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GIS Technology for Documentation of Wall Paintings in Northern Portugal with a Dark Stain Phenomenon

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Introduction

We often come across a problem of deterioration in some 15th and 16th century mural painting (MP) ensembles on the inner walls of granitic Romanesque religious buildings in the north of Portugal (fig. 1). It is manifested by the presence of dark pigmentation staining both granite supports and mural paintings (Marco, 2016 and 2019). The origin of this phenomenon is unknown and may be due to synergy of factors such as microbiological and chemical attacks.

Figure 1. 1. N. Sra. da Azinheira Church (Chaves); 2. Sta. Leocádia Parish Church (Chaves); 3. S. João Baptista da Comenda Church (Arcos de Valdevez); 4. S. Salvador de Ceivães Church (Monção); 5. Sta. Maria Madalena Church (Melgaço); 6. S. Julião de Montenegro Parish Church (Chaves); 7. S. Brás Chapel (Vila Real); 8. Mouçós Parish Church / N. Sra da Guadalupe Church (Vila Real); 9. Cimo Vila Castanheira Parish Church / S. João Baptista Church (Chaves); 10. Sta. Cristina Church (Guimarães); 11. Sta. Maria de Negrelos Church (Sto. Tirso); 12. Sta. Marinha Church (Vila Real).

Objectives

▪ Gathering of relevant data associated to geographical issues and elaboration of a database in a Geographic Information System (GIS) (Burroughs & McDonnel, 1998; Huisman & Rolf, 2009) to understand and uncover spatial analysis correlations between potential factors of the deterioration;

▪ Study of georeferenced data to complement the characterisation of the microbiological species responsible for the degradation, as well as the material characterisation of the mural paintings (Campos, 2021);
▪ Mapping these case studies and their chromatic alterations, supports conservator-restorers in their conservation activities, and will serve as a strategy for a preventive conservation guideline.

Methods

A map was created on open-source software (QGIS®) to pinpoint the location of each case study and its relevant information for characterization of this phenomenon with the incorporation of other maps such the lithology of the region (fig. 2) and climatic variables (precipitation, temperature, i.e.). A fire hazard regions map, and a hydrographic pathways map have been added as a tool for a preventive conservation viewpoint. All maps were obtained from the "SNIAmb platform" of the Portuguese Environment Agency (APA) (SNIAmb, s.d).
The algorithm used to associate the churches to each class of thematic maps was the "Count Points in Polygon": (QGIS > Vector > Analysis Tools > Count Point in Polygon).
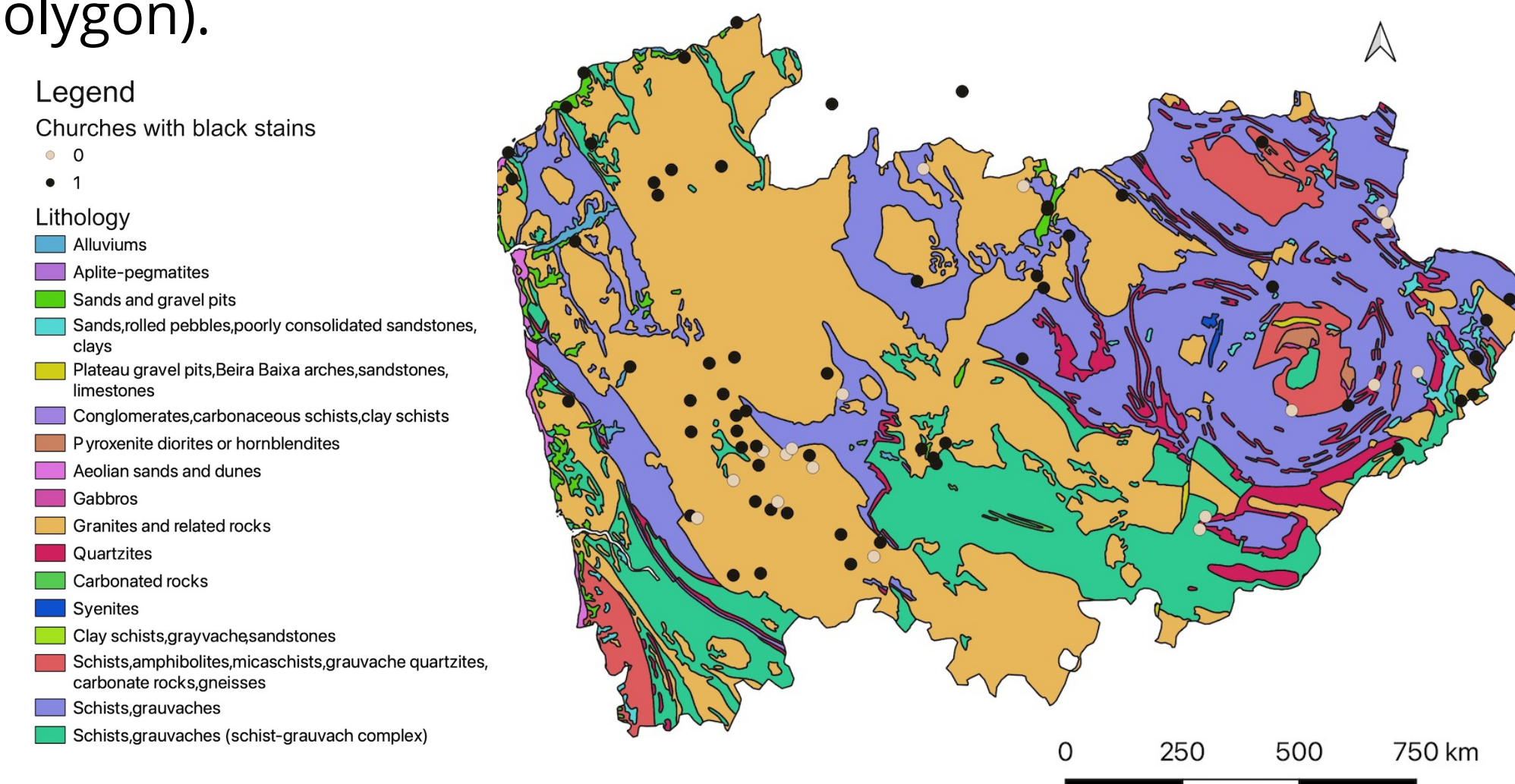

Figure 2. Lithologic map

Results and discussion

The processing results were observed in a new file (shapefile) and in the attribute tables quantitatively. An exhaustive survey of 90 churches was taken and 64 were observed *in situ* with dark stain phenomenon. In 21 no degradation was observed, and 5 need further inspection. Thirty-three churches are in the second high-level interval of the temperature (T) map (12,5-15ºC) and also 33 in the previous interval (10-12,5ºC). The observation of the lithologic map shows that 57% of churches with dark stains are located in granite and similar rocks region soil (fig. 2).

In Fig. 3, the selected churches are located mainly in the range of 1200-1400 mm (8 of 13 classes). The analysis suggest that conditions such as high-temperature associated with precipitation in medium-range intervals on specific rock regions may be associated with the dark stain phenomenon, although other variables must still be considered to fully grasp its origin. The database created with the geographical information and church characterization including church's cardinal orientation, environment surroundings (graveyards, waterways, etc.), construction date, as well as date, materials, painter, or guild (if possible) of mural paintings, and whether they are exposed to the environment or covered by mortar and or altars, will constitute a base for further studies.
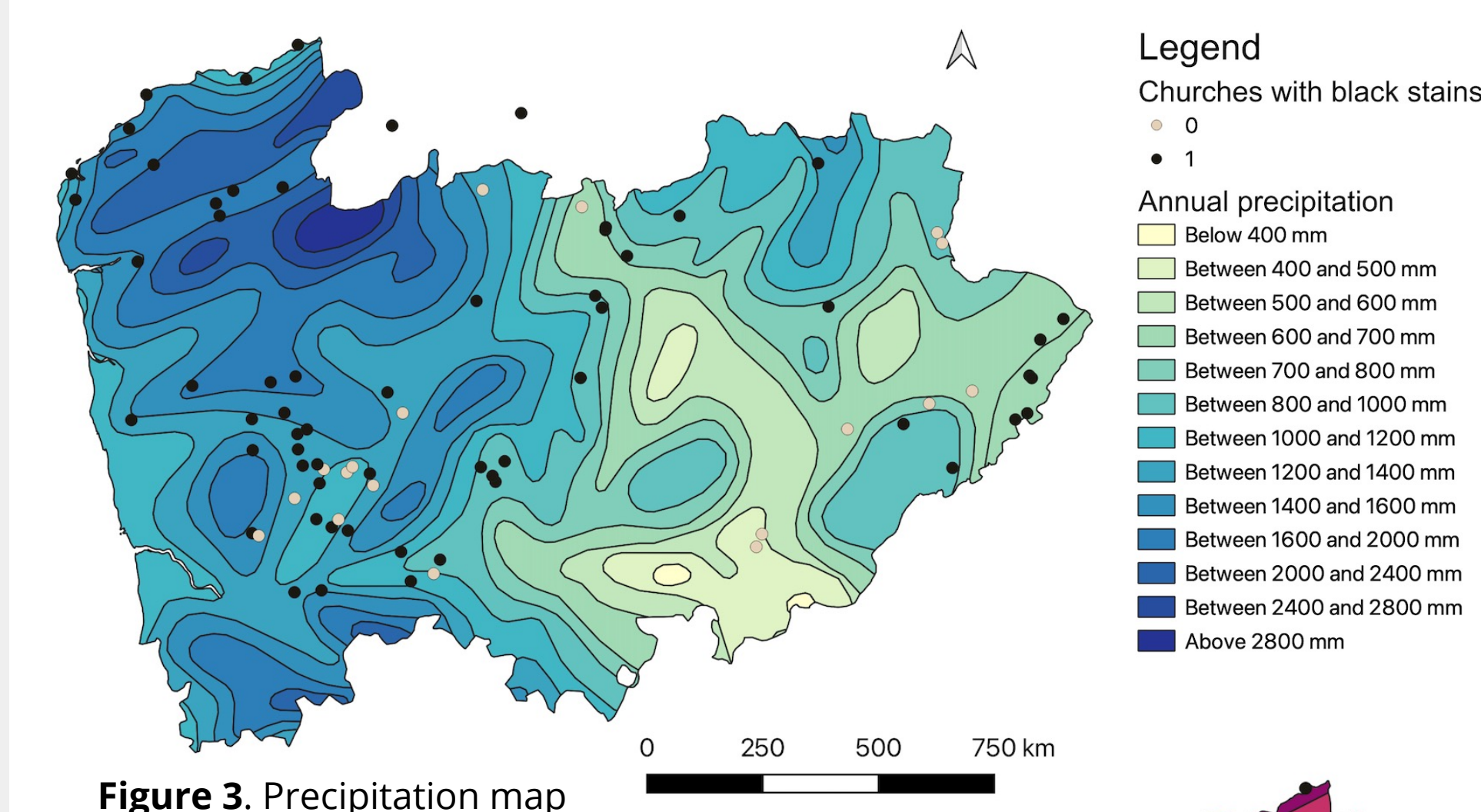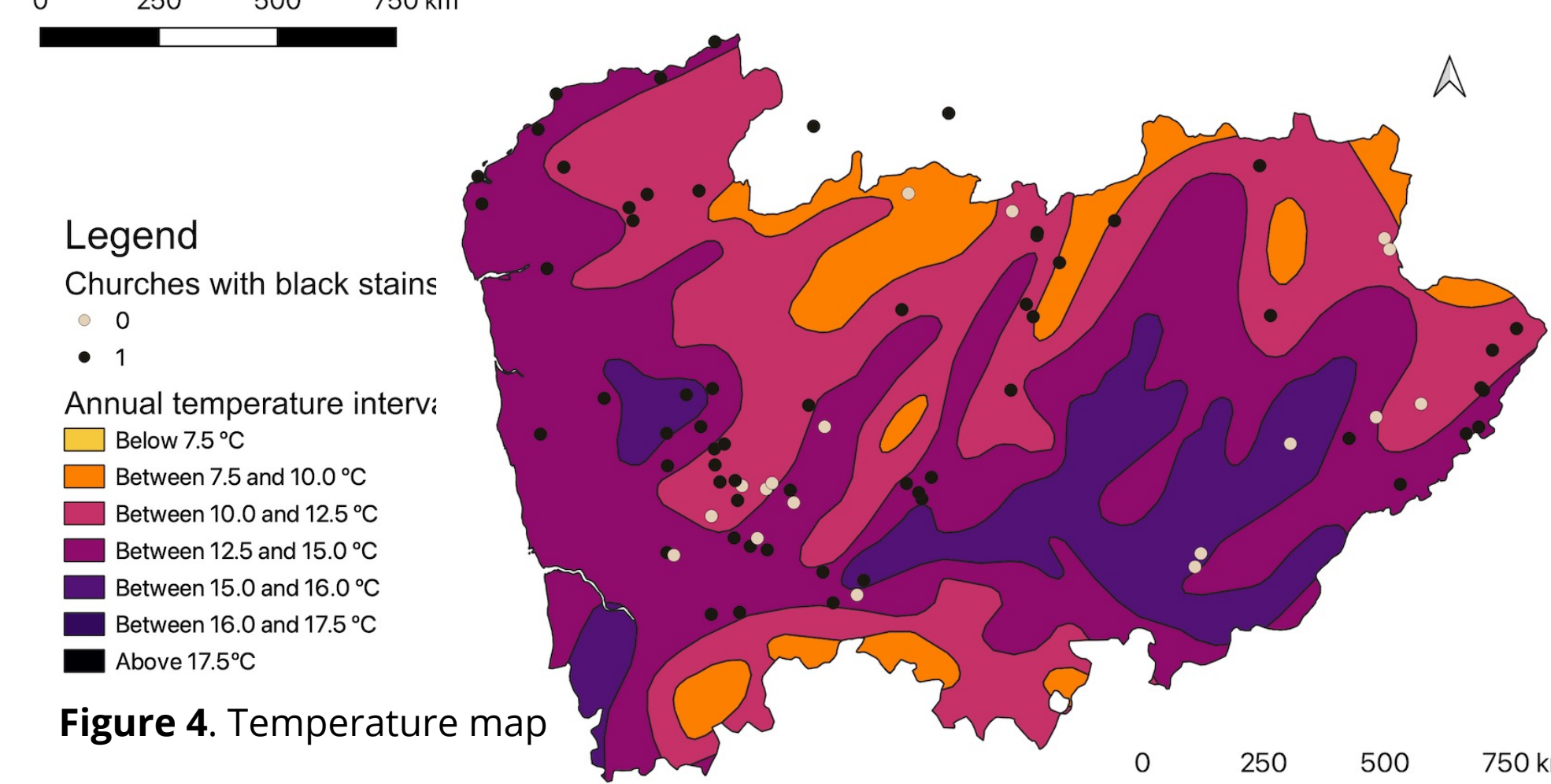

Figure 3. Precipitation map

Figure 4. Temperature map

Conclusions

Ninety mural paintings of northern Portugal and five in the north of Galicia were surveyed, and maps related to specific climate and geological variables were constructed that might indicate a relation between these variables and the black stain phenomenon. However, this relation must be further validated as well as expanded with other variables to help clarify the origin of this deterioration problem.

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