

Geostatistical modelling for invasive plant species distribution mapping and visualization using spatio-temporal data

Katarzyna Bzdęga¹, Adrian Zarychta¹, Roksana Zarychta²,
Sylwia Szporak-Wasilewska³, Barbara Tokarska-Guzik¹

¹ Institute of Biology, Biotechnology and Environmental Protection, Faculty of Natural Sciences, University of Silesia in Katowice, Poland; katarzyna.bzdega@us.edu.pl

² Institute of Geography, Faculty of Exact and Natural Sciences, Pedagogical University of Krakow, Poland

³ Water Centre WULS, Institute of Environmental Engineering, Warsaw University of Life Science, Poland

INTRODUCTION

Plant species distribution modelling focused on forecasting their spread is an essential for maximizing efficiency and economy for management of invasive species. The aim of the study was to model the current spatial distribution of invasive *Heracleum sosnowskyi* and to predict its coverage with geostatistical tools and space time pattern mining.

MATERIAL & METHODS

The main subject of our interests was *Heracleum sosnowskyi* invasive biennial or perennial plant, reproduces exclusively by seeds, The study was carried out for HE2 area where grows *H. sosnowskyi*. The field data were acquired in dates of species optimum development on selected area in 2017-2019 to generate spatio-temporal cover pattern of the invasive plant species *H. sosnowskyi*, and then predict its spatial distribution in 2020 with the use of SGS (Sequential Gaussian Simulation) and Space Time Cube.

ANALYSIS RESULTS

To visualize the spatial variability of the analyzed species, variograms in HE2 area and years were created. In order to verify the correctness of the conducted modelling the cross-validation was tested. The values of each calculated error (e.g. Mean Error, Root Mean Square, Average Standard Error, Mean Square Error) oscillated from 0.0008 to 0.7942, whereas Root Mean Square Standardized Error took values more than one i.e. between 1.2685 and 1.9725. These error values underline correctness of SGS (Tab.1). For the purpose of this study, the collected field data were tested for the presence of spatial autocorrelation by computation of the Local Outlier Analysis (Anselin local Moran's I statistic) and Emerging Hot Spot Analysis z-score for the analyzed species on the area in three years. The results showed that z-score (3.42-12.75) indicate significant clustering of spatial phenomena, which confirmed the existence of a spatio-temporal patterns. The results revealed new, consecutive hot spots of *Heracleum* which were appearing in HE2 area.

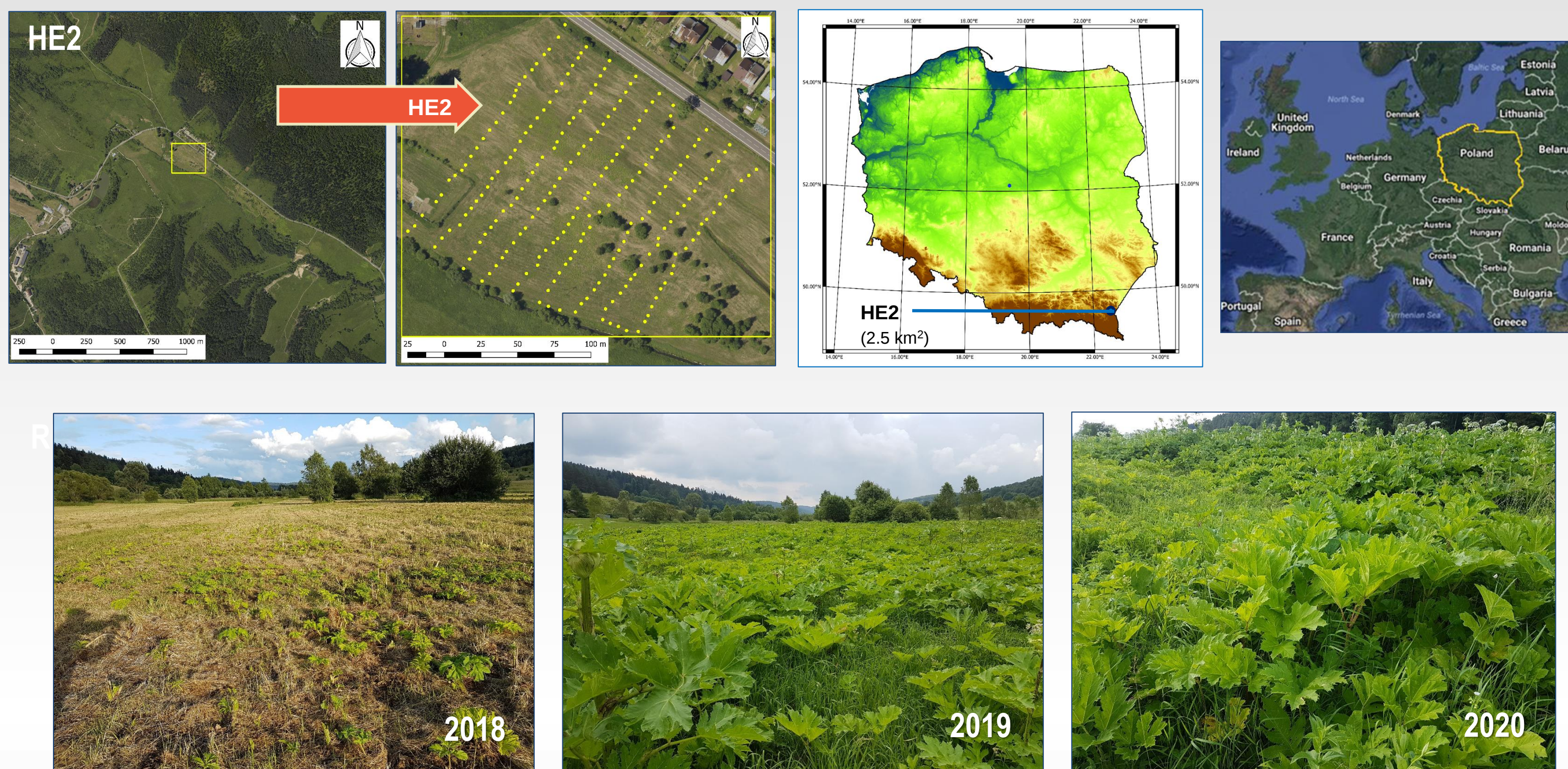


Table 1	Time	ME	RMS	ASE	MSE	RMSSE
HE2	2017	0.004	0.678	0.684	0.002	1.454
	2018	0.001	0.793	0.794	0.0008	1.268
	2019	0.034	0.706	0.639	0.021	1.972

Explanations: ME - mean error, RMS - root mean square error, ASE - average standard error, MSE - mean square error, RMSSE - mean square standardized error

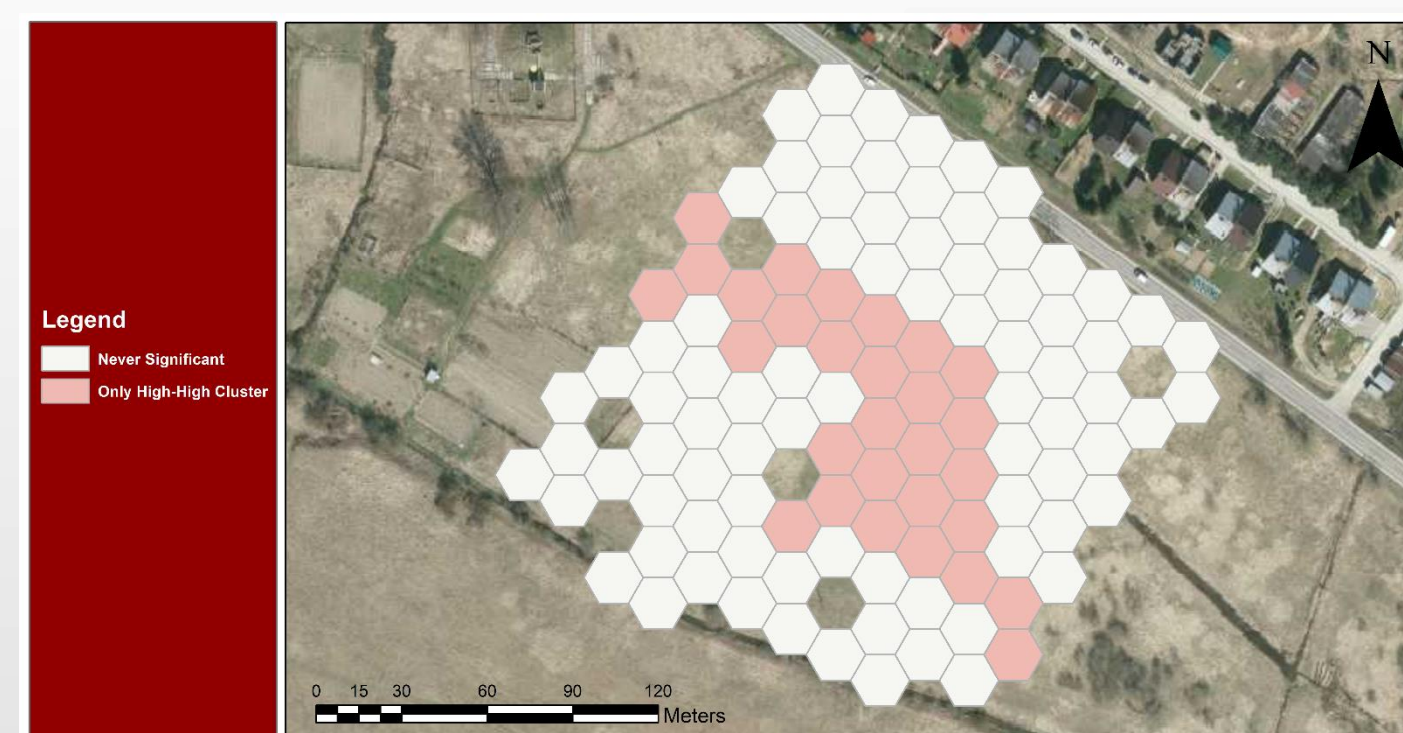


Fig. 1. Local Outlier Analysis (Anselin local Moran's I statistic).

unconfirmed by field verification in 2020

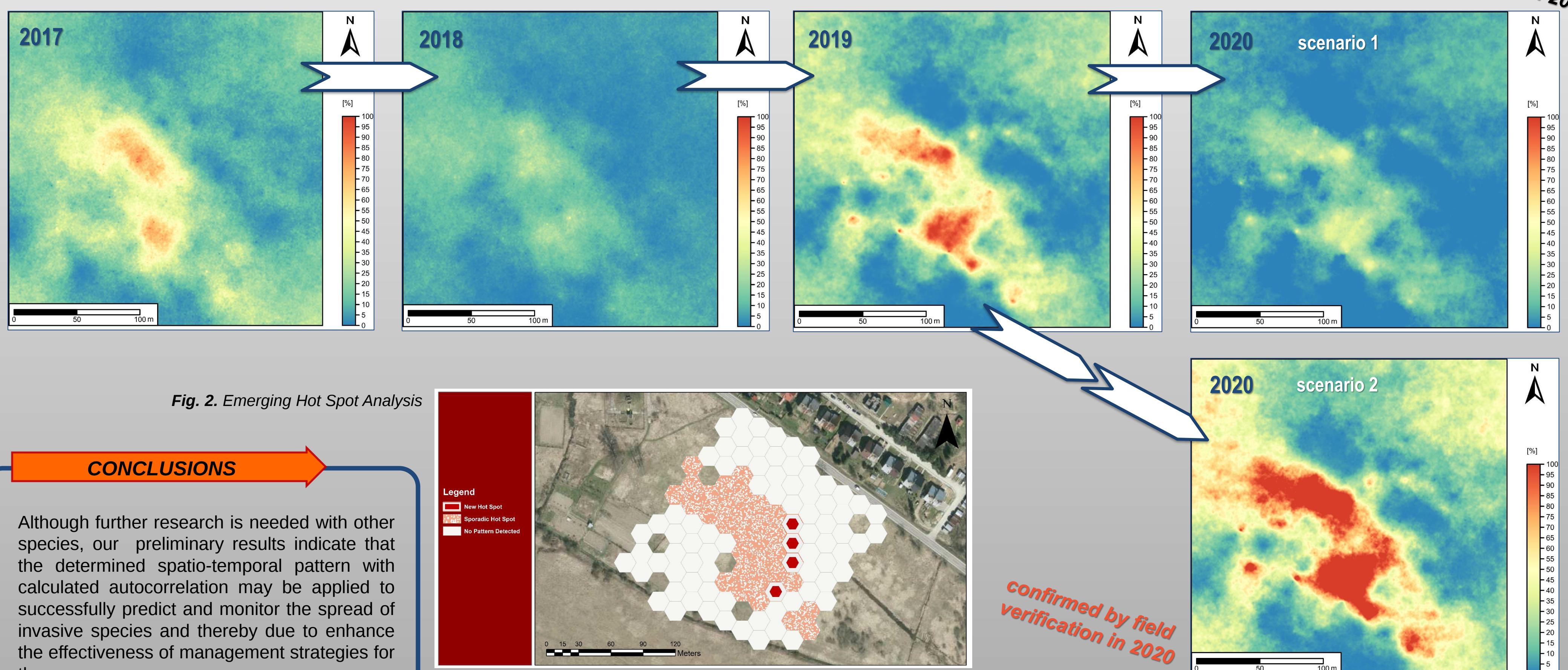


Fig. 2. Emerging Hot Spot Analysis

CONCLUSIONS

Although further research is needed with other species, our preliminary results indicate that the determined spatio-temporal pattern with calculated autocorrelation may be applied to successfully predict and monitor the spread of invasive species and thereby due to enhance the effectiveness of management strategies for them.

confirmed by field verification in 2020