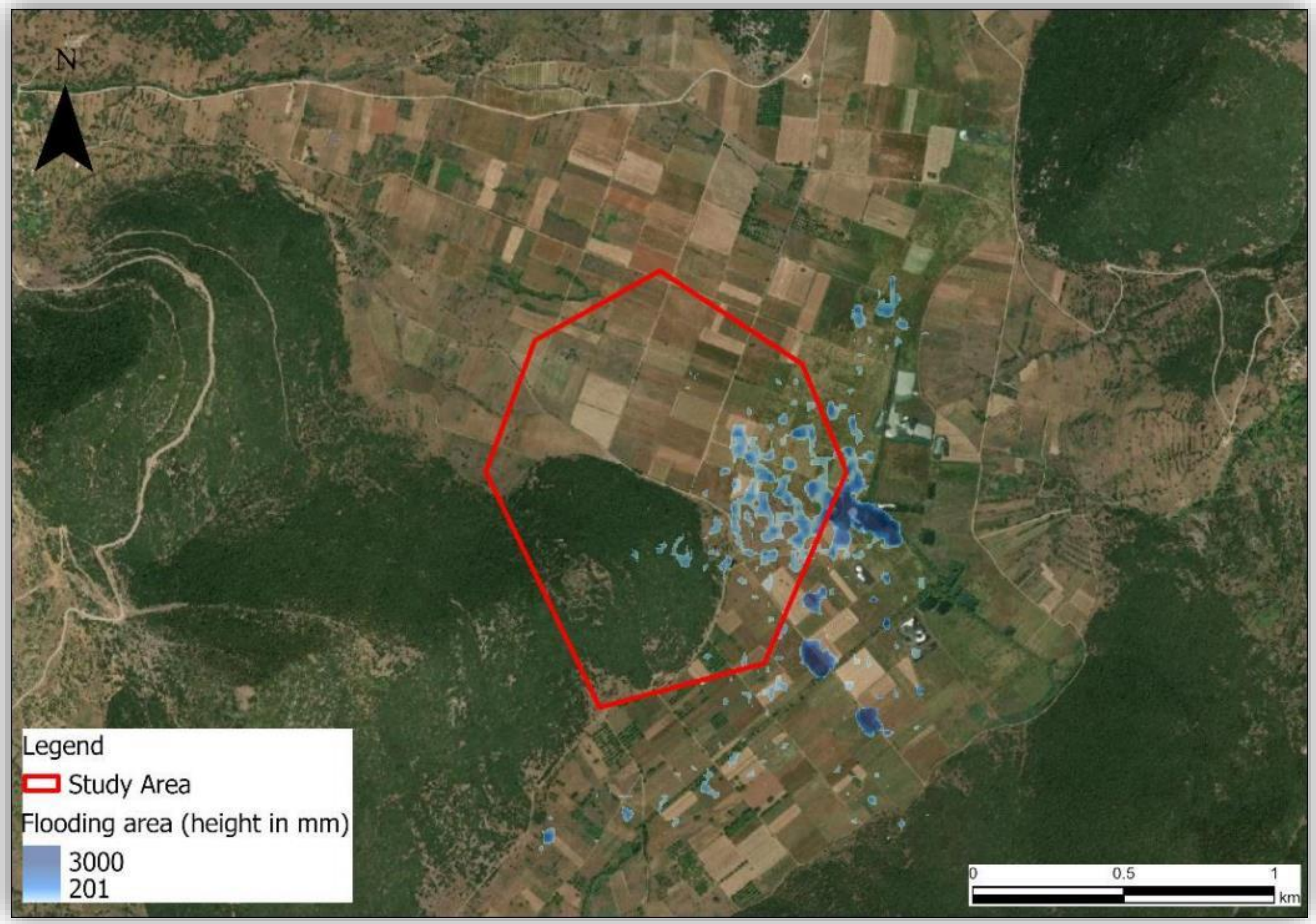
Regarding the **flooding risk,** the impact of heavy rainfall on the area of the hypothetical PV park has been analyzed using ArcGIS Pro software tools (Flood Simulation). This tool provides an efficient means to visualize potential flood scenarios for a study area.

Methodology – Flooding risk estimation



For flooding analysis, data such as soil permeability, lithological formations, and rainfall height in the area have been utilized, based on international literature from sources like the Hellenic Survey of Geology and Mineral Exploration (HSGME) and Meteo.gr.

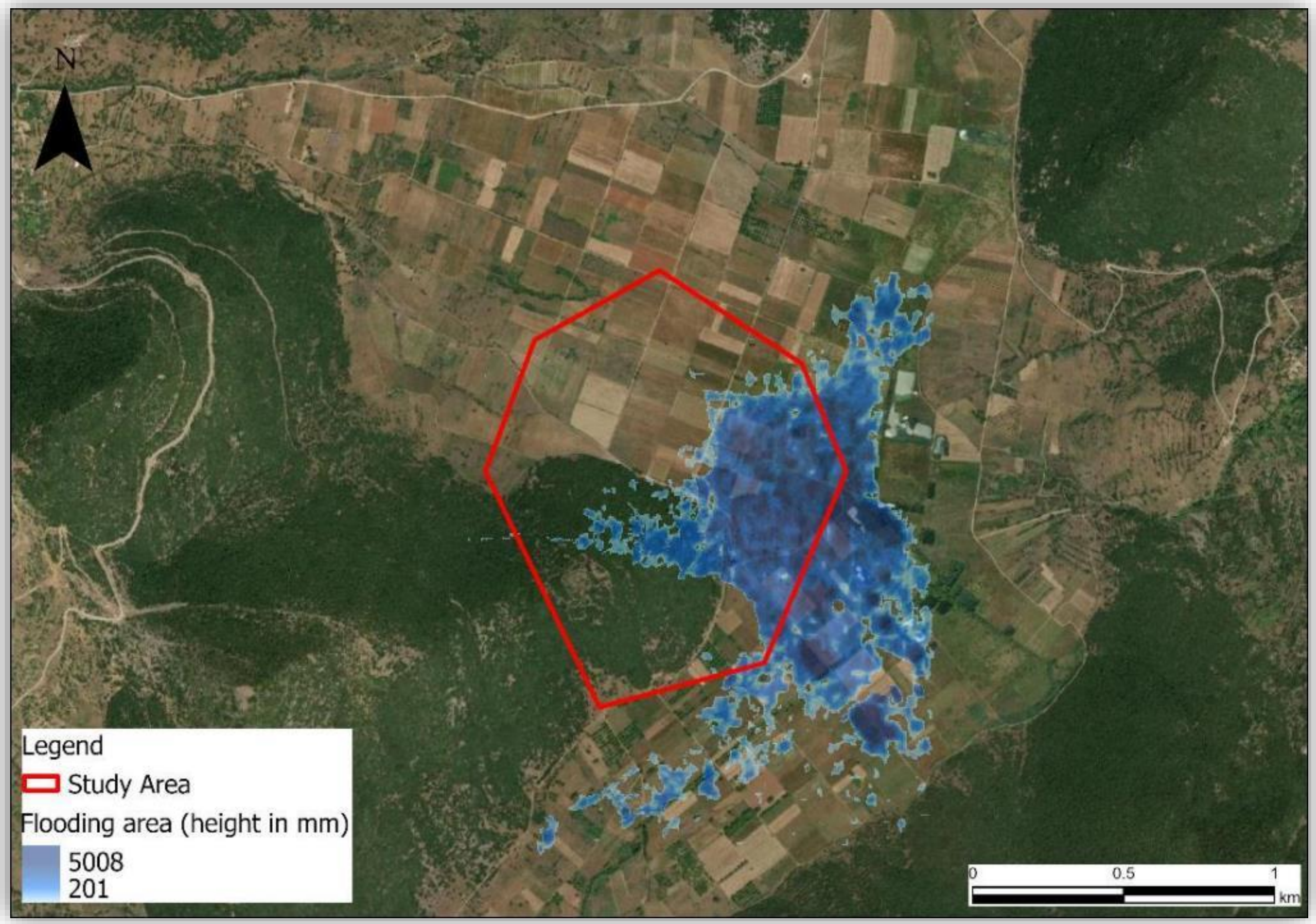
Flooding Risk - current



Two scenarios have been considered (current and extreme):

The **first** was based on the actual daily rainfall measured in 2024 at the nearby Ziria station (~85 mm, Meteo.gr). The results show that the flooded area is primarily located near the hydrological network of the area. The maximum height of the flooding surface within the studied plot is less than **0.6 meters.**

Flooding Risk - extreme



The **second scenario** was based on an extreme event, where the daily rainfall is equal to the estimated annual precipitation (~720 mm). The flooded area is significantly larger, where the water heights in the flooded area near the plot are ~5 meters and within the plot, **~1.6 meters**.

Conclusions

- The analysis of the two phenomena clearly indicates that severe events can cause major issues to PV infrastructure.
- Based on the methodologies applied, it is critical to note that RES infrastructures are projected to be significantly impacted by climate change in the future.
- This underscores the urgent need for proactive measures to mitigate these anticipated adverse effects during the PV park design phase.

Mitigation measures

Prevention is the most cost-effective and safest method for any facility

Some proposed mitigation measures are:

- Adequate spacing between the panels (e.g., Namikawa et al., 2017) and installing fireproofing equipment.
- Measures such as elevated foundations for the PV panels or even relocation of the panels in neighboring plots should be considered.
- Redesigning PV panels to incorporate even more fireproof materials.

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Namikawa, S., Kinsey, G., Heath, G.A., Wade, A., Sinha, P. and Komoto, K., 2017. Photovoltaics and firefighters' operations: best practices in selected countries (No. NREL/TP-6A20-68415). National Renewable Energy Lab.(NREL), Golden, CO (United States).

EXERGIA, Climate Change Consultants

Βουκουρεστίου 15, ΤΚ 106 71 Αθήνα
T: +30 210 6996185
http://www.exergia.gr