2023 Visual Resource Stewardship Conference
Exploring Multisensory Landscapes

The prospects of reverse GIS visibility analyses for the anticipation and mitigation of landscape impacts of renewable energy projects in large scales

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THE PROBLEM OF VISIBILITY

1. Reasons for problems with visibility

<u>Renewable energy Infrastructure works</u>

<u>(particularly wind and solar)</u>

- Critique on **<u>industrialization</u>** of landscapes

Infrastructure with fixed form – no possibility of architectural intervention

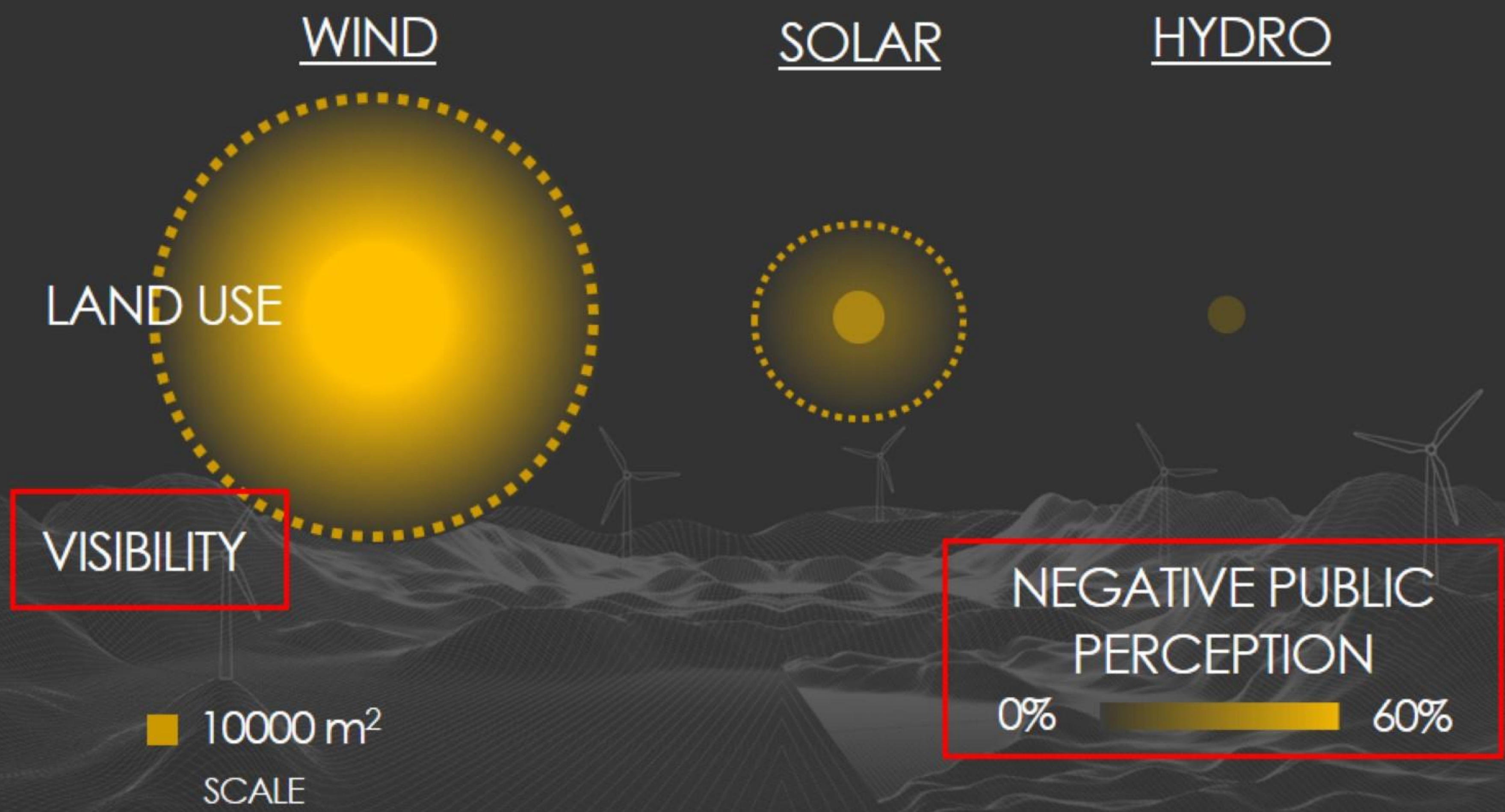
- Extensive **<u>spatial and visual</u>** impact of landscapes

More perceivable in wind turbines due to their size and movement

1.a QUANTIFICATION of LANDSCAPE IMPACTS of RE

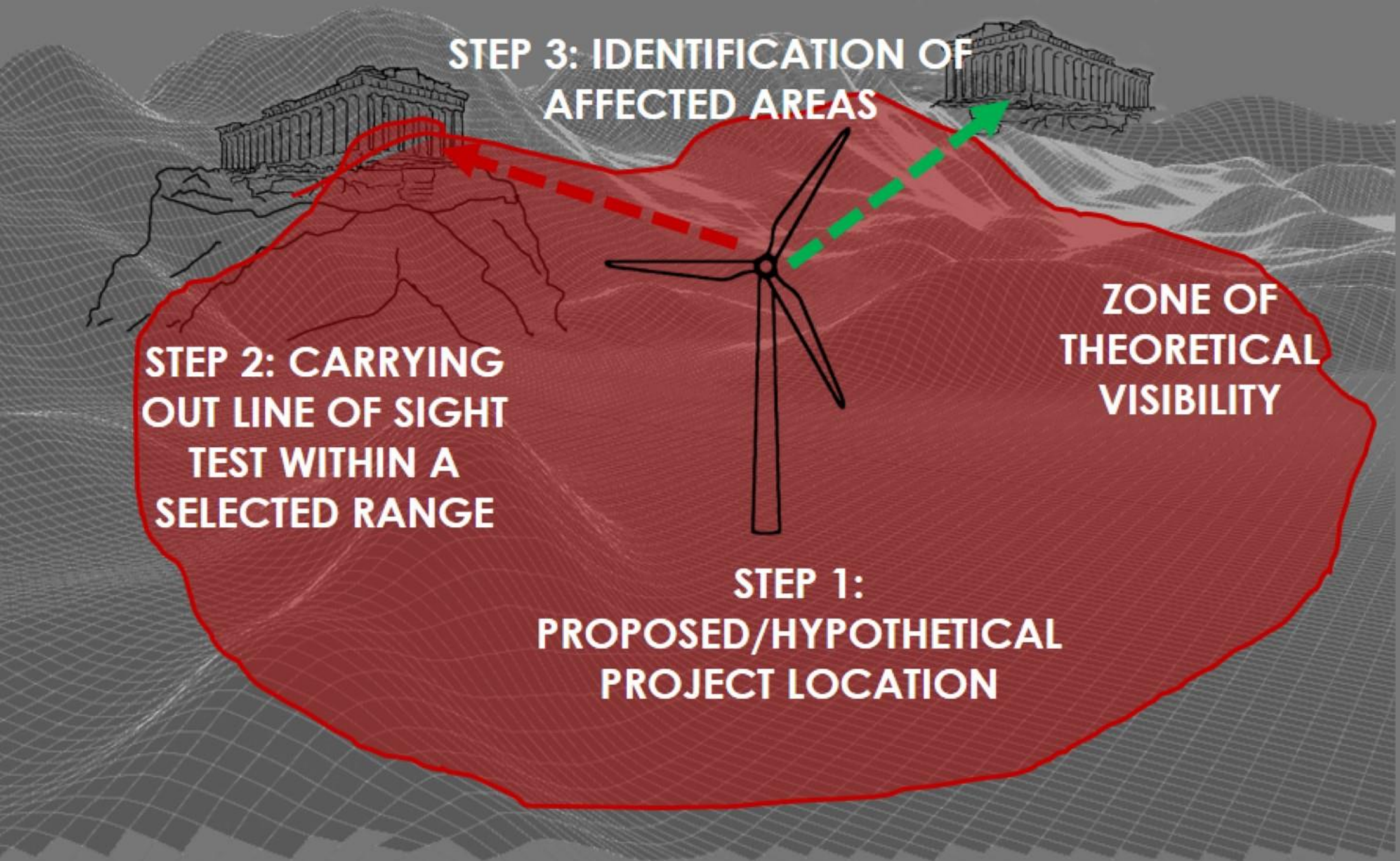
AVERAGES(per GWh/year)

Ioannidis, R., & Koutsoyiannis, D. (2020)



CHALLENGES FOR SPATIAL PLANNING WITH CONVENTIONAL VISIBILITY ANALYSIS
(in large spatial scales)

CONVENTIONAL ZTV VISIBILITY ANALYSIS

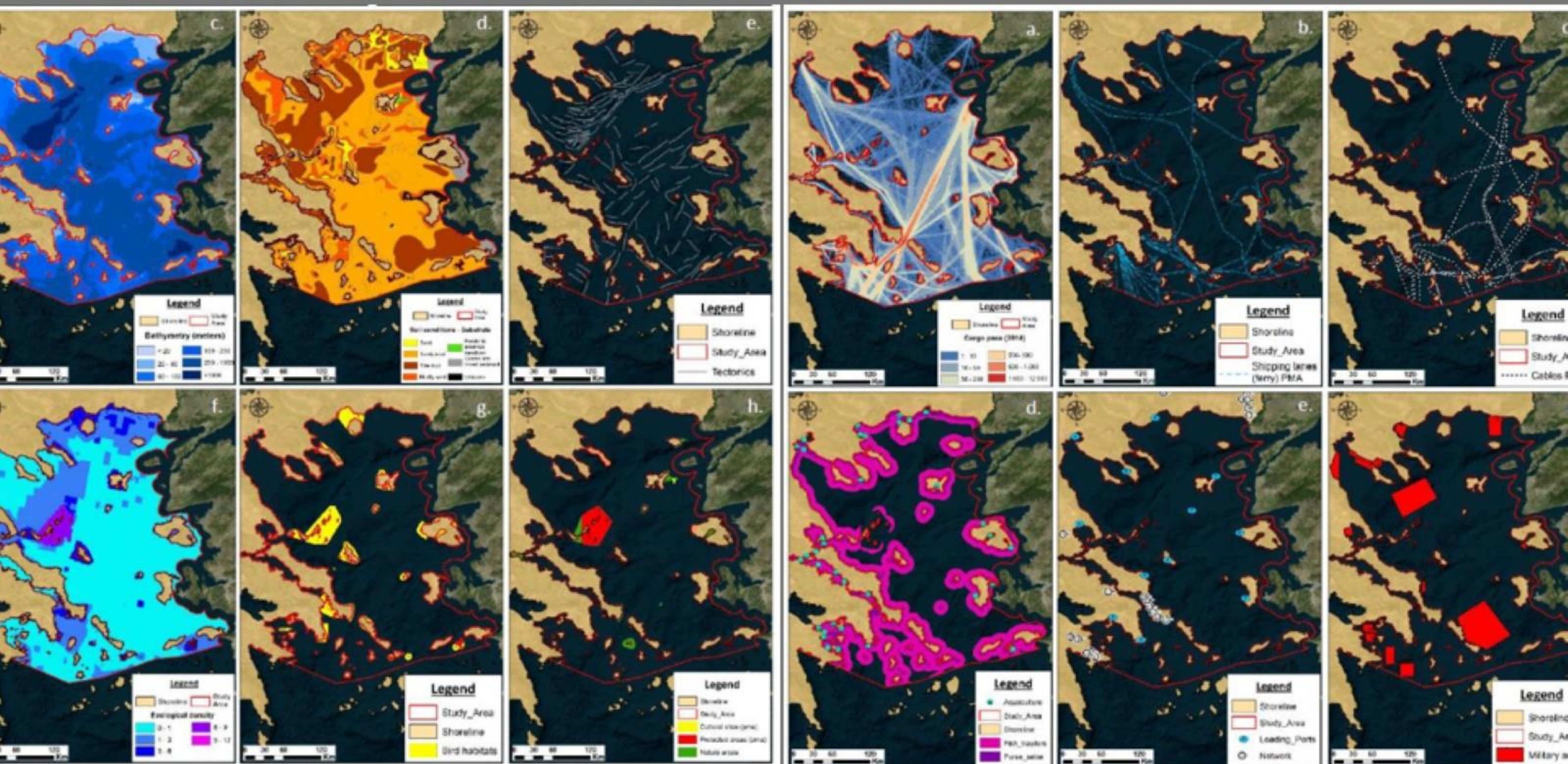


The problem of multicriteria studies

Study of the Aegean Region for offshore wind energy

Katikas & Kavouras (2022)

We do not have any project locations yet



No visibility analysis on early planning multicriteria studies

THE PROBLEM

CURRENT PARCTICE IN INITIAL STAGES OF DESIGN AND LICENCING OF WORKS

Multicriteria studies

Initial assessment of locations on large spatial scales

➡

Location selection &

Production License Application

In Greece:

- **1 year** of wind measurements
- Several other studies

➡

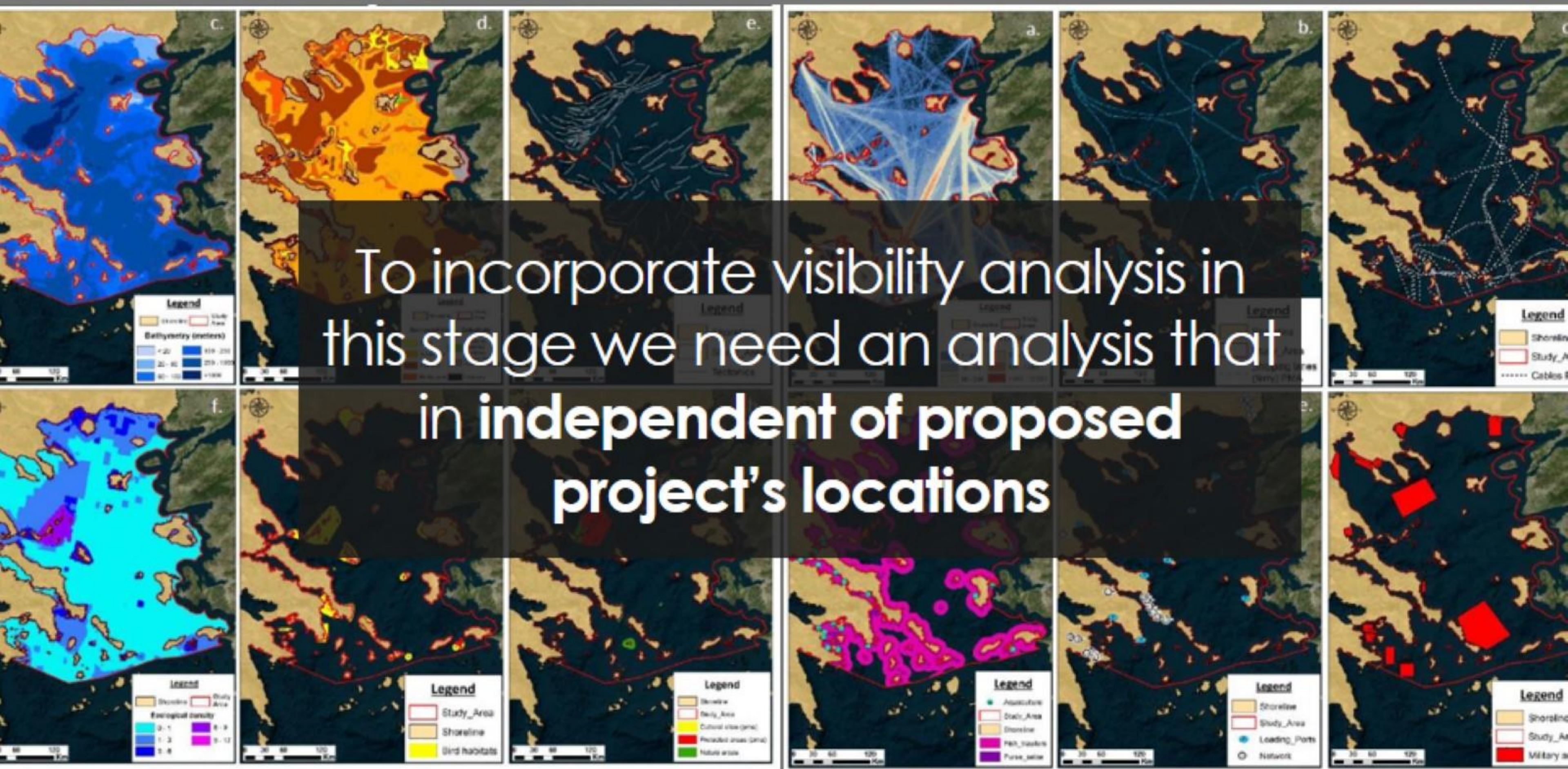
Environmental Impact Assesment

➡

1. Conventional Visibility analysis Landscape impact mitigation

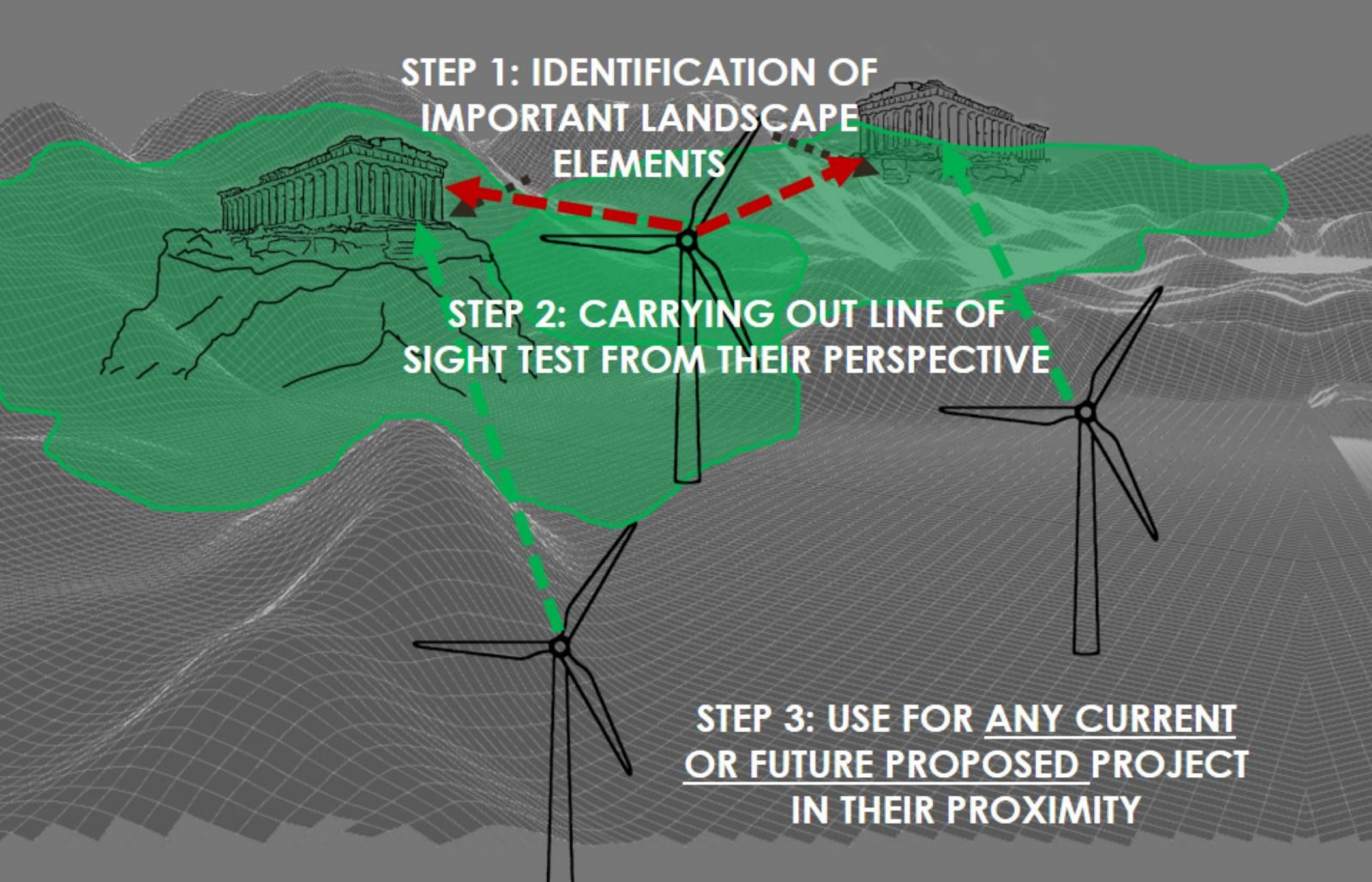
REVERSE VISIBILITY ANALYSIS

The problem of multicriteria studies



To incorporate visibility analysis in this stage we need an analysis that in **independent of proposed project's locations**

REVERSE ZTV VISIBILITY ANALYSIS



THE PROBLEM & PROPOSED SOLUTION

INITIAL STAGES OF DESIGN AND LICENCING OF WORKS

Multicriteria studies

Initial assessment of locations on large spatial scales

1.Reverse visibility analysis
(quick and dirty)

- Earlier anticipation of impacts
- Avoiding opposition/conflicts and developmental issues

Location selection &

Production License Application

In Greece:

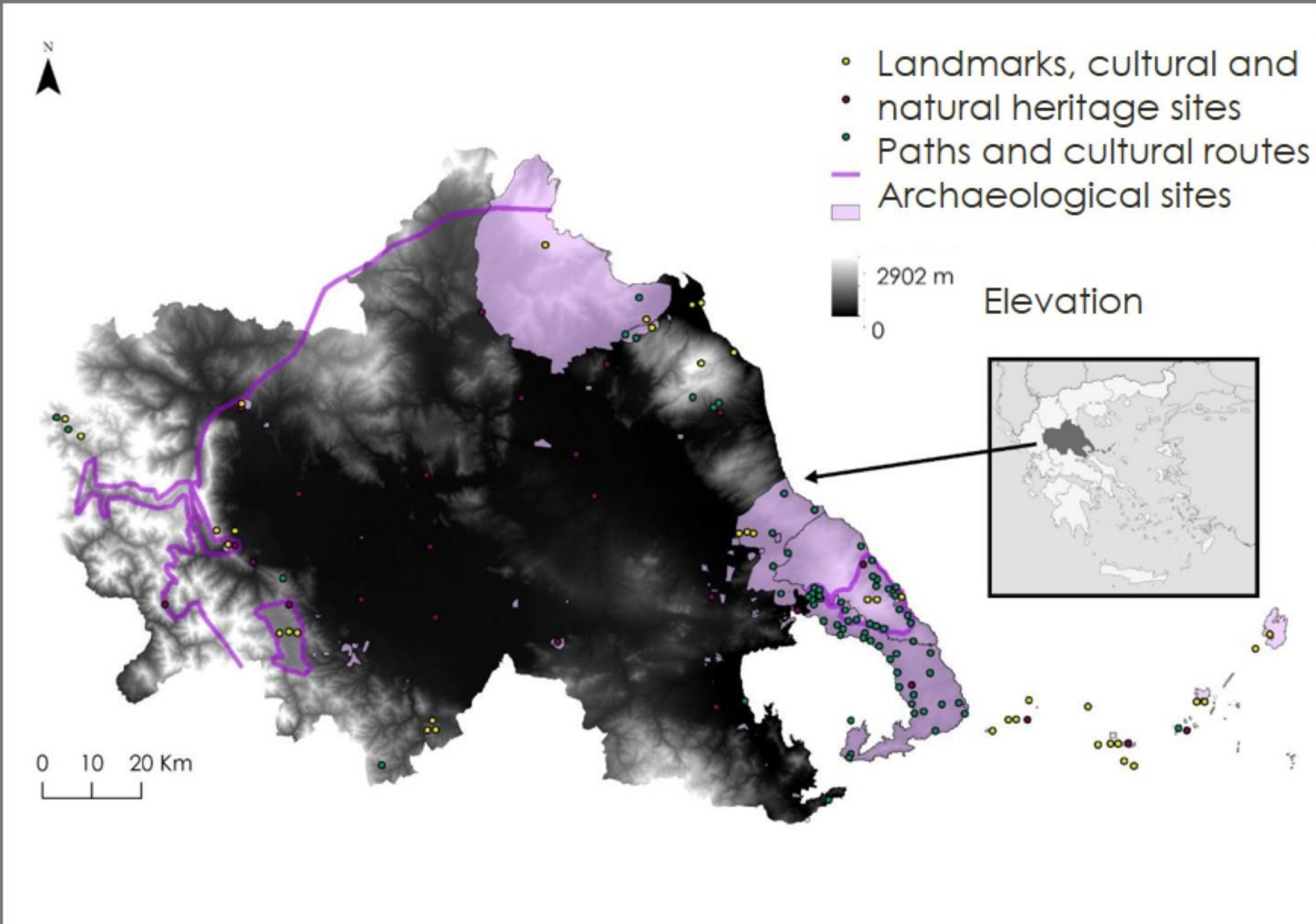
- **1 year** of wind measurements
- Several other studies

Environmental Impact Assesment

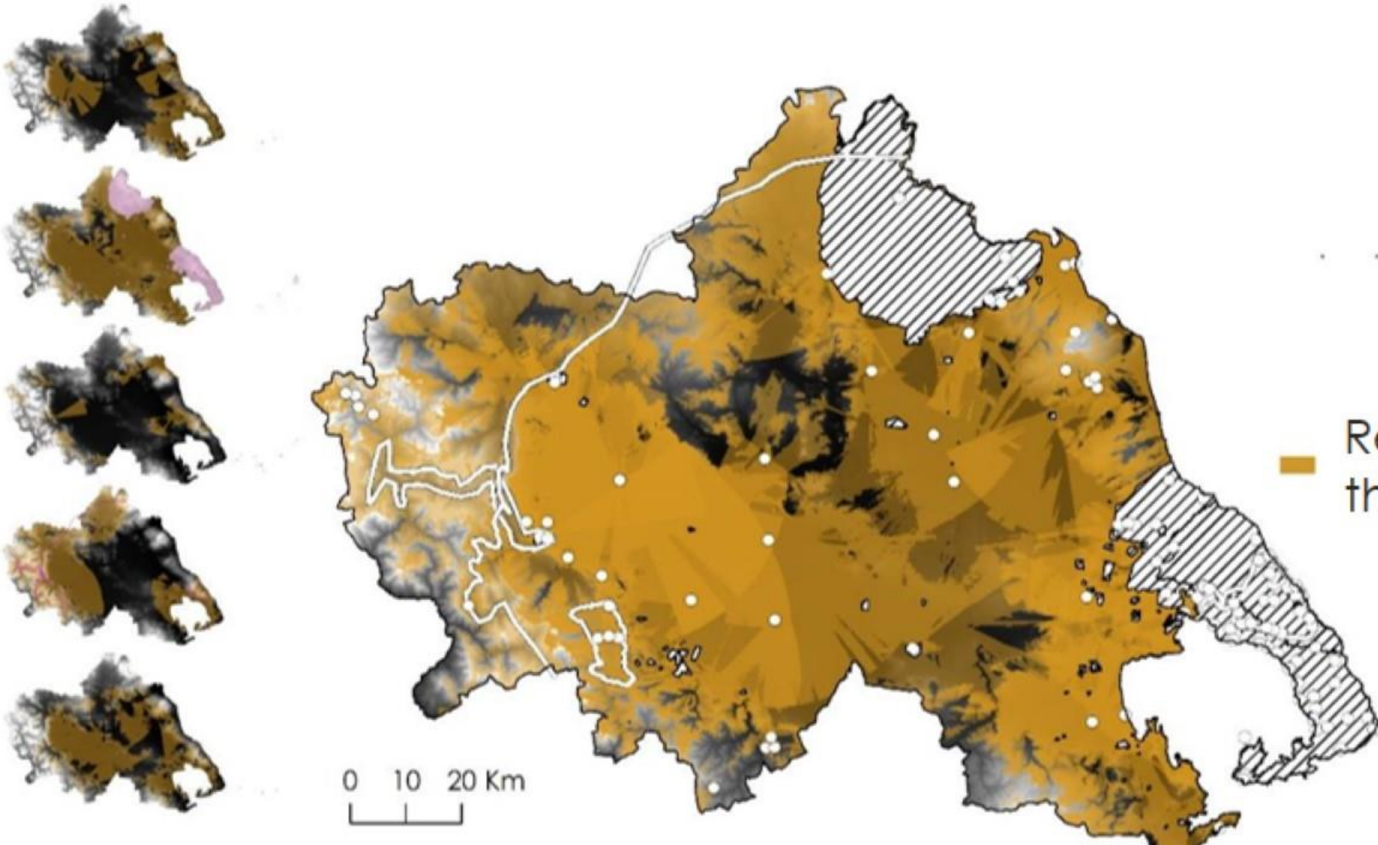
2. A conventional visibility analysis at this stage
(which is more detailed)

EXAMPLE OF APPLICATION
Thessaly region - Greece

R-ZTV Application (1) Selection of landscape elements



R-ZTV Application (2) Calculation of R-ZTV

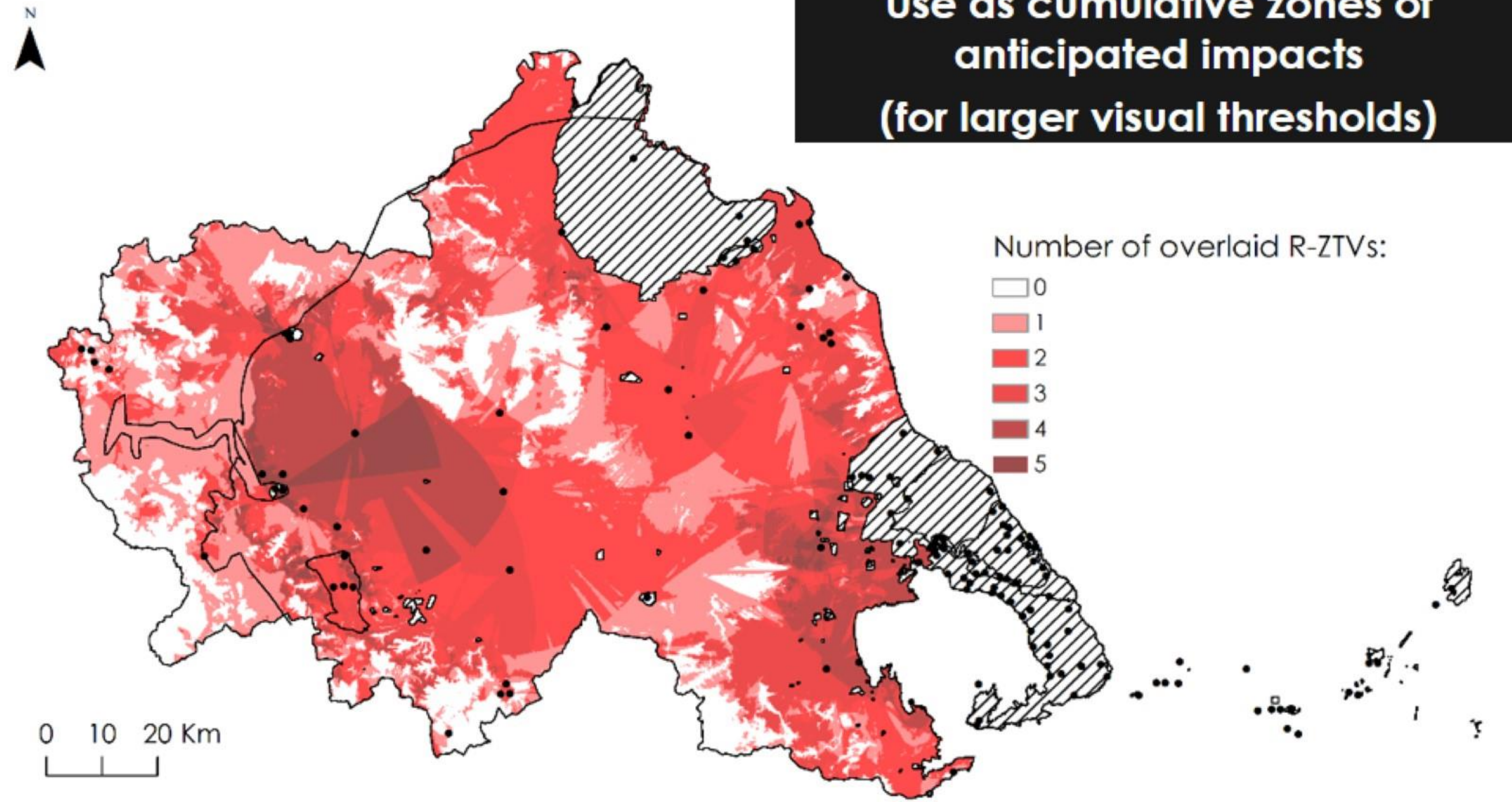


Reverse Zones of theoretical visibility

Visibility threshold 30 km

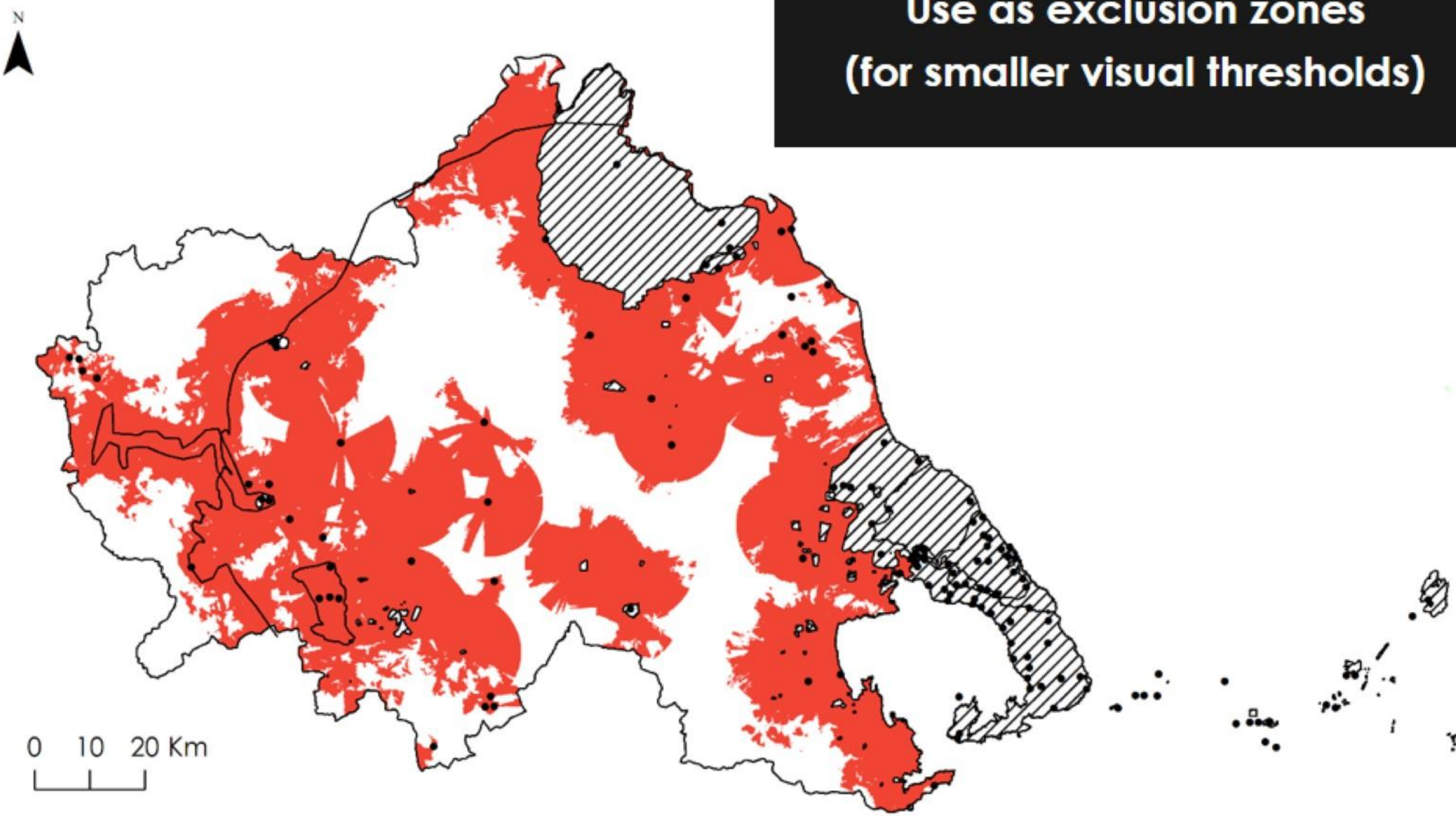
R-ZTV Application (3.a) Use for planning

Use as cumulative zones of anticipated impacts (for larger visual thresholds)



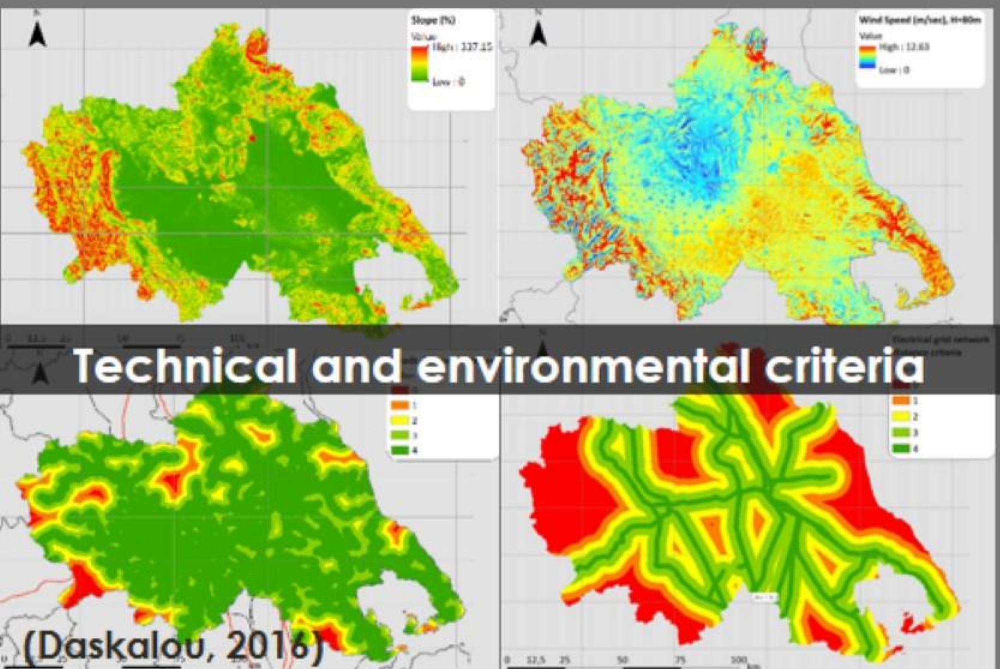
R-ZTV Application (3.b) Use for planning

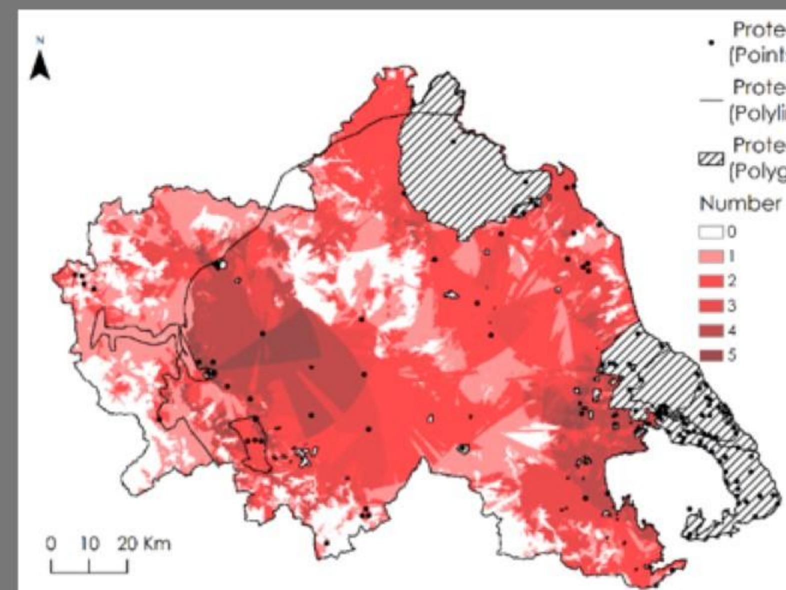
Use as exclusion zones
(for smaller visual thresholds)



R-ZTV Application (3) Use in early planning

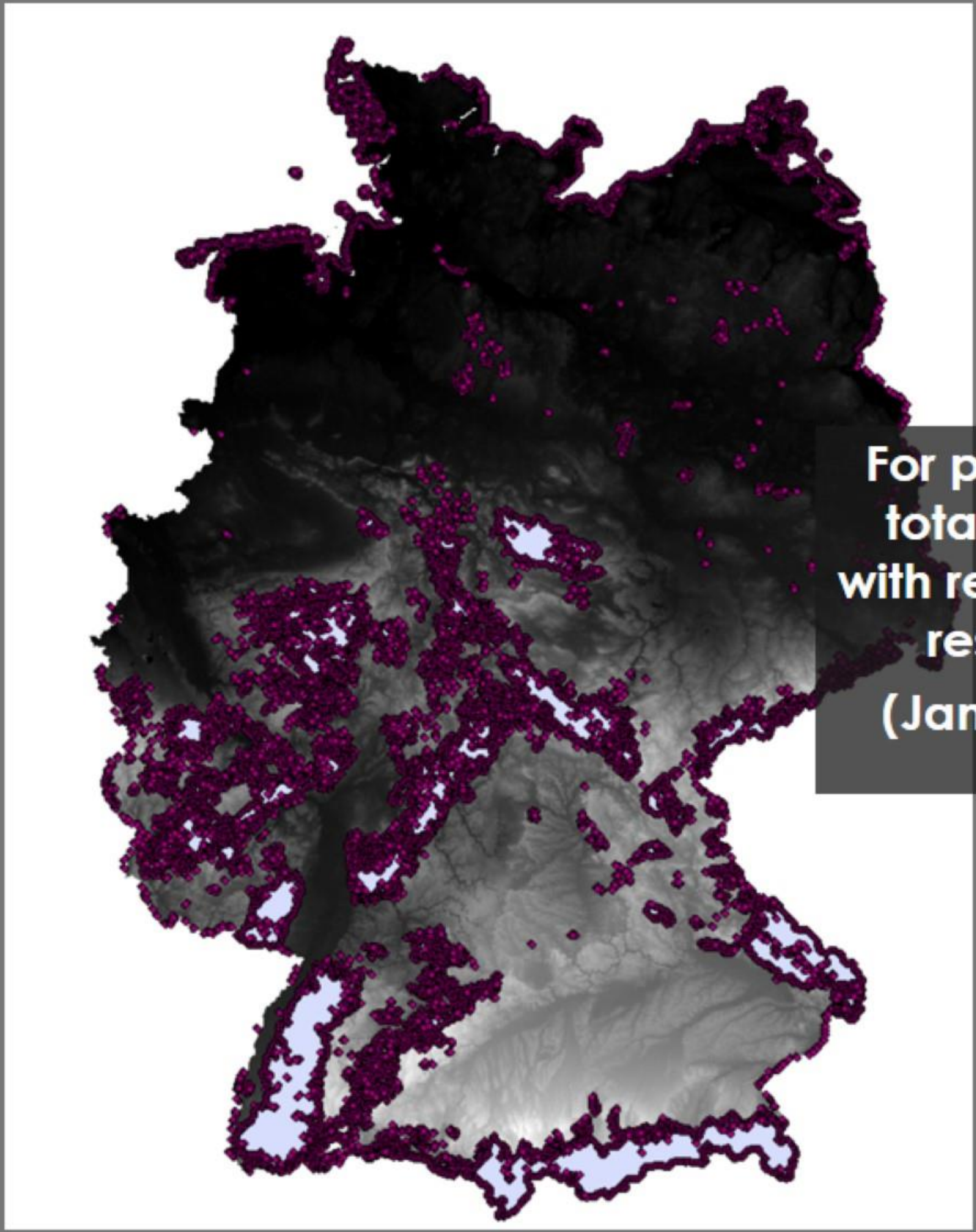
E.g. use in multicriteria studies





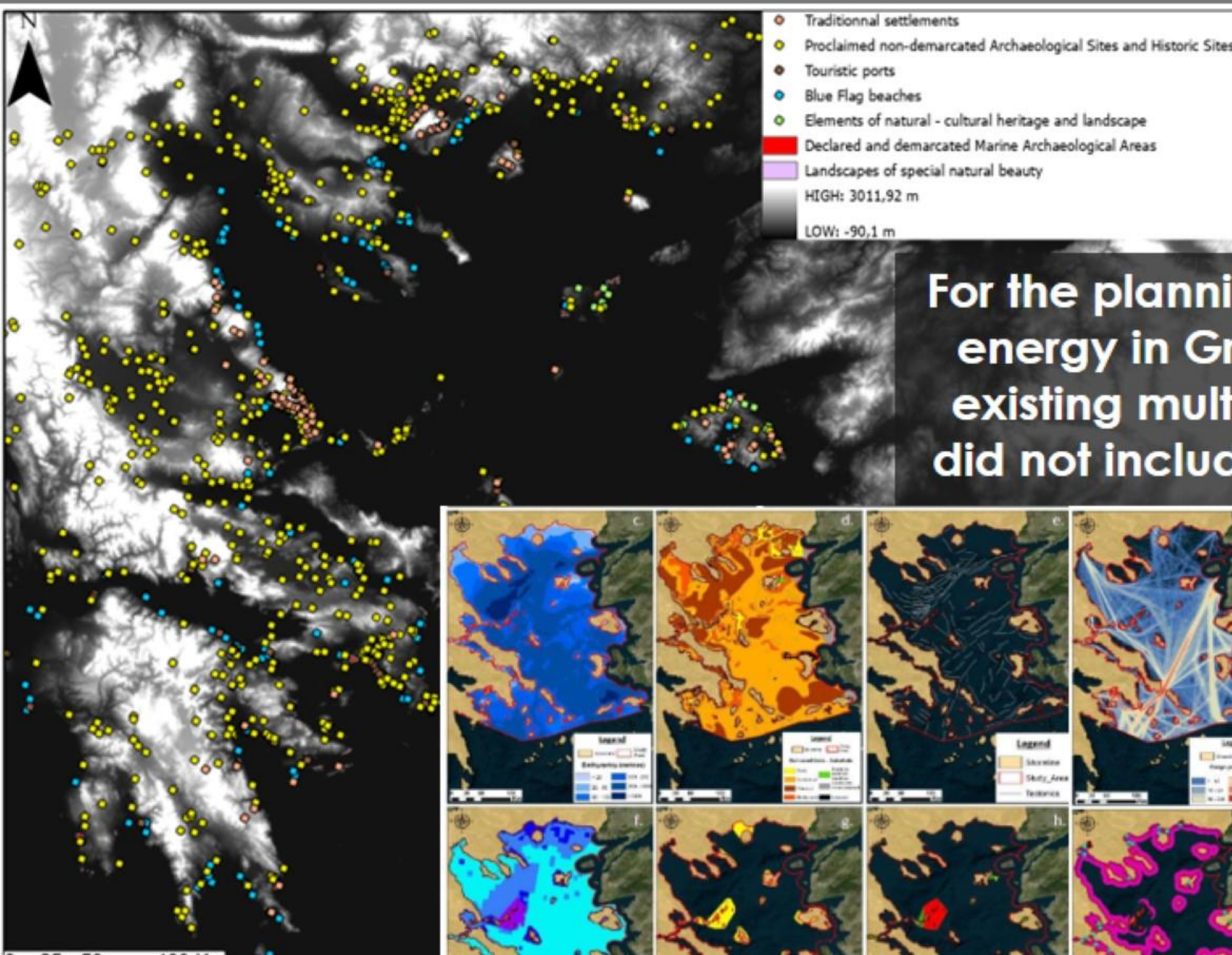
Integration of visibility analysis in early planning

ONGOING APPLICATIONS

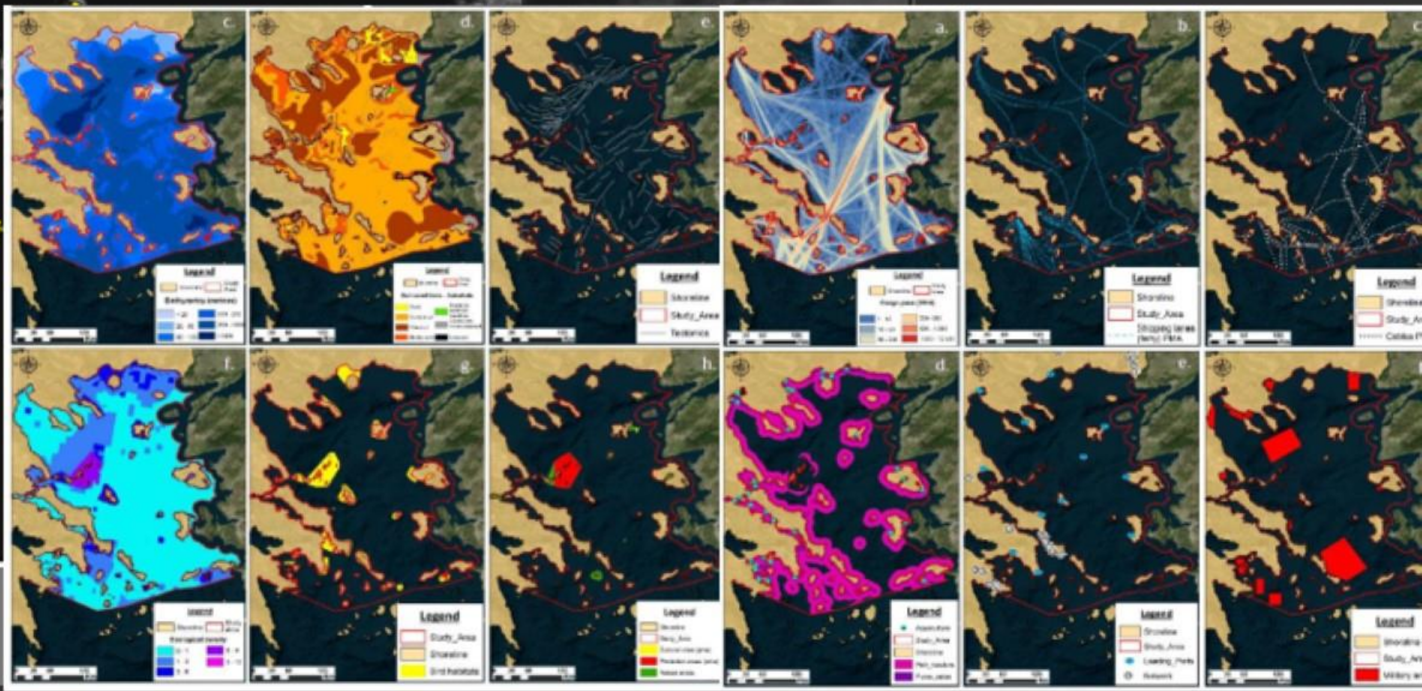


For planning wind energy in the total of land area of Germany with researchers from the national research center FZ - Jülich

(Jann Michael Weinand et al.)



For the planning of offshore wind energy in Greece, expanding existing multicriteria study that did not include visibility analysis



CONCLUSIONS

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Uses and advantages of R-ZTV

- Are **compatible** with **multicriteria planning** studies for renewable energy
- Can be used to create static maps for landscape protection **in large spatial scales (national or regional)** which can be used **proactively**
- After their calculation, R-ZTV maps can be utilized for **any proposed project** in the area they cover; thus they have the potential to reduce the load of EIA if utilized
- Are compatible with **participatory planning**, through the inclusion of the public in the selection of protected areas

Limitations of our applications

- A binary-visibility approach was applied
- The large scale of the applications limits the detail of the analysis

PUBLISHED WORK

Contents lists available at ScienceDirect

Renewable and Sustainable Energy Reviews

journal homepage: www.elsevier.com/locate/rser

Reversing visibility analysis: Towards an accelerated *a priori* assessment of landscape impacts of renewable energy projects

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ABSTRACT

Impacts to landscapes have been identified as major drivers of social opposition against renewable energy projects. We investigate how the process of mitigating landscape impacts can be improved and accelerated, through a re-concepeualization of visibility analysis.

In their conventional format, visibility analyses cannot be implemented in early planning phases as they require the finalized locations of projects as input. Thus, visual impacts to landscapes cannot be assessed until late in development, when licensing procedures have already begun and projects' locations have already been finalized. In order to overcome this issue and facilitate the earlier identification of impactful projects we investigate the reversal of visibility analyses. By shifting the focus of the analyses from the infrastructure that generates visual impacts to the areas that have to be protected from these impacts, visibility analyses no longer require projects' locations as input. This methodological shift is initially investigated theoretically and then practically, in the region of Thessaly, Greece, computing Reverse - Zones of Theoretical Visibility (R-ZTVs) for important landscape elements of the region, in order to then project visual impacts to them by planned wind energy projects.

It was demonstrated that reversing visibility analyses (a) enables the creation of R-ZTV-type maps that facilitate the anticipation of landscape impacts of projects from earlier planning stages and (b) discards the requirement for individual visibility analyses for each new project, thus accelerating project development. Furthermore, R-ZTV maps can be utilized in participatory planning processes or be used independently by projects' investors and by stakeholders in landscape protection.

1. Introduction

In the last two decades, the expansion of renewable energy (RE) has imposed extensive land use requirements [1–4] and resulted to major transformations of the visual character of landscapes [5–8]. Since the design of the RE equipment is mostly predefined by industrial specifications and cannot be adapted to architectural traditions and local landscape features, RE projects have been strongly criticized for industrializing landscapes [9]. This is primarily the case for wind turbines, but also applies to photovoltaic solar panels, and to a lesser extent to hydroelectric projects [10–12]. Following the definition of landscape by the European Landscape Convention [13], i.e. "landscape is part of the land, as perceived by local people or visitors, which evolves through time as a result of being acted upon by natural forces and human beings", the industrialization of landscapes by infrastructure can be the cause of negative perception due to unwanted cultural, environmental and aesthetic transformations to landscapes. In the case of RE, landscape impacts have been identified as one of the major motivators for opposition against new projects [6,9,14]. Indicatively, In Europe, the conflict between RE development and landscape quality is demonstrated in the following two ways:

A) Public opposition against RE on landscape-protection grounds has significantly delayed their desirable penetration into the energy mix. Even though RE has been associated with significant impacts to the natural [14], cultural [15,16] and aesthetic [17,18] character of landscapes, so far spatial planning of RE systems for the mitigation of landscape impacts has been given a secondary role [19]. Thus, landscape impacts have become a major cause of public opposition and, consequently, of delays in the pan-European effort to make renewables the key player in energy

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THANK YOU!

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