Using IT approaches to promote public participation in renewable energy planning: Prospects and challenges

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Abstract

In response to recent policy initiatives and UK and European legislation there is increasing focus on alternative methodologies and procedures to encourage public participation in environmental planning. This paper is concerned with outlining those methodologies that involve the use of IT methods in enabling a possible consensus to be reached between participatory groups on decisions that may effect their local environment. Specifically, we focus on integrated approaches that involve the use of Geographical Information Systems (GIS) and Multi-Criteria Decision Analysis (MCDA) techniques in facilitating public participation using the case study of the planning of wind farms. The introduction of renewable energy technologies can be a particularly contentious issue in some areas of the UK and we draw on a review of the use of such software tools in order to highlight their application within a decision support system framework. One area where there has been less input from potentially affected local communities or stakeholders relates to the use of computer-generated visualisations in the environmental impact assessment (EIA) process. We describe future research challenges facing those charged with encouraging participation in the siting of such facilities before re-iterating the policy relevance of this research given the UK governments’ stated commitment to the incorporation of public input into the decision-making process.

Keywords: Public participation techniques; Geographical Information Systems (GIS); Multi-Criteria Decision Analysis (MCDA); Renewable energy; Wind farm planning

Introduction

There have been a number of citizen-based studies that have been concerned with exploring participatory approaches in planning. Public participation in this context is defined as “any of several mechanisms intentionally instituted to involve the lay public or their representatives in administrative decision-making” (Beierle and Cayford, 2002, p. 6). Loukopoulos and Scholz (2004, p. 2205) define participation as “involvement in decision-making with the purpose of influencing the choices being made”. As well as an onus on government agencies to involve the public in decisions which affect their communities, there is an increasing realisation that improving levels of participation at the outset can increase the likelihood the resulting decision will be accepted and that any potential environmental impacts are minimised or mitigated and hence improve the quality of decision-making. A recent review of public participation methodologies published by the Environment Agency (Petts and Leach, 2000) drew attention to the advantages of public participation in three areas, namely, (i) legitimation of decision-making, (ii) enhancement of democracy and (iii) enlargement of citizenship. Involving the public in the decision-making process, it is posited, improves the chances of reaching consensus by enabling different stakeholder perspectives to be taken into account, makes the decision-making process more transparent and hence decision makers more accountable and adds more weight to the final decision. However, the use of public participation processes are not without their problems (for a recent example, see Stewart and Sinclair’s (2007) study of public participation processes in environmental assessment in Canada).

We do not intend to review different participation mechanisms in this paper (see for example, Rowe and...
Frewer, 2004 for a fuller evaluation of different approaches). Rather, we build on previous critiques of the use of information technologies (IT) in engagement mechanisms and explore the potential for IT approaches in public participation exercises using the case study of wind farm planning. In so doing, we start from the premise that “citizens should be partners in the use of the technology for the production and communication of information and the knowledge that results” (Sawicki and Burke, 2002, p. 90). Walker (2007) discusses the use of participatory communication techniques, including visual activities such as participatory video, in environmental policy decision-making. However, as Rowe and Gammack (2004, p. 51) suggest “electronic mechanisms may not be appropriate in every engagement situation, and what is needed is a theory linking particular engagement tasks and scenarios to particular technology types”. A number of studies have focused on the use of ICT in encouraging participation particularly in urban contexts as part of E-Government processes (see for example, Conroy and Evans-Cowley, 2006). However, we would posit that there is a clear need to demonstrate the use of such techniques in wider collaborative spatial decision support contexts applied to real-world case studies such as that highlighted in our on-going research efforts.

Participation can take various forms ranging from public meetings and hearings, questionnaire surveys, focus groups, to more complex deliberative processes with the ultimate goal of enabling the participants to have greater insight into decision-making procedures leading to more informed opinions on environmental issues. As Haughton (1999, p. 52) suggests “there is a compelling need to identify and work with processes which are more open, transparent and democratic, producing decisions which are more widely accepted by all in the community”. As an example, Loukopoulos and Scholz (2004) explore a set of techniques whereby future scenarios (in their example, related to urban mobility) are presented to stakeholders and then evaluated on the basis of different criteria which are then assigned weights according to their perceived importance. Such scenarios, it was suggested, could be provided through computer animations or by other non-IT based methodologies. However, previous general reviews on the role of public participation have also drawn attention to the challenges faced by those charged with increasing levels of participation and ensuring views from a wide variety of stakeholders, including those of marginalised groups, are incorporated into the decision-making process. Other reviews such as that of Beierle and Cayford (2002) have been concerned with the nature of participatory mechanisms and their impact on the success of the decision-making process itself addressing key questions such as,

- Who should participate and at what point in the decision-making process?
- What kind of engagement is appropriate?
- How much influence should the public have?
- And what role should government play? (Beierle and Cayford, 2002, p. 65).

Their meta-review based on findings from over 250 published studies in the US, for example, called for more intensive processes of public participation than mere public hearings. Following on from such studies, the aim of this paper is to highlight the potential for IT approaches in public participation and in particular to demonstrate the potential for using Geographical Information Systems (GIS) approaches that permit public values, concerns and preferences to be incorporated into the decision-making process. In the current study, we are concerned with the use of GIS-based techniques in addressing environmental issues that may involve multiple criteria and preferences and which can take on board the underlying goals and objectives of different interest groups at local or neighbourhood scales in participatory planning. IT approaches based around participatory GIS have real potential to increase the transparency of the decision-making process and are the on-going focus for a number of researchers (see for example, contributions in Craig et al., 2002; Balrum and Dragicevic, 2006). Increasingly environmental data is being made available to the public via such means to support public participation in potentially contentious environmental issues and to empower local community groups in, for example, producing maps to address countryside conservation (e.g. Wood, 2005). Whilst recognising the importance of these techniques, and that of traditional public consultation tools, others have suggested that the full potential of GIS-based technologies are not being realised and draw attention to the potential for the use of collaborative GIS in more pro-active or strategic contexts where such groups have the potential to influence policies, either locally or nationally, on a range of socio-environmental processes and lead to the possibility of public acceptance and legitimisation of the final siting decision (for example, Carver and Peckham, 1999; Towers, 1997).

There has been increased research, largely in urban contexts to date, on incorporating community input via local knowledge or community generated databases into the decision-making process through collaborative initiatives based around the use of GIS (e.g. Elwood and Leitner, 2003). However, there has been comparatively less research in the environmental domain in using data collected by communities and input into GIS within an overall ICT framework (see Gouveia et al., 2004 for an exception to this). Where such tools have been implemented they have been used to integrate data with other sources of information permitting a visualisation of patterns (often via Web-based GIS) but their use in spatial analytical tasks has been more limited. For example, whereas GIS have been used extensively in site suitability analysis to find suitable locations for environmental and social facilities, this is often confined to straightforward
overlaying of data layers that does not have the facility to incorporate value judgements and public preferences into the procedures. Whilst the use of maps has been to the fore in such exercises Jankowski (2000, p. 197), using the example of habitat restoration, advocates that “the development of new ways to visualise spatial information and novel integrations of maps with analytical tools including multiple criteria decision models may help develop more effective collaborative spatial decision support systems”.

This paper describes the potential for IT in the public participation process by drawing on a literature review of participatory techniques in environmental planning. The overall aim is not to replace existing mechanisms of participation (such as consultation and information dissemination) but to demonstrate how existing techniques can be supplemented with new tools that permit a greater degree of public interaction in the decision-making process. We are specifically concerned with the potential of participatory approaches based around the use of multi-criteria evaluation techniques linked to GIS in order to demonstrate the potential of such tools in the siting of potentially contentious wind farm developments. Simao and Densham (2004, p. 265) note in relation to wind farm planning that “the literature contains no reference to collaborative spatial decision support systems involving public participation”. There is some evidence that opposition from local groups to planning applications for wind farms have increased in the last few years in particular in relation to perceived visual intrusion. In our on-going research programme, we are concerned with developing methods through which compromises can be incorporated into the decision-making process through ‘bottom-up’ approaches based on GIS-generated computer visualisations of proposed wind farm developments. In this paper we draw on these studies in order to provide a framework whereby visual preferences can be included as another set of evaluation criteria in decision support tools that enable public participation in the planning process involving the siting and design of such wind farms. In so-doing, we reiterate the potential of involving the general public in decision-making processes through the use of such techniques. In the next section, we outline the case for increased public participation in the siting of wind farms if government targets for renewable energy are to be realised.

The need for participative approaches in wind farm planning

The UK has targets to cut carbon dioxide emissions by 60% by 2050 and renewable energy is expected to play a major role in achieving such targets (in the Energy White Paper the Government has set a target to generate 10% of electricity from renewable energy sources by 2010 against a current contribution from renewables of less than 2%). This will require a significant increase in the amount of energy generated by renewables in the next decade to meet these targets and overcome this shortfall. It is anticipated that wind power, both onshore and offshore, will form a significant element of these targets. Kellett (2003), for example, provides one potential scenario that suggests that, if energy demand remains constant at 1998 levels, that this requires that onshore wind farms will need to provide 65 times as much electricity as they currently do which, in turn, would require another 2000 km² of land (although the use of land-take as an indicator of the environmental impact of wind energy can be questioned). Despite public support for renewable energy in general, and for wind power in particular, at the national level there is public opposition to wind farms in many areas of the UK particularly in locations perceived to be of significant visual amenity (Bell et al., 2005; Hull, 1995; Sustainable Development Commission, 2005; Warren et al., 2005). This, in turn, has led to frustration amongst developers who perceive that the planning system has slowed down wind farm developments in the face of such anti-wind farm sentiments (Beddoe and Chamberlain, 2003; Mitchell and Connor, 2004). Despite this, Toke (2005a) estimates that planning permission given to date for wind power has enabled 4% of electricity to be provided by new renewable sources and suggests that approximately 1000 MW had been installed by the middle of 2005 and that a further 2600 MW had been given planning permission up to that point in time (Toke and Strachan, 2006).

Recent studies have drawn attention to the complexity of factors influencing the social acceptance of renewable projects in general and wind farm planning in particular across Europe particularly in relation to the siting of specific projects (e.g. Loring, 2007; Ellis et al., 2007; Jobert et al., 2007; Wustenhagen et al., 2007; Wolsink, 2007a, b). The diversity of opinions regarding such developments, for example, is reflected in different polls. A recent Welsh Consumer Council (WCC, 2004) report based on public attitude surveys of just under a thousand people, for example, has found general support for wind energy (45% of their sample were supportive of wind farms on land). At the same time, attitude surveys caution against assuming similar responses for all sections of a community and highlight the need to take into account, for example, socio-economic factors (e.g. age, income, educational attainment, etc.) as well as general attitudes to the environment and hence to incorporate a diversity of opinions in public consultation exercises. The WCC report found real concerns amongst the surveyed public, especially elderly (55+) population groups and those living in South West Wales, in relation to factors such as landscape amenity, concerns over wind developers motivations and general scepticism that this form of renewable energy would help meet government targets. Such findings have to be tempered by the fact that in only 60 cases (of 988 respondents) had the person lived near an onshore wind farm and as the authors themselves suggest more research is needed to examine regional and spatial variations in responses in relation to such factors. The report also concludes that,
there is much that can be done to empower communities in this respect and to assure them that their concerns are being heard. Developments stand a much greater chance of being accepted by the local population if the community is allowed to participate in decision-making from an early stage. (Welsh Consumer Council, 2004, p. 5)

The report encourages developers to involve local communities in open and participatory dialogues from the outset of the proposed wind farm development in order to “ensure residents concerns are adequately addressed” (Welsh Consumer Council, 2004, p. 38). This was echoed by the recently published report of the Sustainable Development Commission (2005) which encourages community involvement at all stages in the wind farm planning process. A recently published study has found that the attitudes of local residents in the vicinity of a proposed wind farm was the most influential factor on the decision made by the relevant planning authority (Toke, 2005b). The importance of the relationship between levels of public acceptance and project success are also noted by Loring (2007) who drew on the findings from 18 case studies in England, Wales and Denmark to examine the types of factors including the combination of, and relationships between, public participation levels and the stability of supporter and opposition networks in influencing planning permission for developments. Her findings led Loring (2007, p. 2658) to conclude that although “projects with high levels of participatory planning are more likely to be publicly accepted and successful” there were instances where there had been low levels of participation but high project acceptability by the public suggesting that factors such as the early involvement of the public and perceived benefits to the local community could lead to more positive reactions. Toke’s (2005b) research also emphasises the importance of the potential impacts of such schemes on local economies and environments on the success of planning permissions. The importance of such factors as local community involvement was demonstrated in a recent case study of a community owned wind farm in south Wales before and after a variety of public participation events (Devine-Wright, 2005a). There have been a number of high profile campaigns of resistance to both onshore and offshore wind farms in South Wales by local opposition groups (for example, in relation to the proposed offshore Scarweather Sands wind farm developments). At the same time, planning policy guidance on renewable energy published in August 2004 by the Office of the Deputy Prime Minister (now Communities and Local Government) has drawn attention to the need for local authorities to take into account local opinion and engage in active consultation from an early stage in the planning process (Planning Policy Statement 22 (PPS22): Renewable Energy; ODPM, 2004). Szarka (2004, p. 327) suggests that “negotiation for a compromise solution at the planning stage remains the most common resolution procedure, usually taking the form of a reduced number of turbines and/or adjustments in turbine alignment, distance from housing, etc”.

Despite this, as Devine-Wright et al. (2001, p. 133) conclude, from an investigation of previous case studies in the UK, “few opportunities for genuine consultation and participation were made available”. The need for local involvement and support schemes, where there appears to be conflict between development and, for example, nature conservation has been seen in other countries such as Denmark (Christensen and Lund, 1998) and Sweden (Khan, 2003). This may involve a fuller justification by the wind farm developers for the location, size, scale and design of the development proposal, for example, to minimise visual effects of such schemes through collaborative approaches (ODPM, 2004, p. 15). In the case of the latter criteria the planning guidance draws attention to the use of objective methods to assess the suitability of such sites whilst recognising the subjective nature of the decision-making process with regard to possible visual intrusion and the need to take into account local landscape types and the nature of the proposed renewable energy developments (such as those related to siting, landscaping, design and colour). The key research question that follows on from this relates to the extent to which collaborative computer-based visualisation techniques can help minimise perceived impacts for those developments that fail to get planning permission due to local opposition on the grounds of visual intrusion. This is discussed in further detail in section four of the paper in a review of existing studies.

A recent study commissioned by the Scottish Executive examined the attitudes of 1810 residents living within 20 km of 10 operational wind farms consisting of nine or more turbines (Braunholtz, 2003). Attitudes were largely positive amongst those that commented on the wind farms (especially amongst those residents living closest to them) and the survey found “substantial support for the idea of enlarging existing local wind farm sites, particularly if the increase in the number of turbines involves the addition of not more than 50% of the existing number” (Braunholtz, 2003, p. 2). This was particularly the case for those that live within 5 km of the wind farm. Perhaps contrary to pre-conceived notions, the study also found that those who feel that the wind turbines had had a generally positive impact on their area were more likely to see the turbines (either from home, travelling or walking in the area). Those that expressed negative sentiments towards the wind farms highlighted concerns over landscape impact. Findings from an attitude survey conducted in Sweden (Ek, 2005) found that attitudes towards wind power from those living near to wind power installations were not significantly different from those living outside such areas, supporting some of the findings of Wolsink (2000) and Warren et al. (2005) on the lack of a NIMBY effect. Other studies have reported changes in attitudes regarding visual attractiveness post-wind farm construction (e.g. Eltham et al., 2008). Nevertheless, positive sentiments towards proposed wind farms
are not replicated in other areas leading to opposition groups being formed in a number of areas of the UK where such developments are opposed in both onshore and offshore wind farm developments. Ek (2005, p. 1688) suggests that such local resistance can be addressed through promoting collaborative approaches “by inviting local residents to participate in early stages of the planning and implementation of wind power projects” or, as Szarka (2006, p. 3047) suggests “upstream of bringing actual projects forward”. Bell et al. (2005, p. 470) also advocate the use of inclusive participatory processes and suggest that, for example, “the only way of accommodating people’s landscape concerns is to site wind farms in places that people find more acceptable”. Thus, they suggest that “at the first ‘level’ of site negotiation a participatory process that begins before potential developers make any siting decisions is essential” (Bell et al., 2005, p. 472).

However, whilst there is some evidence that traditional consultation mechanisms such as information provision and public exhibitions/meetings can result in changes to individual proposals such as to the layout, number and height of turbines (Devine-Wright et al., 2001), others have pointed to a general lack of awareness, frustration, dissatisfaction or mistrust in existing participation processes (Warren et al., 2005).

There has been some research conducted in the UK that has focused on the social and environmental impacts of wind farm developments. The majority of these take the form of policy reviews and interviews with those individuals/groups that are either pro- or anti-wind farm developments (for example, Strachan and Lal, 2004). However, relatively few studies have been concerned with developing IT tools that permit the visual impacts of such wind farms to be explored interactively from any pre-defined location to reach a consensus through, for example, multi-criteria approaches. The use of such tools would appear to be particularly timely in the light of the concerns expressed by the increasing number of protests groups that are opposing such developments in their local areas and the need to adopt a more participatory approach in wind farm planning. As Strachan and Lal (2004, p. 567) recommend there is “a need for greater citizen participation in the planning process” and that “there is a distinct need to measure more fully the perceived visual and aesthetic impacts of wind farms”. Whilst we concur with Eltham et al. (2008, p. 30) who suggest that there is the “need to ensure that the consultation and engagement methods used are individual to each wind farm development to ensure their effectiveness”, more research is needed into how the public can collaborate in wind farm planning decisions. Our particular research focus has been on the use of IT methods to increase public participation in the siting and design process and in the next section we outline how GIS has been used to date in wind farm planning applications before describing how integrated multi-criteria/GIS approaches have real potential to address such concerns in participatory frameworks through, for example, Web-based tools.

The use of GIS-based techniques in wind farm planning

GIS has been used in a number of studies in order to find potential suitable sites for wind farm developments, to produce environmental impact assessments (EIAs) with scenario modelling, to perform visibility analysis and to analyse the quantitative and qualitative impacts on local populations. The majority of studies to date have used GIS to identify potential sites based on factors/constraints such as wind speed, site access and connection to the grid as well as planning considerations (see examples in Baban and Parry, 2001; Howes and Gatrell, 1993; Hurtado et al., 2004; Kidner et al., 1999; Moller, 2006; Ramachandra and Shruthi, 2004; Voivontas et al., 1998; Yue and Wang, 2006; Ramirez-Rosado et al., 2008). GIS has, for example, recently been used to identify strategic areas for wind farms within Wales using a geographical filtering (‘sieve’) mapping approach applied to all-Wales databases (Dunsford and MacFarlane, 2004). Similarly, Rodman and Meentemeyer (2006) incorporated suitability criteria based on physical, environmental and social factors within a grid-based GIS model in order to examine the appropriateness of sites of existing wind farms and to identify areas which could be potentially targeted for future schemes. However, without empirical evidence to the contrary, the weighting schemes adopted to reflect the importance of different criteria in the GIS model which influence the inclusion or exclusion of potential sites are often arbitrary and do not necessarily reflect wider public opinion or preferences. Recent approaches have involved the application of multi-criteria techniques to enable such factors to be differentially weighted according to the perceived importance of different layers in the GIS model and this forms the basis of a number of recently published siting studies. However, a review of published studies (see below) has revealed that, despite the potential for integrated GIS-MCDA approaches to increase levels of involvement in the wind farm planning process, few studies to date have incorporated public opinion in the types of participatory frameworks advocated in this paper.

The majority of proposals for wind turbines have to be accompanied by an Environmental Statement (ES) which, as well as including relevant information about the proposed development, also assesses the potential impact on the environment including a cumulative landscape and visual impact assessment. This could include an analysis of those areas from which the development can be wholly or partially seen and the calculation of the number of households within the viewshed of the proposed wind farm using sources such as census or unit postcode data (which includes population and household numbers for each postcode in the UK) (Moran and Sherrington, 2007). Increasingly the potential visual impacts of such schemes are being modelled and there have been a number of
studies concerned with providing 3D animations in evaluating alternatives (Hansen, 2004) or with demonstrating the potential of different visualisation tools in wind farm planning (see for example, Miller et al., 1999, 2005; Lange and Hehl-Lange, 2005 Benson, 2005). GIS are increasingly being used to derive visibility profiles in environmental statements using the types of tools developed in previous studies in inter-visibility analysis or viewshed analysis or to generate 3D models of visual quality (e.g. Orland, 1994; Appleton and Lovett, 2003; Bishop, 2003; Kim et al., 2004). Moller (2006), for example, has used GIS to quantify changes in visual impact over time (1990–2010) given changes in the configuration and size of wind turbines in a region of Denmark and found changes in visual influence which could have a more heterogeneous impact than currently exists and hence potentially influence existing levels of public support for this form of renewable energy. Much early work was concerned with creating maps of visual preferences based on public surveys/attitudes to various landscape elements or with predicting the impact of future changes in land use (e.g. Miller et al., 1994). Kidner et al. (1999) provide examples of the use of GIS in visualising potential impacts of wind farms through, for example, simulated views of the wind farm development superimposed on panoramic photomontages or through computer-generated landscape assessments. They suggest that the visual impacts of wind turbines can be mitigated through site selection procedures which provide objective comparisons for different elements of wind farm design. With regard to the latter, for example, wind turbines can be ‘placed’ in a rendered landscape scene and then users can navigate around the scene to view impacts from different viewing angles in order to determine the optimum locations for wind farms in order to minimise the visual impact. Their research therefore outlines methods by which visual and landscape assessment could be considered during the initial site selection process, for example, by predicting the numbers and locations of households within the zones of visual influence (ZVI) of a proposed scheme or by calculating the numbers and extent of turbines visible from individual properties. They conclude by drawing attention to the possibility of presenting this information as an interactive visualisation in real time via the Internet through user-friendly interfaces that would facilitate public participation in wind farm design planning.

Web-based approaches have been investigated in a spatial decision support system framework in order to provide a means by which local opinions/perceptions and differing within-community attitudes can be incorporated into a GIS using multi-criteria decision-making (MCDM) software. Examples in relation to general wind farm siting processes include on-going (December 2007) research at the Centre for Advanced Spatial Analysis, University College London which involves the development of a prototype web-site (Simao, 2006). However, there remain few attempts to engage with the public in assessing potential impacts of specific schemes in particular through the use of participative multi-criteria techniques particularly in the siting decision. Coleby et al. (2007) assembled experts in wind farm environmental assessment techniques and described how Multi-Criteria Decision Analysis (MCDA) software could be used in order to assess potential sites for wind farms that could incorporate factors that the public perceive as important in the siting decision and hence provide a platform for more effective participation in the planning process. A review of the potential of such techniques is discussed in the next section.

**Integrating GIS and multi-criteria approaches in wind farm planning in public participation frameworks**

Despite recent interest in the development of Internet-based spatial decision support tools, there remain relatively few studies that have used such technologies to incorporate public views and opinions in relation to real-world planning issues. Those systems developed to date have largely involved prototype tools that have explored the use of participatory GIS approaches in environmental applications (Kingston et al., 2000). Such systems have been shown to increase levels of public participation in the decision-making process facilitating public input into the planning process (Kingston et al., 2002). Traditional means of incorporating public opinion such as workshops, exhibitions, telephone surveys, opinion polls and public presentations have been criticised as information provision and gathering exercises as opposed to improving public decision-making (DM) processes. MCDA permits stakeholders to make a contribution to the DM process through iterative means and successful MCDA-based projects involve a series of well-rehearsed stages starting with problem structuring and stakeholder identification through to establishing evaluation criteria and applying differing priorities for such groups (Voogd, 1983). Rauchmayer and Wittmer (2006, p. 108) suggest that “the combination of participatory and multi-criteria methods generally provides a good starting point for conflict facilitators looking for methods supporting the decision-aid process”. Techniques such as the analytic hierarchy process (AHP) technique have shown real potential in a range of individual and group decision settings where the subjective preferences of experts and stakeholders can be incorporated into the DM process and a consensus reached in a collaborative environment (see examples in Schmoldt et al., 2001). Furthermore, such techniques have the potential to be used at a variety of scales in order to encourage deliberation (see for example, Stagl, 2006 for a national-scale application of multi-criteria evaluation in the consideration of future energy scenarios for the UK). At the local level, the move to new modes of communication and participation, aided by developments such as the Internet, had led commentators such as Malezewski (2004) to suggest that the availability of visualisation tools on the Web enables users to conduct networked GIS-based
land-use suitability analysis and may result in widening public participation in land-use planning. The ability to undertake a sensitivity analysis of the results of MCDA by varying the weights to see the impacts of such variations is also an important consideration in the final siting decision.

To date, MCDA techniques have been largely employed in the preliminary stages of wind farm planning in evaluating the use of different renewable energy sources and to examine how variations in factors and constraints can be incorporated into the final siting decision in order to incorporate preferences of interested stakeholders (Table 1). Ramirez-Rosado et al. (2008), for example, have developed a spatial decision support system based on GIS techniques that permits a compromise in the siting process between economic groups (investors, developers) and environmental groups (conservationists, community groups). This involves the construction of criteria maps for the two groups based on their individual objectives and the use of relative weights for the criteria set based on negotiation between the groups. Prohibited areas such as national parks are used to filter out potential locations of the wind farms and maps of the potential visual impact of farms are incorporated as a criterion in the model along with other preferences such as distance buffers around potential sites. The visual impact was modelled using the perceptions of a sample of 100 people based on photomontages at different distances (up to 30 km away) and for a range of wind turbines. This was subsequently used as one of the criteria in the multi-criteria model in order to try to reach agreement on the “consensual better locations” for the wind farm(s) from the two groups and to compare the consequences in terms of the numbers and locations of sites given any modifications to the rankings agreed to in the negotiation process.

Cavallaro and Ciraolo (2005) have also explored the use of multi-criteria approaches in siting wind turbines on the island of Salina in Italy. Four configurations were compared and sensitivity analysis conducted on economic/technical criteria (such as operating costs) and environmental criteria (such as qualitative measures of visual impact). One of the criteria they use for the latter includes ‘social acceptability’ which “expresses the index of acceptance by the local population regarding the hypothesised realisation of the projects under review” (Cavallaro and Ciraolo, 2005, p. 241). However, no details are provided on how either the visual impact or social acceptability are calculated (e.g. survey numbers or respondents) in order to gauge local opinions. Although there may be other concerns of relevance to the public in the vicinity of proposed or hypothetical sites such as social and economic impacts (e.g. potential impacts on property prices) there has been a lack of research concerned with examining potential visual impacts of wind farms and the potential of utilising IT techniques in the ‘trade-off’ between visual and other impacts using multi-criteria techniques which involve multiple stakeholder input. In particular, there is an urgent need to address and update Dearden’s (1981, p. 16) claim that “it would appear hopefully to be but a matter of time before public input is routinely included in determination of the visual quality of landscape”.

Early studies that examined published environmental statements associated with some examples of the early wind farm developments found that there was little consideration of alternative sites and layouts and that analyses of the visual assessment of such schemes was limited. This led researchers to conclude that “since the siting and positioning of turbines will create favourable public opinion for the technology as a whole, such an omission is unfortunate” (Coles and Taylor, 1993, p. 220). Furthermore, they recommend that “the investigation of alternative sites and layouts using the range of evaluation methods available should be a standard requirement; this can only assist the development of good practice” (Coles and Taylor, 1993, p. 220). Such investigations could explore, for example how the location, height, spacing and potential noise pollution of such wind farm installations impact on the subjective landscape perceptions of different sectors of the community with different vantage points. Since the
time of that study, new technical developments in visualising impacts have meant that such landscape visualisations have been increasingly incorporated into environmental impact assessments through their use in environmental statements related to proposed wind farm developments. However, as Devine-Wright (2005b, p. 135) argues “there is a lack of valid and reliable quantitative methodological tools for operationalising public perceptions of wind farms”. More research is needed to explore the extent to which GIS is being used in those environmental statements associated with more recent proposals and to examine if and how the outputs from such techniques are being used in public consultation exercises or public inquiries associated with such developments in order to update this earlier research. In particular a potentially important research strand could be to identify the role for IT approaches in increasing the numbers of the public participating, in widening participation to those social groups that traditionally do not tend to participate and in promoting a greater depth of involvement in participatory approaches in renewable energy projects (see Mulvihill, 2003 for examples of the use of new technologies in the Canadian context).

There has been a significant amount of research in the area of computer-generated visualisation, with the recent availability of new software packages but there remain few attempts to integrate an assessment of visual impacts into the participatory process as another set of criteria in the siting process. Despite recent attempts to develop objective measures of aesthetic impacts of wind farms (for example, Bishop, 2002; Sibille et al., 2008), there is a clear need to incorporate subjective elements of their visual preferences of different stakeholder groups with varying values and judgements. Visualisation tools within GIS when linked to a multi-criteria analysis permit such preferences to be compared using a bottom-up approach to incorporate differing values and preferences of individuals, local communities and stakeholders in order to minimise visual impact. Software has been used previously to extend traditional tools such as photomontages, either as part of generic GIS packages or for specialised landscape simulator packages tailored for visualising differing configurations of wind farm developments as part of environmental impact assessment procedures. These new visual techniques have real potential to incorporate public perceptions of landscape changes into a participatory decision-making process by permitting movement through the landscape. Despite a number of studies that have incorporated public preferences using GIS data in multi-criteria frameworks (for example, in the selection of areas for land conservation; Strager and Rosenberger, 2006), there has been little research to date that has explored the potential for GIS-based visualisation scenarios within such models in participation exercises (a notable exception in the forestry management context being the work of Sheppard and Meitner, 2005). Such techniques have potential here; for example, Benai-Kashani (1989, p. 686) suggests that “the AHP exhibits flexibility in dealing with both the qualitative (intangible) and quantitative (tangible) factors in a multi-criteria evaluation problem”. The subjectiveness inherent in visual preference analysis and the quantification of landscape views and their incorporation into such models, in our view, warrants further study. Given the Government’s targets with regard to renewable energy, the promotion of policies encouraging public participation and the need to bring on board the general public at earlier stages in the siting process (in particular local communities potentially affected by such schemes) there is an urgent need to redress this situation. More research is needed to examine the feasibility of an integrated MCDA–GIS approach to incorporate public perceptions and preferences in the visualisation of landscape impact assessments in relation to such developments building on the work, for example, of Gamboa and Munda (2007) who varied the criteria used in such models in order to reduce the visual impact of an original wind farm proposal in an area of Catalonia, Spain using viewshed mapping. As Wolsink (2007a, p. 2694) argues “in the case of collaborative decision-making, the significant discussions about the benefits and costs of a wind power scheme will be about the visual impact and how to fit the wind farm into the landscape”. Spatial decision support systems provide a means by which local opinions/perceptions and differing within-community attitudes can be incorporated into a GIS and for stakeholders and the general public to evaluate the visual impacts of such schemes through MCDA methods. More research is needed on the barriers preventing developers from engaging in the use of the types of IT tools highlighted in this paper that permit collaborative approaches in visual impact assessment as well as to gauge the current levels of pro-active consultation with collaborative methods in wind farm planning (and other forms of development).

Further research is needed in order to investigate how integrated GIS–MCDA techniques can be used in a public participation setting to reach a consensus on final sites that incorporates an analysis of proposed visual impacts. This involves the use of multi-criteria decision models with GIS in an individual and group environment and an evaluation of the potential use of such technologies for public input at each stage in the decision process from the initial data design stage through to the GIS-based analysis (criteria selection, weighting of factors) to the output stages of the project. Whilst there has been some attempt to integrate qualitative factors into the AHP, more research is needed, for example, to examine ways in which subjective measures of landscape views can be incorporated into the site suitability process. Our future research plans include an investigation of the potential for using GIS tools developed in other planning situations that provide visualisation, impact analysis and policy simulation/forecasting tools for communities/groups and their integration with AHP software such as Expert Choice. Previous research in urban areas has, for example, linked virtual reality modelling...
languages and GIS systems in a collaborative framework in planning and urban regeneration applications (see for example, Hudson-Smith and Evans, 2002). These permit varying degrees of public involvement in the decision-making process but have demonstrated the usefulness of such collaborative tools in practical planning scenarios through customised interfaces. There has been some attempt to use a collaborative GIS approach to integrate spatial components (such as access to green spaces) into public attitudinal surveys (see for example, Balrum and Dragicic, 2004). However, such information has had to be quantified in some way in order to incorporate these components into a GIS. Whereas GIS has been good at handling such ‘hard’ data, it has not, to date, been extensively used to incorporate subjective information (although see Elwood, 2006 for a recent discussion on the potential for the integration of qualitative methods with GIS and linkages to participatory GIS initiatives). More research is needed however to incorporate visual preferences from a range of stakeholders using GIS-based models in order to propose alternative scenarios and share the potential consequences of the proposed alternatives in collaborative frameworks. This forms the basis of our on-going research in this area.

Finally, it would be naïve to suggest that, despite the potential of the types of IT techniques implemented in the largely prototype systems described in this paper, such collaborative tools will automatically help achieve consensus on the location and types of wind farms planned in the UK. Researchers have to be realistic given the respective standpoints of some stakeholders to the concept of wind energy as a resource, with vehement opposition from some conservation and protest groups unlikely to be conducive to facilitating such a consensus irrespective of the nature of the participative tools that are being developed (Bell et al., 2005). However, those studies conducted to date suggest that the use of participatory approaches based around combined GIS/multi-criteria techniques have real potential to enable compromise solutions between different stakeholders. In particular, there is a real need to examine if such techniques have potential amongst those who are ‘conditional supporters’ as distinct from ‘fundamentally anti-wind power groups’ (Wolsink, 2007a; p. 2694) using ‘live’ planning applications. As Eltham et al. (2008, p. 31) suggest “whilst early engagement is unlikely to change the opinion of those who object to wind power, it may serve to reduce opposition and enhance acceptance levels” for those living in the vicinity of the proposed development. The use of participatory GIS-based visualisation techniques in such regards forms the basis of our on-going research investigations for a South Wales case study.

Conclusions

Demand for greater accountability in environmental decision-making and calls for enhanced public participa-

- tion have led researchers to explore a number of different collaborative approaches to solving problems. There have been increasing calls for more participation in the planning system concerning wind farm developments (Strachan et al., 2006). Wolsink (2007a, p. 2692), for example, states that “local involvement to represent the local values of site-specific landscapes is crucial”. However, as Ellis et al. (2007, p. 538) suggest, such “public engagement should be viewed as an interactive, rather than one-way, process, with the aim of changing the attitude of developers as much as objectors”. To date however, wind farm developers have been slow to take on board participatory approaches based around IT in pre-planning or consultation stages with local communities in the vicinity of wind farm projects. Techniques such as photomontages or 3D visualisation techniques of a wind farm proposal may be used to inform the public in consultation exercises but these are by no means interactive or conducive to the aims of getting the community involved in the project design. It can also take a long time for ‘traditional’ forms of visual impact information to be prepared and organised for exhibitions of wind farm plans so, from a developers perspective, IT-based tools have real potential in providing impressions of any proposed amendments to wind farm design ‘on the fly’. Those studies conducted to date have used GIS-based techniques to find suitable sites for wind farms that satisfy physical, environmental and social criteria using ‘sieve’ analysis to create suitability maps for each criterion and then using overlay analysis to find sites that meet such criteria. Some studies have also extended the functionality of existing GIS using multi-criteria methods to include sensitivity analysis to vary the criteria or their associated weights in collaborative frameworks to include the views and preferences of interested experts and stakeholders. At the same time, others have examined the potential impacts of wind farms through a variety of new GIS-based visualisation techniques using, for example, viewshed analysis. This is aided by the analysis of more detailed and accurate data sets such as remote sensing imagery, digital terrain models and land cover databases that have come on-stream in the last 5 years or so. However, input from the public in the data input or modelling/analysis stages of such GIS projects has been limited despite the improved visualisation capabilities of GIS and the use of distributed networks that potentially permit a closer integration enabling public participation in a wider range of tasks. Studies to date have involved experts providing scenes to the public or stakeholder groups using a variety of approaches, including posters of photographs of proposed sites in workshops or public meetings, but a natural extension to such studies that follow on from some of the participatory GIS research currently being conducted in some urban areas of the United States, would enable individuals themselves to investigate different options through on-line interfaces. This would represent a more interactive participatory approach in the design and planning stages of such projects which offer the potential to...
reach a consensus in the final siting process. However, as MacFarlane et al. (2005, p. 356) suggest, such a “truly participatory landscape visualisation is not yet available”. Whilst there are now a number of examples of using computer-generated landscape visualisation in a public participation environment, more work is required in order to gauge the perceptions of planning professionals and the general public to the use of such visualisations (Appleton and Lovett, 2005). Their survey of 12 planning professionals, for example identified a number of benefits and limitations to the use of computer visualisations relating to, for example, levels of realism, incorporating uncertainty and choice over the location of viewpoints.

The aim of our future research will be to demonstrate the advantages of linkages between the technologies as part of an overall decision support system framework. Whilst specifically related to siting wind farm developments in this instance, the techniques and approach adopted will be transferable to other types of assessment for which a consensus view is needed from a range of interest groups although as is acknowledged previously, such processes may not necessarily create or construct a consensus. As Joao and Fonseca (1996) comment there is a real need for research to explore methods by which public input into the EIA process can be enhanced through the use of GIS techniques as early as possible in the assessment process. The proposals contained in the UK Governments White Paper, Planning for a Sustainable Future (HM Government, 2007) aim to provide for better consultation and improved engagement in the planning process. Our on-going research, based on a case study of a wind farm planning application in South Wales, is evaluating the use of Web-based techniques in relation to more ‘traditional’ approaches of engaging stakeholders in actual wind farm siting applications such as the use of advertisements in local newspapers or public meetings/information sessions.

Judging the effectiveness of such approaches is not straightforward but could, for example, draw on the work of Rowe and Frewer (2000) who provide measures by which effectiveness could be evaluated through for example identifying changes in development proposals resulting from consultation procedures. Further measures of effectiveness may involve in-depth studies examining the behaviour of participants as they use new technological approaches versus more traditional methods of participation (see Rowe and Gammack, 2004 for a review of such studies). Toke and Strackm (2006, p. 164) advocated, “strategies for deploying wind power that involve greater communication with, and involvement of, residents who are near to the wind power schemes”. It is our contention that the types of participatory decision support processes reviewed in this paper have real potential to facilitate the incorporation of stakeholder values and preferences into the siting process in order to make the DM process more transparent, resolve differences or conflicts and ultimately to help gain public acceptance of such schemes; factors that will be vitally important if the Government’s renewable energy targets are to be met in subsequent years.

References


