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At which distance are the soils influenced by the sea spray?

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INTRODUCTION

Sea spray, transported as liquid droplets or evaporated particulates, can be a significant contributor to the base cation content and cations equilibrium of coastal soils. Significant quantities of aerosols derived from sea spray can be transported inland by wind. There they are directly deposited on the soil surface, or on foliage, from which they are then transported to the soil surface during subsequent precipitation. In particular, the marine salt deposition may lead to an enrichment of exchangeable sodium in soil. Large amounts of exchangeable Na in soils are known to influence some soil physical properties and may also affect the growth of some sensitive crops and impact the plant biodiversity. Recently, several large storm events happened in western France, and may have led to an increase in exchangeable Na content in soils. In this study, our aim was to map the baseline value of exchangeable Na prior to these events on a study area bordering Atlantic Ocean.

MATERIAL AND METHODS

STUDY AREA

The study area covers 65,625 km² located in western France, close to the Atlantic Ocean (Fig. 1).

DATA

We used 2512 topsoil legacy data for which measurements of exchangeable Na were available. Land cover was classified into 3 broad classes: drained marine marsh, forest and other (Fig. 2).

MODELLING AND VALIDATION

We used a recent robust geostatistical algorithm proposed by Saby *et al.*, (2011) to map the ratio Na+/CEC (Na/T). This algorithm uses the winsorising method to separate the spatial distribution of Na/T according to:

- the effect of land cover,
- continuous gradients within land cover classes and,
- anomalous point processes.

The appropriateness of the fitted model was tested by leave-one-out cross-validation and the mean and the median of the squared standardizing prediction errors (SSPEs) were calculated.

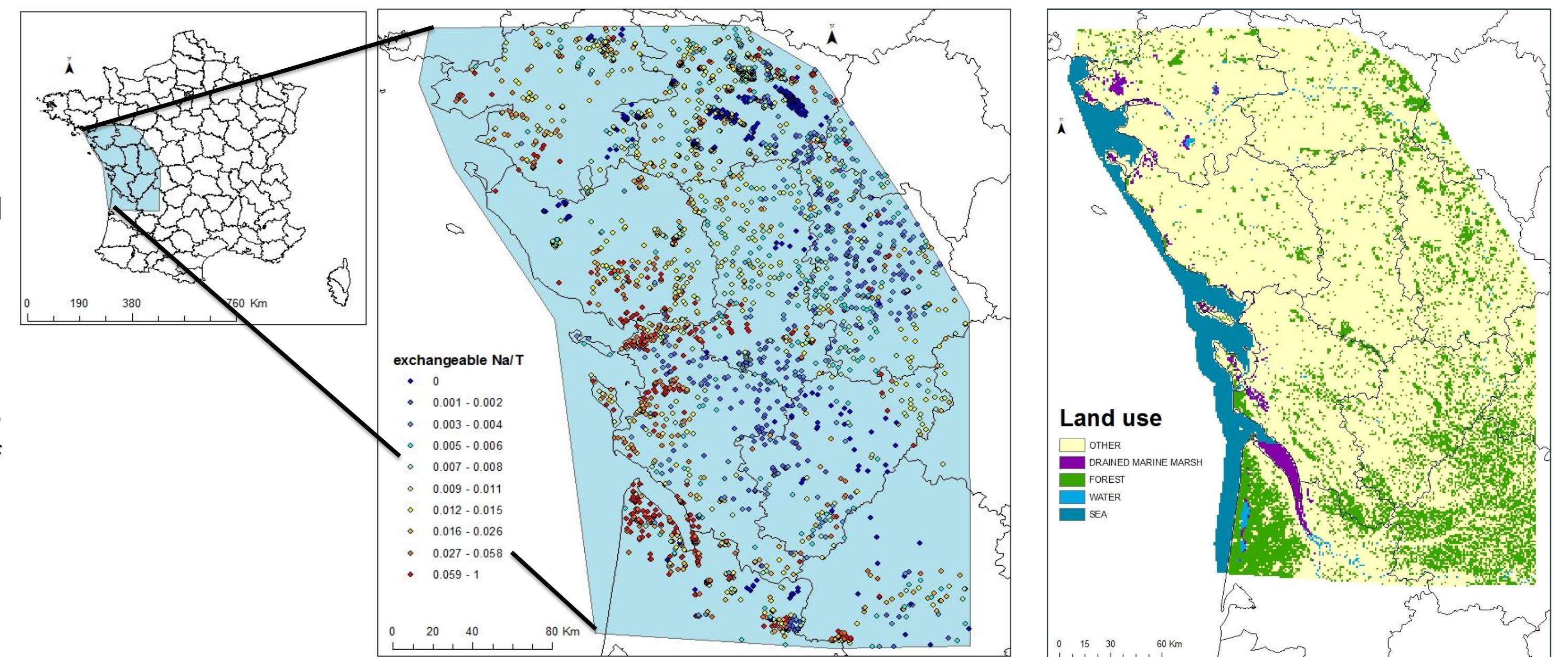


Fig. 1: location of the study area

Fig. 2: land cover

RESULTS

LAND COVER EFFECT

The largest Na/T was observed in drained marine marsh followed by forest land cover (Fig. 3).

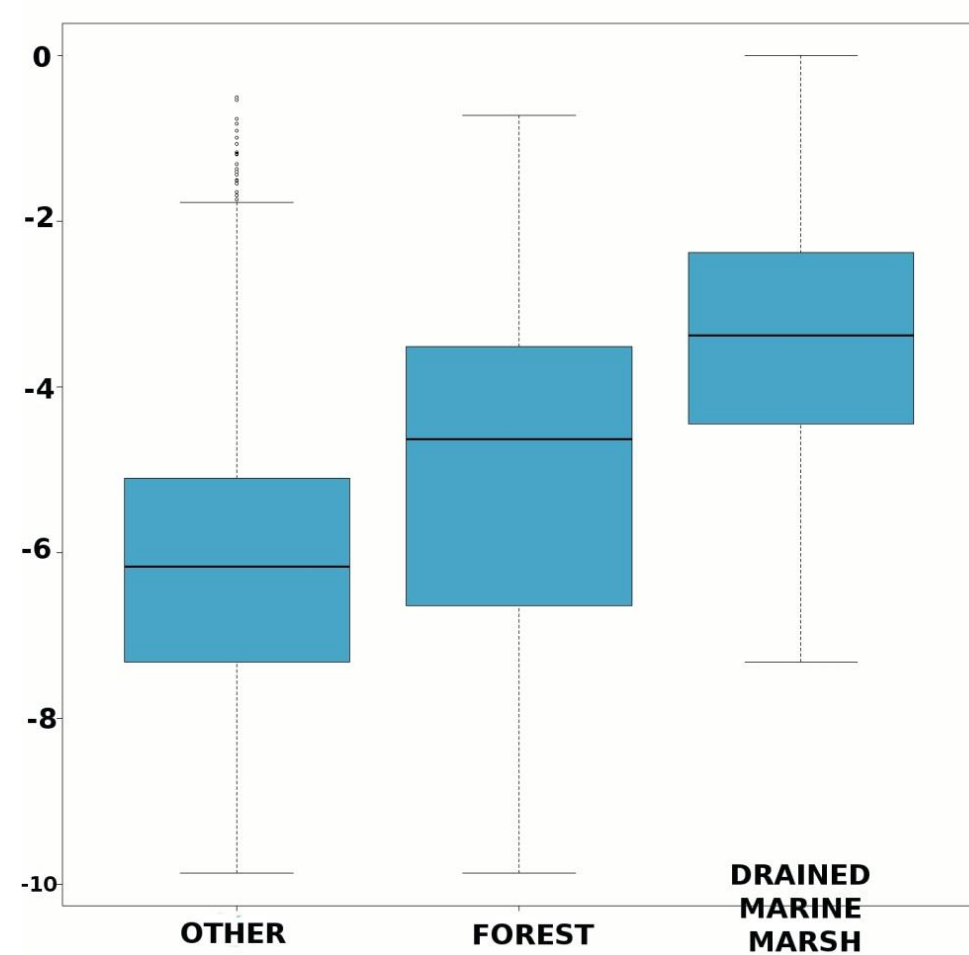


Fig. 3: box-plot

VARIOGRAM

The variogram exhibits two nested spatial structures. We adjusted the experimental variogram using a spheric structure from 0 to 0.8 km, and then an exponential one from 0.8 to 15 km (Fig. 4).

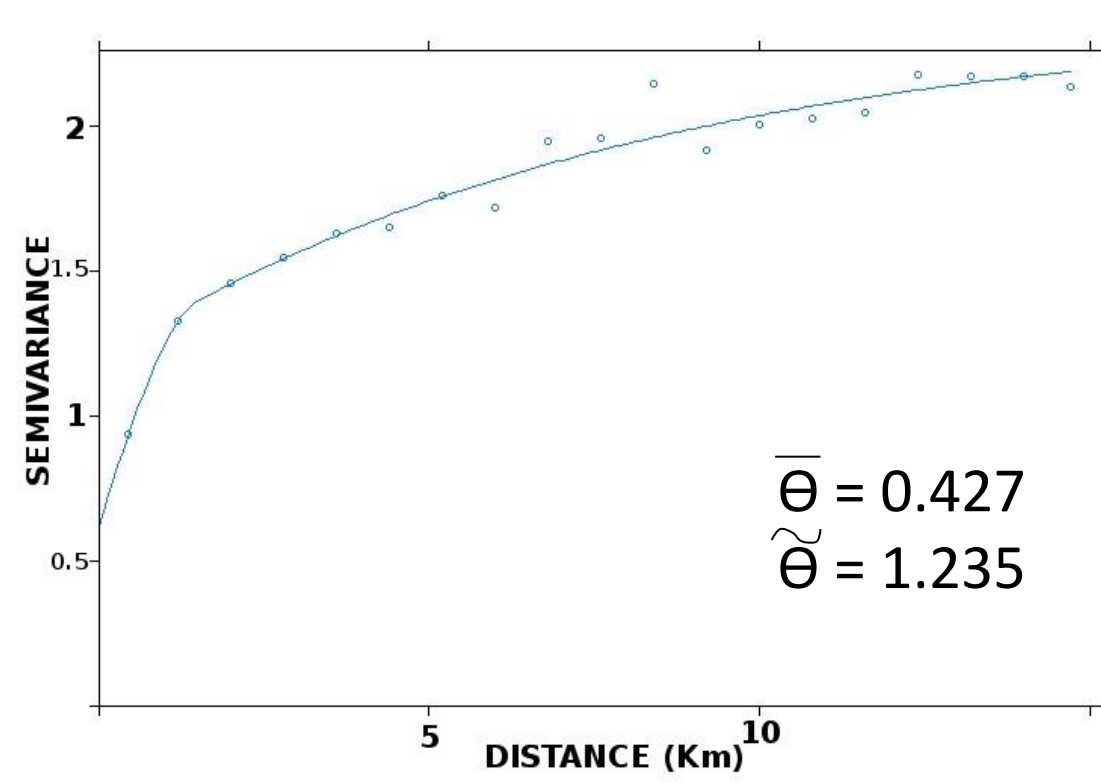


Fig. 4: variogram modelling

MAPPING

The geographical distribution of Na/T is highly complex, since hot-spots are superimposed upon more regular patterns linked to land-cover and to diffuse natural gradients coming from the sea spray (Fig. 5). The influence of the sea spray may reach up to 50 to 70 km far from the coast line. On the eastern part of the map a large area of high Na/T values is observed and still needs to be explained (Fig. 6).

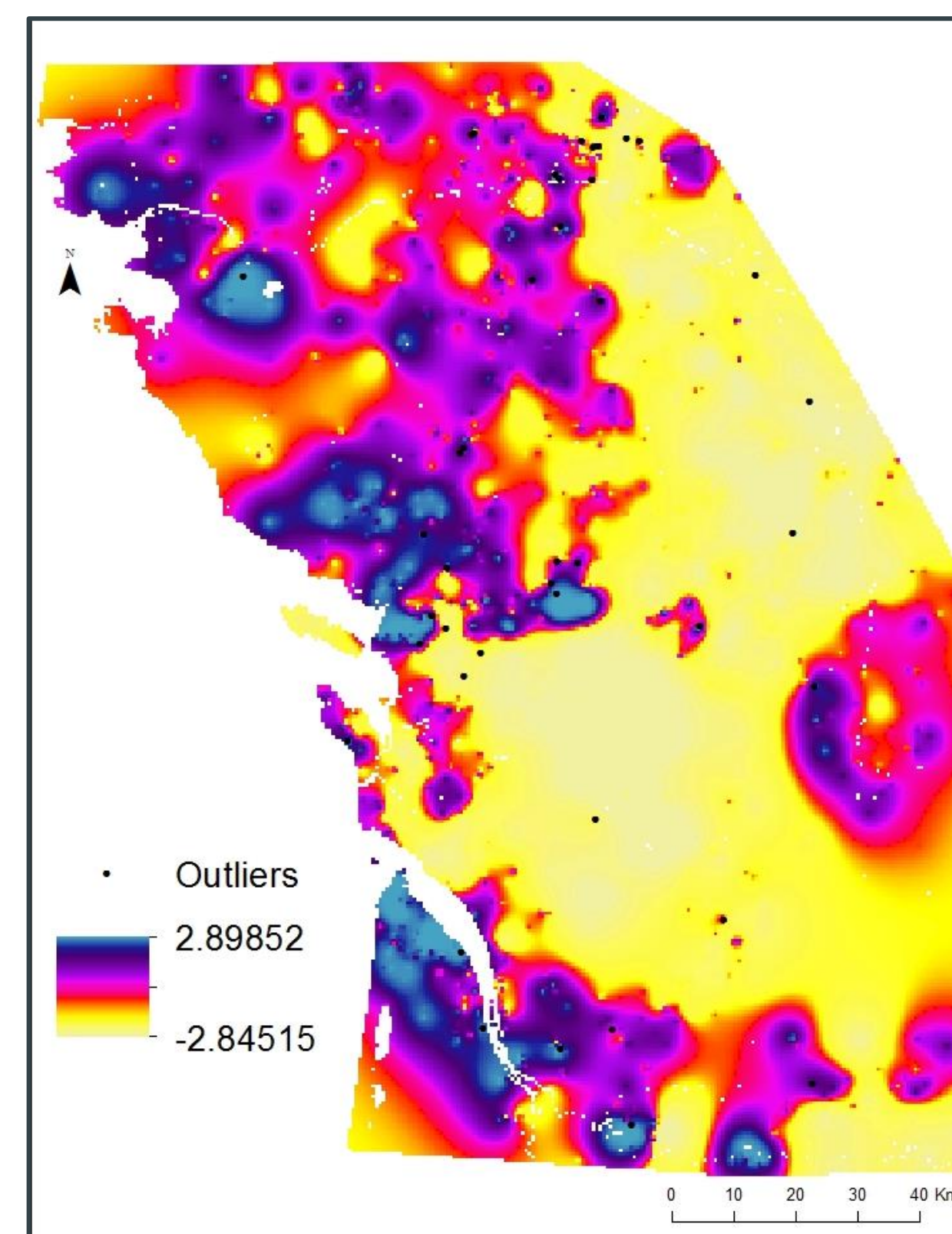


Fig. 5: random effect

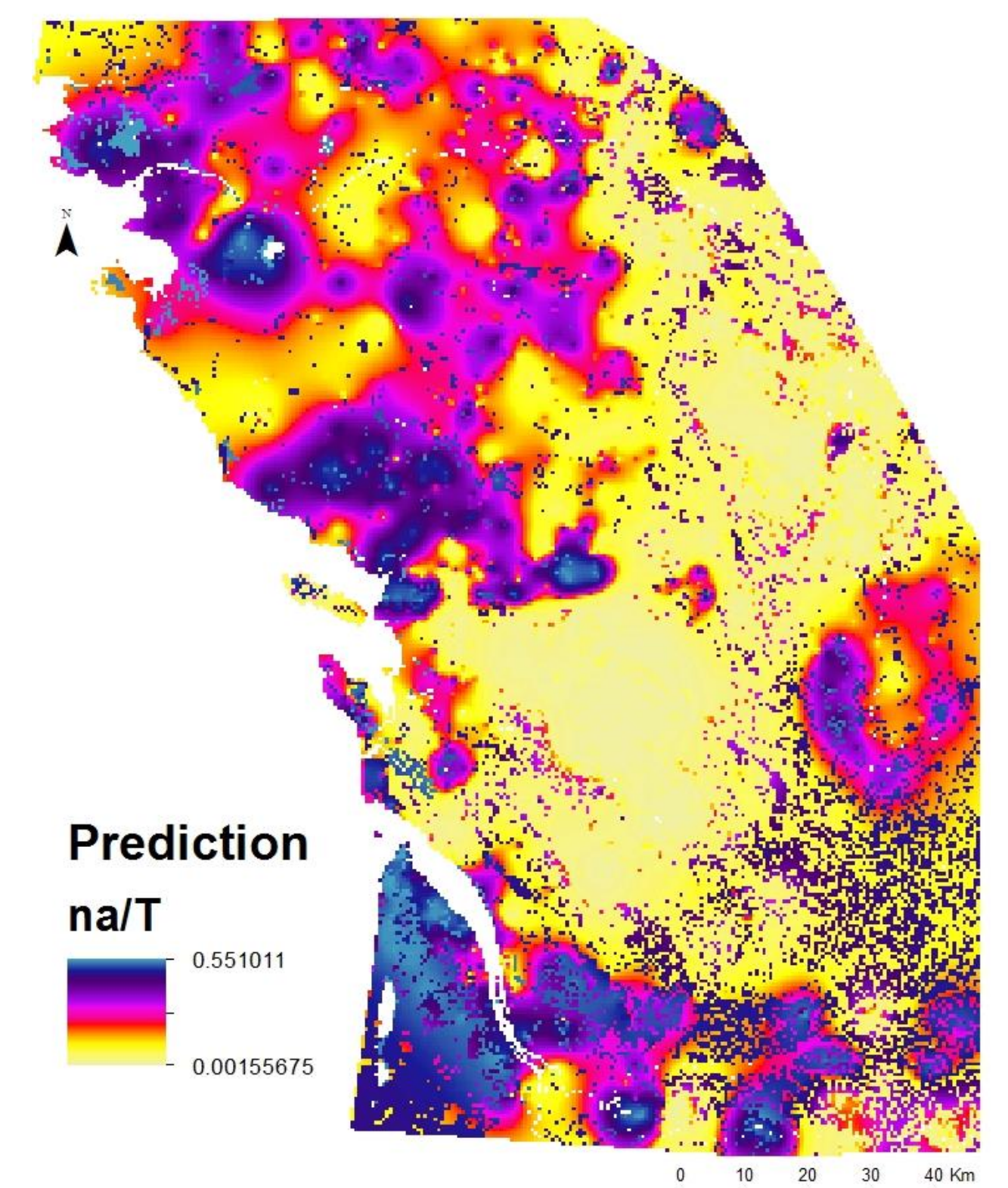


Fig. 6: prediction of Na/T

DISCUSSION & CONCLUSION

This study is a preliminary attempt to assess the influence on sea spray on Na/T in coastal soils. The findings demonstrate:

- an obvious direct effect of sea water on sodic soils from marine marsh,
- an effect of forest, attributable to sea spray interception by leaves from which Na is then transported to the soil surface during subsequent rainfall events.

Further research should be conducted including analyzing the effect of other potential co-variates such as soil type, texture and carbonates content. Whatever, the results demonstrates that the sea spray may influence soil Na/T at quite large distances from the coast.