Zooming to the study area in GIScience research: a three stage approach

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1. Introduction

In most Geographical Information Science (GISc) research projects, the selection of the methodology is only half of the design - the other half is involved in identification of the study area on which the methodology will be tested, followed by data collection for this specific area. In this paper we describe the methodology adopted for selecting a study area in a GISc research project currently in progress (Simão & Densham, 2004). In the following sections the research project is introduced, then the methodology adopted for selecting the study area is described and subsequently each step of this methodology is further detailed, namely by identifying the information sources used for its completion and the analysis. The paper concludes with a short summary and some comments on the analyses carried out.

2. The Context: development of Internet-based Public Participatory System

The selection of a study area is, of course, tightly linked to the specific research project for which the area will be used. In this case, the project involves the development of an Internet-based Public Participatory System (IPPS) to promote learning during the participatory process and its evaluation (Simão & Densham, 2004; Simão *et al.*, 2004). The purpose of the IPPS is to involve the public in a debate about the siting of wind farms. This planning-related topic has been selected due to its current relevance and controversial nature, hence making it capable of stimulating the public interest in participating and using the IPPS. It is controversial to the extent that some people find wind farms attractive and even relaxing whereas others find them intrusive and scenery-spoiling. Whilst the first group put forward arguments to foster wind energy development, such as wind being a freely available resource and that electricity generation from wind is environmental friendly, the second group argue that wind farms interfere with birds, dampen property value, and denigrate the regional economy by discouraging tourism. The relevance of this topic arises from the U.K. need to comply with the Kyoto Protocol (United Nations, 1997), eventually entered into force on the 16th February 2005, and the European Union's Directive 2001/77/EC on electricity production from renewable energy sources (European Parliament and the Council, 2001). The following sections describe the methodology adopted for the selection of the study area, where the IPPS will be tested. Users of the IPPS will be referred to this methodology to allow them learning about the selection of the study area for this project.

3. Selecting the study area

In many cases, researchers select a study area on the basis of data availability or personal familiarity with the location. The reasoning behind the specific selection is often left mute in the publications of the specific study, and the selection process is not explained. In this study, an alternative approach was adopted by applying a rational and transparent methodology for supporting the decision-making. Of course, some decisions were made beforehand. Firstly, it was decided that the study area would be located in England – this is due to logistical aspects (e.g., facilitating the researcher ability to travel to the area and contact regional and local planners) as well as justified by the good wind resources experienced in England[1]. Secondly, the study area size was restricted to several hundred square kilometres. This constraint was imposed by limitations in the processing power of available computers. The research project involves a significant element of viewshed analysis using detailed datasets (10m resolution)[2] and, despite improvements in computer processing, there are still practical limitations on the size of the area that can be used for visibility analyses. Moreover, there are limitations on the ability to contact and engage the public in large geographical areas.

The methodology applied for selecting the study area is outlined in Figure 1. Essentially, an initial, broad area is successively reduced and refined through three steps. At first, the whole of England is considered and the goal of the analysis is to select a region from which the study area will be drawn. For this analysis two criteria are evaluated. Subsequently, a county within the previously selected region is chosen through the examination of contextual information. Finally, a multi-criteria evaluation analysis (MCEA) is conducted to identify a smaller area within the selected county. These steps are described in the following sections.

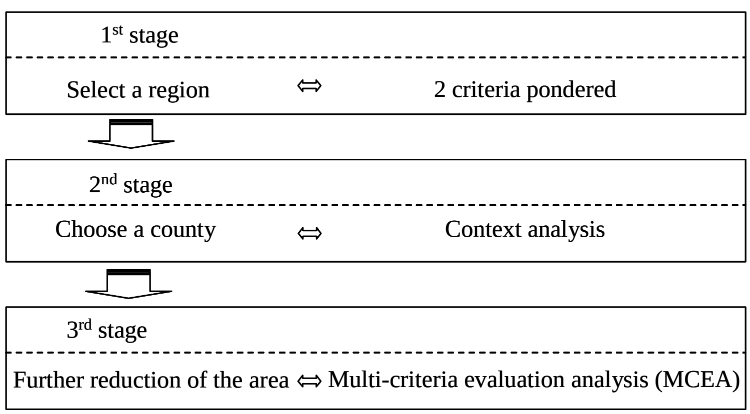

Figure 1 – Three-stage methodology for the selection of the study area.

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[1] Estimates from the European Wind Atlas (1989) suggest that England experiences mean winds between 4.5 and 11.5 m/s at 50m above ground level.

[2] The use of such datasets is justified by the fact that fairly accurate and trustworthy maps need to be supplied to the public in order to acquire their confidence and engage them in using the IPPS.

3.1 First step: selecting a region

As Figure 1 informs, two criteria were considered for selecting the region that will include the study area. They are: 1) the regions' potential for onshore wind energy production, as the existence of such potential is vital for discussing the problem of wind farm siting; and 2) the regions' rate of Internet access, as the project is Internet-based.

The appraisal of the first criterion is based on the detailed analysis of the renewable energy potential conducted by each region in response to the U.K. Government call for regional assessments and targets for renewable energy provision[3]. The evaluation of the second criterion is based on data from omnibus and household expenditure surveys carried out by the Office for National Statistics. Table 1 presents the information used and systematizes the analysis performed.

	Onshore wind energy potential		**Internet access**					
	Highest scenario for wind electricity generation by 2010[1]		**Individual access[2] Apr 03 - Feb 04**		**Households access[3] Oct 02 - Sept 03**		**combined**	**overall**
English regions	**Electricity (GWh)**	**ranking**	**%**	**ranking**	**%**	**ranking**	**ranking**	**ranking**
North East	1 230	3	43	9	43	6	9	4
North West	651	6	57	5	43	6	5	3
Yorkshire and the Humber	800	4	56	6	43	6	7	3
East Midlands	319	7	54	8	48	3	5	4
West Midlands	1 345	2	55	7	46	5	7	2
East of England	**1 700**	**1**	**59**	**3**	**48**	**3**	**3**	**1**
London	22	9	64	1	52	2	2	3
South East	303	8	64	1	53	1	1	2
South West	716	5	58	4	43	6	4	2

[1] Source: Regional renwables energy assessments

[2] Source: National statistics omnibus survey

[3] Source: Expenditure and food survey

Table 1 - Qualitative analysis undertaken for selecting the region that will contain the study area.

As Table 1 shows, East of England combines the greatest potential for onshore wind energy development with a reasonable diffused Internet access (both, at individual and households levels). These performances provide for the achievement of the best ranking over all regions in a qualitative assessment of these criteria. Hence, the study area will be part of the East of England and the next step will focus on this region.

3.2 Second step: selecting a county

Two main aspects were considered for selecting a county within the East of England region: 1) policies for renewable energy, and wind energy in particular, within each County Structure Plan and District Local Plan; 2) counties' potential for wind energy generation. In addressing the first aspect, the main source of information was a review of the strategic and local planning polices for renewable energy, energy conservation and energy from waste in the Eastern region conducted in June 2000 (Government Office for

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[3] Letter of 9 August 1999 headed "Renewable Energy and Land-Use Planning" to Regional Directors from the Directors of Energy Technology (DTI - Department for Trade and Industry) and Town and Country Planning (DETR- Department of the Environment, Transport and the Regions), reproduced as technical paper No. 1 - available at: www.renewableseast.org.uk/images/pdfs/renewables_annexes.pdf [19th November 2004].

the East of England, 2000). All Structure and Local Plans approved later than this date were also examined to complement that report. With respect to the second aspect, the base dataset consisted of the county targets for onshore wind energy generation put forward by the regional renewable energy assessment (Hams *et al.*, 2001). Furthermore, the potential of the wind resource was considered (Department for Trade and Industry's windspeed database), as well as existing landscape and nature conservation designations, which constitute constraints for wind energy development. A holistic and contextual evaluation of this information resulted in the selection of the County of Norfolk for passing onto the next stage of the methodology.

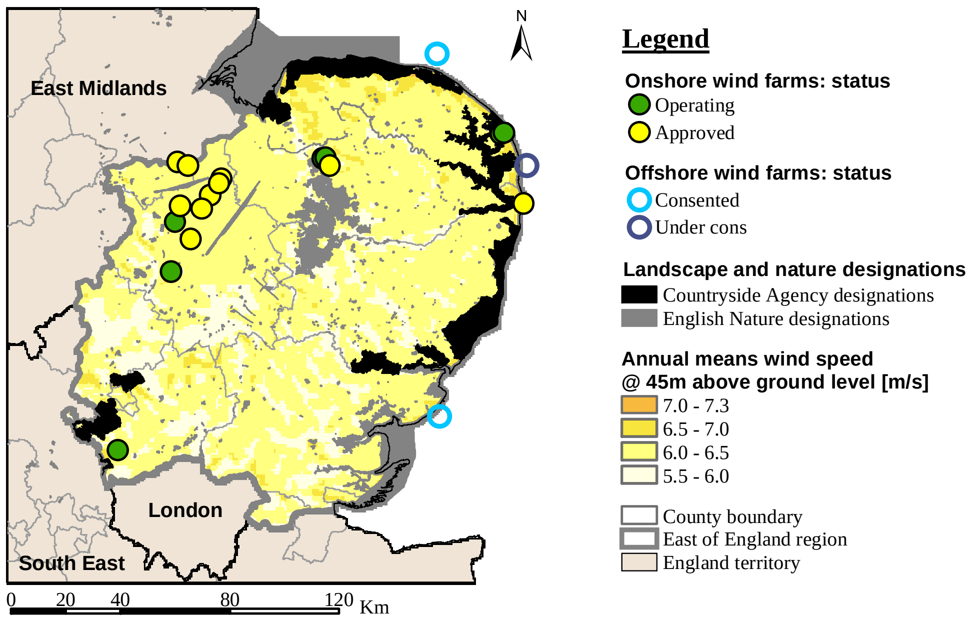

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Figure 2 - Wind resource, landscape and nature conservation designations, and wind farms in East of England.

3.3 Third step: identifying the study area

The third stage of the methodology consists of a Multi-criteria Evaluation Analysis (MCEA). MCEA imply the use of a multi-criteria evaluation (MCE) technique, which basically is an analytical procedure for encountering the "best" solution amongst a set of feasible alternatives (Starr & Zeleny, 1977). The conducted MCEA evaluated six feasible alternatives on 10 decision criteria, as presented in Table 2 and Figure 3.

Decision Criteria - identification, specification and importance			
Designation	**Criteria**	**Specification of performance's evaluation**	**Weight**
A - Wind energy-related issues			
A.1	Feasible surface	Feasible surface for wind farms siting within the boundaries of the alternative study area	100
A.2	Developers' interest	Total number of applications for wind energy development received by the area's LPA(s)	30
A.3	Aliveness of the topic	Nr of applications for wind energy development received by the area's LPA(s) in the past 4 years	80
B - Targeted public-related issues			
B.1	Potential participants	Total population living within the area	60
B.2	Onshore experience	Whether or not there are wind farms currently operating in the area	50
B.3	Offshore feasibility	Feasibility and current development status of wind energy offshore in the area	40
C - Experiment-related issues			
C.1	Total surface	Total surface of the area	50
C.2	Nr of authorities	Number of authorities with jurisdiction in the area	70
C.3	Urban population	Ratio between urban and total population living within the area's boundaries	90
C.4	LPAs' concern	Area's LPAs "investment" in wind energy (current policy and siting studies)	70

Table 2 - Decision criteria used for selecting the study area.

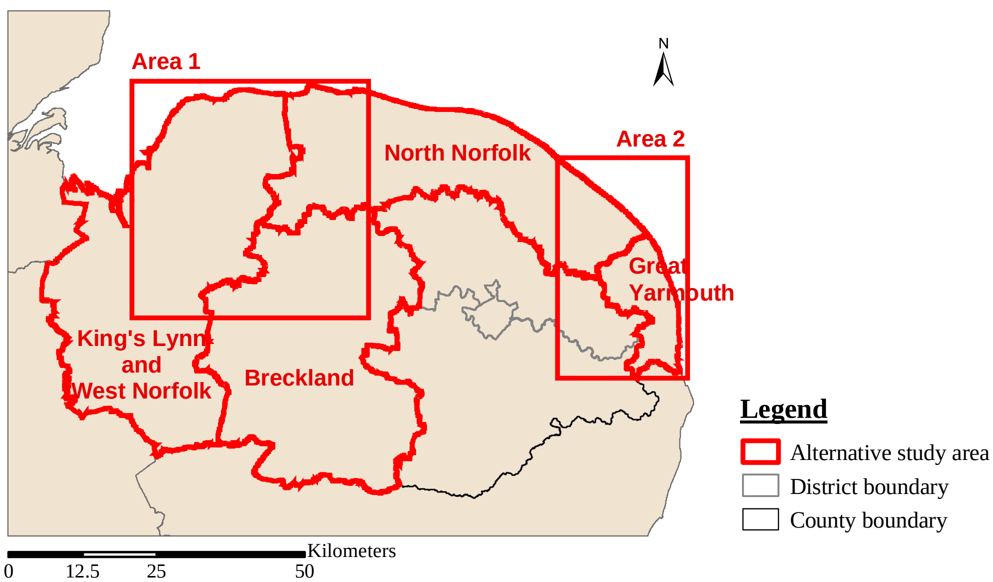

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Figure 3 - The six decision alternatives in evaluation, all located in the County of Norfolk.

The performance of each alternative under each criterion was assessed and this information compiled in a decision matrix. Information for these assessments (e.g., population, geographic boundaries, received applications for wind farms licensing, etc.) was collected from national bodies and local planning authorities alike. The decision matrix and the importance that the decision-maker attributes to each criterion for the final decision constitute the basis for any MCE technique. For this analysis the Simple Additive Weighting (SAW) technique (Yoon & Hwang, 1995) was selected. SAW calculates an aggregated score for each alternative by multiplying the normalised[4] performance of an alternative in each criterion for the importance of this criterion to decision-making[5] (“weight” column in Table 2). The higher the resulting score, the more preferable is the alternative. Table 3 shows the normalized performances for the alternatives as well as the aggregate scores. Accordingly, the “best” alternative is Area 1, which includes part of three districts: King’s Lynn and West Norfolk, North Norfolk and Breckland, Figure 3. This alternative was found to be quite robust as significant changes in the importance of the criteria for the final decision (decision-making) resulted only in slight changes in the aggregate scores.

	Criteria										
	A.1 Feasible surface	**A.2** Developers' interest	**A.3** Aliveness of the topic	**B.1** Potential participants	**B.2** Onshore experience	**B.3** Offshore feasibility	**C.1** Total surface	**C.2** Nr of authorities	**C.3** Urban population	**C.4** LPAs' concern	**Alternative aggregate score**
Alternatives	**normalized values**										
North Norfolk	0.35	0.60	0.00	0.64	0.00	1.00	0.18	0.50	0.17	0.40	0.34
Great Yarmouth	0.06	0.80	0.00	0.59	1.00	0.60	1.00	0.50	1.00	0.40	0.54
King's Lynn and West Norfolk	0.76	0.40	0.50	0.88	0.00	1.00	0.12	1.00	0.44	0.70	0.60
Breckland	0.16	0.80	0.75	0.79	1.00	0.00	0.14	1.00	0.44	1.00	0.60
Area 1	1.00	1.00	1.00	1.00	1.00	1.00	0.13	0.33	0.52	0.80	0.77
Area 2	0.13	1.00	0.00	0.86	1.00	0.60	0.33	0.20	0.69	0.40	0.45
Normalized weighting	0.156	0.047	0.125	0.094	0.078	0.063	0.078	0.109	0.141	0.109	1.000

Table 3 - Normalized decision matrix with aggregated scores calculated according to the SAW technique.

4. Conclusions

The area used for exploring a planning-related question should be adequate to the problem that is at the centre of the discussion. Moreover, the selection of such an area should be elucidated to the audience of the research. This paper describes a rational and iterative methodology developed to identify a study area suiting research into the problems associated with sitting of wind farms. Within the three stages of the methodology both qualitative and quantitative-based analysis are used. For complex analyses, where large volumes of information are involved, quantitative-based analyses are found preferable as they enable transparency and accountability. Accordingly, the last stage of the methodology involves the application of a MCEA to select the study area amongst six feasible alternatives. The area finally identified will be used to support the development of the study case, which we hope to report on it in due course. It is envisaged that full details of the selection process described in this paper will be integrated into the final system for public participation (Simão & Densham, 2004).

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[4] Performances on criteria need to be normalised in order to convert them in non-dimensional values and make them comparable.

[5] Due to the purpose of this analysis the first author of the paper assumed the role of decision maker as the main researcher of the project.

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Biography

Ana Simão is a third year PhD student at the University College London (UCL). She graduated in Territorial Engineering from the Instituto Superior Técnico and holds a MSc degree in Civil Engineering (with a specialization in Hydraulics and Water Resources) from the University of Coimbra, Portugal. Since 1997 she has been working as Teaching Assistant for the Department of Civil Engineering of the University of Coimbra.