

Living in the Vicinity of Wind Turbines — A Grounded Theory Study

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Little is known of wind turbines' impact on people living in their vicinity. The aim of this study was to gain a deeper understanding of how people perceive and are affected by wind turbines in their living environment. In-depth interviews with 15 informants, strategically chosen to form a heterogeneous group, were analyzed using the constant comparative method of grounded theory. The informants were to different extents affected by the swishing noise, flickering light, and constant movement of the turbines' rotor blades. Some informants perceived the exposures as outside their territory while others perceived them as intrusion into privacy; a divergence partly determined by the informants' personal values about the living environment. The feeling of intrusion was associated with feeling a lack of control, subjected to injustice, a lack of influence, and not being believed. Informants used various coping strategies, such as rebuilding their houses or complaining, but mainly tried to ignore exposures from the wind turbines. The findings can help us to better understand the severe reactions wind turbines sometimes evoke and contribute to the knowledge base used when planning for new wind farms.

Keywords: audio-visual interaction; coping; environmental stressors; grounded theory; home; human response; multimodal perception; noise annoyance; shadows; sound; territoriality; wind power

Introduction

Background

Wind turbines generate renewable energy and thus contribute to sustainable development in accordance with the Kyoto Protocol (Ghosh, 1995). These modern windmills have been erected in many parts of the world, often in inhabited regions. Studies on public attitudes in Europe and Canada show strong support for the implementation of wind power (Devine-Wright, 2005). Despite this, residents often oppose planned wind turbine developments in their neighborhoods, a dilemma that has in part been dismissed as a communication problem or a not-in-my-backyard (NIMBY) syndrome. A thorough analysis of the nature of resistance to wind turbine projects shows that the matter is far more complicated and involves several factors (Wolsink, 2006). One of these identified factors was a fear among the public of the risk of being annoyed by noise, light, and flicker that may occur after the turbines were erected. The base of that fear is not easily understood, as the

audible and visual exposure levels from wind turbines are low compared to those known to generate annoyance with other sources, such as road traffic.

The few previous studies of the impact of wind turbines on humans have focused on the wind turbines as sources of noise, investigating dose–response relationships between sound exposure and noise perception using epidemiological methods developed in community noise research. In a cross-sectional study performed in Sweden among people living in a rural but densely populated area containing 16 wind turbines, the sound exposures as A-weighted sound pressure levels were calculated for each respondent ($n = 351$) and compared with reported perception and annoyance as measured by questionnaires (Pedersen and Persson Waye, 2004). Compared to other sources of community noise, such as road traffic where respondents are seldom annoyed at A-weighted sound pressure levels below 40–45 dB (Miedema and Vos, 1998), many respondents in this study unexpectedly reported annoyance with wind turbine noise at A-weighted sound pressure levels below 40 dB. For example, 20% of 40 respondents living in an area exposed to noise of 37.5–40.0 dBA from wind turbines stated that they were “very annoyed” by wind turbine noise on a five-point scale ranging from “do not notice” to “very annoyed,” although the 95% confidence interval were rather broad due to the small sample: 8–32%. On the other hand, at the same A-weighted sound pressure levels, 15% of the respondents reported not hearing the wind turbine sound and 35% hearing the noise but not being annoyed by it. So even though a statistically significant dose–response relationship between A-weighted sound pressure levels and annoyance with wind turbine noise was found, the response variance within a single exposure level was large, indicating that other physical and/or subjective factors influenced reported effects.

The results of a study performed in Germany, Denmark, and the Netherlands showed a similar pattern (Wolsink *et al.*, 1993). Only a weak correlation, although statistically significant, was found between A-weighted sound pressure levels from wind turbines and resulting annoyance. Furthermore, when exploring intervening variables, A-weighted sound pressure levels were found not to be statistically significantly related to noise annoyance. The explanation could be that only 6.4% of the respondents reported annoyance with wind turbine noise or that variables other than sound pressure level contributed to noise annoyance.

Flickering light due to movement of the rotor blades could occur in autumn, winter, and spring in the morning or in the evening, i.e., during the time of the day when the sun is rising or setting. Responses to flickering light have not been thoroughly investigated. In the Swedish study mentioned above (Pedersen and Persson Waye, 2003), no dose–response relationship was found between duration of flickering light (hours per year) and resulting annoyance. Annoyance with flickering light seemed instead to be related to A-weighted sound pressure level.

Since audible and visual stimuli from wind turbines cause annoyance among some individuals, wind turbines could be viewed upon as environmental stressors (Lazarus and Cohen, 1977; Campbell, 1983). Particular to ambient stressors, such as road traffic, is that they are not circumscribed events, but relatively continuous conditions of the environment, even though they may vary in intensity. Ambient stressors could to a degree pass unnoticed until they interfere with goals and beliefs. For example, traffic noise that usually stays unnoticed by a student who does not consider himself sensitive to noise may become very annoying when the same student is preparing for his first exam. The two stimuli from wind turbines previously identified — noise and flickering light — may qualify as ambient stressors, and if appraised as threatening could affect well-being (Campbell, 1983). They are, however, in some aspects different from ambient stressors previously explored.

The sound from wind turbines is amplitude-modulated, which means that the sound varies rhythmically in intensity with the rotor blade movement. Wind turbines are typically placed in a rural landscape with low background sound pressure levels. They are also very large objects with an impact on the landscape scenery. All these factors make wind turbines atypical objects so that results from studies of road traffic, for example, cannot be directly generalized to wind turbines.

This review of findings indicates that the relationship between exposure and response is complex and possibly influenced by variables not yet identified, some of which are non-physical. Exploring and understanding wind turbines' impacts on people in their home environments would presumably benefit from an interdisciplinary perspective in which theories from fields such as psychology and sociology are integrated with an epidemiological approach. Such a perspective could also provide a more contextualized analysis and lead to a deeper understanding of the implications of living in the vicinity of a wind turbine. This understanding is essential for the development of wind power clear of negative impact on quality of life and well-being — thus clearly demonstrating a need to study the effects of wind turbines on humans in a broader sense. To do this, we should use methods suitable for describing and understanding a multifaceted phenomenon. A first step is to listen with an open mind to people who are living close to operating wind turbines, as they describe how they experience the turbines in their daily life and, if possible, identify factors of importance for the effects on human beings.

The qualitative study presented here was part of a larger project investigating human responses to audio-visual exposures from wind turbines. The project was carried out in a Swedish county that was one of the first areas in Sweden with a rather large number of wind turbines placed in the vicinity of dwellings.

Aim

The aim of this study was to gain a deeper understanding of how people living in the vicinity of wind turbines perceive and are affected by the turbines.

Method

Grounded theory

The constant comparative method for discovering a grounded theory was chosen for the study. The method is useful when a new perspective of a research area is needed, as in the studies of wind turbines' impact on people living close by. Grounded theory is not a method for verifying existing theories; it is an inductive method for generating conceptual models and hypotheses for further testing. This study attempted to apply classical grounded theory as presented by Glaser and Strauss (1967); i.e., we tried to set aside prejudices and systematically explore data until concepts, models, or theories emerged. The developed abstractions were then tested against the original data to ensure that the concepts were empirically grounded. As suggested by Glaser and Strauss, data collection (interviews) and analysis were conducted iteratively in this study until no new information relevant to the analysis in process appeared and saturation was reached, i.e. no new data was disclosed. Although grounded theory has developed towards a methodology for a constructivist perspective, this study was conducted with the assumption that an objective reality exists, even if it is never perfectly apprehensible.

Participants

Selected participants were initially sent a letter with information about the purpose of the study. A few days later they were contacted by phone and asked whether they wanted to participate. Three people declined to participate, two because of lack of time and with no opinion on wind turbines, and one for unknown reasons. Participants were initially chosen from a previous survey of wind turbines investigating the dose–response relationship between A-weighted sound pressure levels and resulting annoyance (Pedersen and Persson Waye, 2004). The intention of the previous survey was masked by presenting the survey as a study of general living conditions in the countryside. At the end of the questionnaire, respondents were asked to give their telephone numbers if they were willing to be contacted for further questioning. For the present study, the participants were chosen strategically to obtain a heterogeneous group with as large as possible variation of self-rated annoyance at wind turbine noise in relation to calculated A-weighted sound pressure levels from wind turbines at their dwellings. Participants exposed to similar A-weighted sound pressure levels but who reported that they were “not annoyed” ($n = 2$) or “very annoyed” ($n = 4$) were initially interviewed. The purpose of starting with these participants was to capture a variety of descriptions already in the beginning of the study. As concepts emerged, the sampling became more theoretical, seeking variance within the identified categories. For example, to saturate the concept of personal values of the living environment, people who earned their living off the land and people who commuted to work in a nearby city were sought, as they were predicted to have different relations to the living environment. To broaden the base of eligible participants, some were at this stage chosen from among those who had complained to local authorities concerning various aspects of wind turbines ($n = 4$); sampling meanwhile continued from among respondents in the previous study who had reported that they were “not annoyed” ($n = 3$) or “very annoyed” ($n = 2$). Even though gender previously has not been found to influence noise annoyance, a balance between men and women was sought to cover as many different experiences as possible.

Overall, 15 participants were interviewed, 8 female and 7 male, ages 32–75 (median: 54) (Table 1). Two participants were farmers, five were self-employed or worked in small family businesses, seven were employees, and one was retired. Two of the participants were a married couple. All participants lived in detached houses in a small rural district (25,000 inhabitants) in the south of Sweden. In the flat agricultural landscape, 44 wind turbines of various branches were operating. Most of them were placed as single objects and not in groups, which gave a scattered impression. All of the participants lived within 600 meters of a wind turbine and could see more than one wind turbine from their dwelling, often in several directions. The development of wind power in the area started in the early 1990s and culminated around 2000. The local implementation of the planning legislation varied during this time, and therefore some of the participants were asked to approve the erection of a wind turbine near their house, while others were not. Since the end of 1990s, all people living within 500 meters of a planned wind turbine received letters from the local authorities in which they were asked to approve the wind turbine. The wind turbines are mainly privately owned by farmers or self-employees.

Interviews

Interviews took place either at the participants' homes ($n = 12$) or at Halmstad University ($n = 3$) and lasted between 30 minutes and 1 hour. All interviews were conducted by the first author. An open-ended approach was used in the first six interviews, i.e., participants

Table 1
Study sample ($n = 15$)

Gender	
Male	7
Female	8
Occupation	
Employed	7
Self-employed	5
Farmer	2
Senior citizen	1
Annoyed by wind turbine noise	
No	5
Yes	10
Exposed to wind turbine noise ^a	
<32.5	1
32.5–35.0	1
35.0–37.5	3
37.5–40.0	5
>40.0 dBA	3
Primary stimulus noticed	
Noise	10
Flickering light	3
Movement	1
Age (years)	
Range: 32–75; Median: 54	

^aFor two of the informants exposure could not be established.

were asked what they thought when the first wind turbines were erected in their neighborhoods, what they thought of them now, and how they would describe the implications of living near them. Follow-up questions were used for clarification and to reveal thoughts and feelings. This open-ended approach was kept for the remaining interviews, but with added questions related to the emerging concepts. The interviews were audiotaped and transcribed verbatim by an independent research assistant. After each interview, the interviewer recorded observations on the participants' non-verbal reactions and, if the interview took place at the subject's home, descriptions of the exterior and interior settings.

Analysis

The transcribed interviews were initially coded line-by-line, using the participants' own words or immediate expressions. All codes found in the first six interviews were listed together with the interviewer's free reflections and ideas related to each code. As codes were associated with each other to form clusters, categories were identified and the coding became more focused. Theoretical reflections on data and assumptions as to conceptual relationships between categories were continuously recorded in memos, mostly as running text. Constant comparison among and between transcribed interviews, memos, and categories led to rejections, confirmations and adjustments in formulating the emerging concepts. Saturation

was reached after 10 interviews, i.e., we could not foresee finding any more data that would contribute to the study. Comparisons with existing theories presented in the discussion below were made after the final conceptual model was confirmed in five additional interviews.

Ethical considerations

The study was approved by the Ethics Committee at Lund University. All participants were informed that they had the right to terminate the interview at any stage without explanation. All participants consented in writing to participate in the study.

Results

All informants stated that they were exposed to audible and visual stimuli from wind turbines in their homes or in their gardens, but their experiences and consequences of living close to a wind turbine differed. A conceptual model (Figure 1) emanating from the variation of the informants' personal values about the living environment (core category) was developed. Some of the informants, who considered the countryside as a place for economic growth and technical achievements, were indifferent to the exposures from the wind turbines and thought of the wind turbines as objects placed *outside their territory*. Others, who emphasized that the countryside should be a quiet and peaceful place suitable for restoration, described how the noise, flickering light, and rotor blade movement reached into their homes and sometimes led to feelings of violation, summarized as *intrusion into privacy*. Experiences leading to feelings of helplessness — *lacking influence, lacking control, being subjected to injustice, and not being believed* — were also identified in the analysis as important for the perception and effect of the wind turbines for the latter group of informants. The impact of the wind turbines induced some of the informants to *take action*. Whether or not action was taken seemed to be regardless of the distraction they felt or their personal values about the living environment; however, the outcome of the action taken became an experience that in turn influenced how they were affected by the wind turbines. The core category, categories, and related subcategories are further described below.

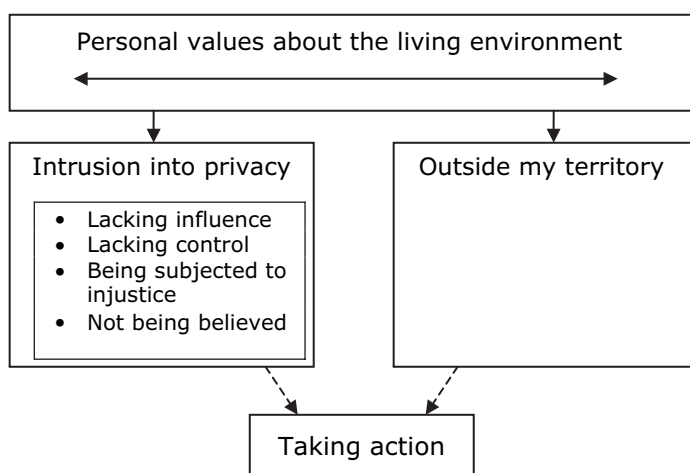


Figure 1. An conceptual model illustrating the relationships between categories and subcategories.

The informants described three main types of stimuli from the wind turbines: noise, flickering light, and rotor blade movement. The noise was often classified as a swishing (*svischande*) sound, but throbbing (*dunkande*), resounding (*rungande*), rattling (*skramlande*), and howling (*tjutande*) were also used as descriptors. The flickering light was depicted by some as being like a strobe light. The movement was described as a constant rotation that always attracted attention, and that was more annoying in winter when there were no leaves on the trees to hide the rotor blades. Most informants emphasised one type of stimulus as dominating the disturbance, typically noise (Table 1), but also added a second and sometimes a third. Wind turbines could not, according to the informants, be compared to other sources of disturbance, as the audible and visual stimuli as well as the situation were felt to be unique. Both rotor blade movement and noise were described as constant, and they could not be compared to noise from cars passing by on the road. Incidents that accidentally increased the noise (e.g., loose parts) were remembered and seemed to increase negative feelings even after they were dealt with.

Personal values about the living environment

Living in the countryside meant different things to different informants. The countryside could be viewed as a peaceful and quiet place. Restoring an old house and creating a garden suited for oneself and one's family were valued highly, the intention being to create a sheltered haven for rest and regaining strength. The conscious attempt to create a home, rather than just a house to live in, was demonstrated by the great care given to both the interiors and the exteriors of the houses. A beautiful view of the surrounding landscape, preferable with an unbroken horizon, was an additional advantage. The work and money invested in the homes were expected to repay the owners in terms of high quality of life and stable property values. The countryside was also described as a place where it was easy to live and where neighbors helped each other. The living environment should be safe for the family, not exposed to known or unknown risks. All these expressed values were regarded as threatened by the impact of the wind turbines and led to feelings of *intrusion into privacy*.

After that we borrowed money and renovated the house. For a lot of money and work, actually. It's the dreams that we've always had. The children grew up here and the Mrs. stayed at home to take care of the kids instead of sending them to day-care. That is kind of our philosophy. (IP7, p. 1)

I've done everything to this house. And now there's a risk that it'll all fall apart. I didn't do it to increase the value of the property and then sell it. No, I did it to enjoy living here. That's the biggest reason why I'm upset: that others can have such a powerful impact on your life. (IP6, p. 11)

On the other hand, some informants regarded the countryside as a place for economic growth and technical achievement. They felt that if one chooses to live in a rural area, one must accept disturbances typical of the countryside such as flies or odor from manure and hence also noise and shadows from wind turbines. The landowner has the right to decide how to use his or her land, and thus has the right to erect wind turbines.

I haven't been bothered by it at least, just remarked that I can hear it. [. . .] In one way it's really about your basic attitude to it, and I'm rather amused by technical developments in general. (IP5, p. 6)

Sure, they can do what they want. It's not my business. Other than that, it's totally commercial. [. . .] If he wants to grow carrots and make a lot of money, that's just fine as well. (IP10, p. 2)

Consideration of the countryside as a base for earning a living or as a place for the development of society through technical achievements, as described by the informants, seemed to lead to the feeling that exposures from wind turbines were of no concern and hence *outside my territory*.

Intrusion into privacy

Informants who perceived the wind turbines as intruders were all affected by the turbines, but to different extents. For some informants, the constant movement of the rotor blades, the swishing sound, or the flickering light intruded into the outdoor recreation areas (gardens) and sometimes into their houses, disturbing their idyll. The wind turbines became sources of annoyance, decreasing their enjoyment of daily life at home and blocking pleasant experiences. These informants described their reactions to the wind turbines in terms of irritation and annoyance:

It's just that always when you're outside it's just irritating. That's not the sound you want to hear — you want to hear the birds singing. [laugh] You can hear that too, but when you're outside, then you think to yourself, yuck, there it is again. (IP2, p. 3)

The perception of audible and visual stimuli had for some informants even further consequences, not only intruding into their home environments but also into their selves, creating a feeling of personal violation. They expressed anger, uneasiness, and fatigue, revealing their strain by their tense voices and sometimes by crying when talking about the impact of the wind turbines. To be affected by the wind turbines to such a high degree, being unable to protect themselves from the intrusion that constantly aroused negative emotions, was experienced as a serious loss of well-being and quality of life. For most informants the negative reactions increased with time or only partly decreased:

I drive wheel loaders and trucks. There's plenty of bang and bonk all day long. You know, a garage. When I turn everything off for the night and hear that wind turbine, it's enough to drive you crazy. It never goes away . . . You go mad, it's sort of like that. It's always there. You get used to it, to some degree. But when you go out in your garden on a Saturday, and you hear it. You get so angry at that sound that you end up being angry at everything. Do you understand what I'm saying? It'll drive you crazy. (IP7, p. 6)

The need for a protected zone, well away from the busy world, where one could rest one's eyes and ears was described as important and sometimes as necessary. With the installation of the wind turbines, this protected zone was taken away.

The feeling of *lacking control*, both of the noise and of the situation, seemed to enhance the adverse effect of the wind turbines. Not being able to control the source of stimuli was mentioned as frustrating, as was the unpredictable occurrence of the noise. Sources of annoyance in a house, such as a fan, could be turned off when they were felt to

be disturbing. The feeling of not being able to control turbine development could also contribute to feelings of intrusion. In addition, the informants felt that they were *lacking influence* over the situation. Many turbines had been erected within a short period and located in several directions from the informants' dwellings. The informants did not believe they had any say in the planning of the turbine locations, even though they had been informed and asked to approve the development as neighbors. None of the informants had prior experience of wind turbines before they were erected near their dwellings, so they were unaware of the consequences of or their reactions to the exposures. The irritation they felt at perceiving the swishing sound, flickering light, and constant rotation came as a surprise to them. This lack of awareness misled them, they felt, resulting in their agreement to the location of the first turbines when asked to sign an approval.

I saw it as a positive development. We didn't have any wind turbines here, and because of that we didn't know what they were. Then we got to know that it meant that every time you went in the garden or looked in that direction, it was spinning. It just spins and spins. It gets irritating. (IP3, p. 2)

To be exposed to noise, flickering light and rotor blade movement, while the owner of the turbine lived further away and sometimes even in a neighborhood of higher status, created feelings of *being subjected to injustice*. "Why do I have to put up with this while he is making the money?" could sum up such feelings. Government grants given to the developers and owners of wind turbines, because turbines contribute to renewable energy production, were also cited as unfair. Bad experiences when contacting authorities were commonly described by those who were negatively affected by wind turbines. Such experiences could have happened before the development of the wind turbines, concerning other changes in the environment (e.g., a new railway location affecting the view), but was mostly described in relation to complaints about wind turbines. Informants felt that they were treated disrespectfully by local politicians and officials when complaining about the impact of the turbines. The feeling of injustice was also expressed by those who had appealed against the issuance of building permits by the local authorities, permits that allowed turbines to be erected close to their homes. They felt that the legal process favored those in superior positions, i.e., the turbine owners:

The thing is that I've been unjustly treated. I've not been treated appropriately. It's as if someone who's been sentenced for murder or an innocent person who's been sentenced, that they go to prison for a crime they didn't commit. (IP7, p. 16)

Concern for wildlife when discussing the location of wind turbines offshore instead of on land was cited by several informants as an example of misdirected environmental concern: caring for wildlife more than for humans.

Being negatively affected by the wind turbines was hard to explain to people who had not experienced the problem themselves, according to the informants who felt that they were *not being believed*. Low-level noise, flickering light, and rotor blade movement were unacceptable sources of annoyance. Friends and authorities did not understand the implications of living with such stimuli every day. Some informants said that they felt somewhat ridiculous at reacting so strongly; most of the informants, however, demanded to be understood and treated seriously.

It gets a little insulting. It is, after all, a fact. That's how I feel. And then they call you a whiner and they dismiss you. You feel insulted, because for you,

it's a fact. That's the way I feel, how it is for me, the way I experience it. It's insulting not to be believed. (IP 9, p. 7)

The regulations only set limits for sound pressure levels (40 dBA) and flickering light (30 theoretical hours per year), and these limits were seldom exceeded. The level of annoyance was nevertheless high, despite exposures being below the limits. Informants sometimes explained this by claiming that the measurements were made on a day with unusual weather conditions, or that the calculations were based on the wrong assumptions. The informants expressed feelings of "us against them" when describing their contacts with local politicians or the general public.

Outside my territory

In contrast to the informants who perceived the stimuli from the wind turbines as intrusion into privacy, other informants described noise, flickering light, and rotor blade movement as something that did not concern them. They observed the wind turbines and noticed the wind direction, but did not think of them otherwise, even though the noise could be heard in their garden and flickering light sometimes would occur indoors.

It doesn't bother us, not really. You can hear it sometimes if you want to. If you listen for it, you can hear it. But of course we have the road out there as well, if you feel like listening for that [. . .]. Sometimes it flashes a little in the house. That can be annoying, but it's rare. (IP 1, p. 2)

The wind turbine was something that was placed on a neighbor's land and therefore outside the informant's territory. Even if the informant could hear the noise, see the constant rotation of the rotor blades, and sometimes receive the flickering light, these exposures were perceived as located at a distance. The informants meant that the exposure from the wind turbine could easily be mentally shut out and thought of as not relevant for themselves. They felt that they could control their reactions to the stimuli even though they could not physically stop the turbines from running. When discussing why their neighbors had reacted against the turbines and they had not, some informants described themselves as more tolerant, and hence not negatively affected.

I do think of myself as a very tolerant person, and I can accept quite a bit of noise and flashing. [. . .] I'm currently working as a service manager in a garage, receiving customers, and I have to take care of people and deal with their problems and opinions. To do that you have to be fairly tolerant of their cars and their views. (IP 1, p. 6)

These informants often expressed respect for the neighbors who, in their view, were not as tolerant as themselves and therefore negatively affected by exposures from the wind turbines. However, the opinion was also articulated that those who complained were people who had too high demands of their living environment.

Informants who perceived the wind turbines and the exposure from the wind turbines as something outside their territory shared the same view as the other informants on several issues, e.g., the development process. Similar to other informants, they did not believe they had had any influence on the numbers of wind turbines suitable for the area or the placement of the turbines. They were convinced that the authorities would issue the

developer a building permit even if a neighbor did not approve. This fact did not disturb them, however, as they did not feel involved even though wind turbines had been placed close to their dwelling.

The wind turbines were often mentioned in a positive sense, e.g., as landmarks when describing the way for visitors or as indicators of the wind direction when deciding where in the garden to place the barbecue. However, the appearance of the wind turbines was seldom viewed as an aesthetic contribution to the landscape. On the contrary, the wind turbines were viewed as neutral or ugly, but necessary devices. The informants commented on the scattered placements of the wind turbines in the area and wished that the planning would have been better, but also declared that the present situation was something one had to live with.

You have to think of it from different ways. No one wants cables and all that, but everyone wants energy. You have to have energy; it's just a matter of picking your poison. This talk about wind power or nuclear power, or whether you burn oil or peat. It all spoils the natural environment. It doesn't matter whether you're a farmer or you live in the city. (IP 15, p. 6)

Taking action

Informants adopted various individual coping strategies in their living environments when they perceived noise, flickering light, and rotor blade movement. Whether action was taken or not was only partly related to whether the informants described the wind turbine exposure as something outside themselves or as an intrusion into privacy. Informants who did not undertake any action were found in both groups. Some informants did not think about the stimuli at all; others observed them, and then let go of them without acting. Some expressed feelings of resignation, which led to annoyance but no action.

It's nothing that I go around dwelling on, because that's just how things are now and there's not much I can do about them. I can't chop them down. You might as well accept it. I would never take things to court . . . I'm too lazy for that. (IP4, p.8)

Other informants, regardless of whether the exposures were perceived as something outside themselves or as an intrusion into privacy, moved to other rooms or places in their gardens to escape disturbance. The latter was a common reaction, especially to flickering light, while noise rarely prompted immediate action. Informants who had taken action that required more effort were also found, but only among those who expressed a strong feeling of intrusion. Some informants had created shelters in their gardens, such as enclosed patios; one found herself a nearby building out of sight of the turbines where she carried out her daily activities; and another person moved. Informants annoyed by noise and shadows from wind turbines adopted different strategies to deal with the authorities. Some were involved in legal actions and some protested in writing to the local authorities; many, however, declared that there was no point in taking action.

Expressing one's negative feelings against the wind turbines exacted a social price as well. Informants annoyed by the turbines, and especially those who had spoken up, described how neighbors had tacitly agreed not to talk about the wind turbines when meeting. Harassment was also mentioned. Losing good, neighborly relations and being unable

comfortably to attend certain social events added to the distress. Informants who thought of the wind turbines as being outside their territory described the situation differently. They had not experienced the feeling that opposing judgments of the wind turbines had changed the social climate.

Discussion

Territoriality and feelings of intrusion

Living close to wind turbines had different implications to different informants. Some had no particular feelings about the wind turbines. Even though they could hear their noise and in some cases perceive their flickering light, they merely noticed them and thought of them as outside their territory. In this group of people, no reactions to audio and visual exposures from wind turbines were observed that could indicate a risk of adverse effect on health or well-being. However, other informants felt violated by the wind turbines, perceiving them as intruders. These persons revealed that they were under strain as a consequence of negative emotions aroused by the stimuli from the wind turbines. The intrusion they felt could be understood as actual physical intrusion into a person's primary territory — the home. According to research into human territoriality (Brown, 1987), individuals rely heavily on physical markers and boundaries put up around and inside their primary territory to stop intrusion from the outside. Fences and bushes are examples of territorial markers, but personal items and decorations put up to show who is living in a place can serve the same purpose. All these markers are salient and cannot be misunderstood by others, so all forms of intrusion into primary territories are regarded as intentional and provoking. Research into territoriality has mainly explored physical intrusion across boundaries by other humans (Altman, 1975; Worchel and Teddlie, 1976), but gases, noise, cigarette smoke, and offensive pictures can also be looked upon as intruders (Scott, 1993). Presumably, then, wind turbines can also be so regarded. This study found that audible and visual stimuli from wind turbines freely crossed territorial markers and intruded into the informants' homes. It sometimes intruded as far as the most private part of the home — the bedroom — leaving informants with no territory to which they could retreat.

Such intrusion could also be understood within the context of a broader interpretation of the concepts of "home" and "identity." Homes are important for reasons other than mere shelter; e.g., they also give meaning and identity to life (Bell *et al.*, 2001, p.401). Several studies (reviewed by Smith, 1994) have found that the concept of home is connected with self-expression and personal identity. Home serves as a symbol of both how we look upon ourselves and how we want others to see us. It has been found that people consciously interact with their physical environments. They do this to express themselves and to develop self-identity; if possible, they choose where to live on this basis (Manzo, 2003). Remaining in a particular place could also meet an essential need, as a place provides a sense of continuity. Places with these characteristics become important parts of our self-identity (Giuliani and Feldman, 1993). Hence, intrusions into one's physical environs could also be experienced as insults to the individual, as was felt to be the case by some of the informants examined in this study.

Indications as to why some informants felt so strongly that wind turbines intruded upon their privacy, while other informants did not, could be found in observing their homes. Several informants took care of and decorated their houses and gardens, personalizing their places into homes and marking their territories. A conceivable association between this observation and annoyance due to wind turbines would be interesting to explore in a future study.

Appraisal and coping

Another, but not conflicting, way to understand the differences between those affected and not affected by wind turbines is to regard the conceptual model in light of Lazarus and Folkman's (1984) cognitive stress theory, focusing on the individual's interpretation of the meaning of environmental events. This study found that informants had different values about their living environments, regarding them either as places for economic growth and technical achievement or as peaceful and quiet places for rest and recovery. Informants in the latter group expressed strong beliefs that wind turbines did not belong in their living environments. The erection of the turbines and the exposure of audible and visual stimuli that followed were for them goal incongruent (primary appraisal). These informants also experienced various constraints — feelings of *lacking influence, lacking control, being subjected to injustice, and not being believed* — sometimes leading to an even stronger belief that the wind turbines did not belong in their environment (secondary appraisal and reappraisal). Other informants who conceived of their living environments such that the wind turbines fitted in, could, according to Lazarus and Folkman's theory, be expected to appraise the turbines as goal congruent and hence as posing no threat to well-being; therefore, they were not affected.

This stress theory is also applicable when reflecting on actions taken by informants to avoid exposure from wind turbines. Informants used different strategies to cope with disturbance from the wind turbines. Surprisingly few reported direct action, such as moving inside when the noise became annoying; instead, they tried to ignore the irritation or anger they felt. Two more problem-oriented coping strategies were also found: making physical changes to one's living environment and complaining to the owner of the wind turbine or to authorities. Lazarus and Folkman (1984) define coping as cognitive and behavioral efforts to manage specific external and/or internal demands. One's choice of coping mechanism emerges from one's evaluation in the appraisal process, including evaluation of the advantageous outcome of the action taken. In this study, the same informant could use one, two or three of the coping strategies indicated above. Making physical changes to one's living environment was in a way successful, as it temporarily reduced audible or visual disturbance; the overall negative effect did not, however, seem to decrease. Contacting owners or authorities led in most cases to increased distress, as their distrust of authorities and sense of being subjected to injustice increased. Several informants did not believe their proceedings against local authorities or wind turbine owners would ever lead to any changes, but they nevertheless persisted. This irrational coping could be regarded as an attempt to gain control over the situation. Several informants reported that communicating with authorities was stressful, and that they had paid a social price for objecting to the wind turbine development.

Little is known of the long-term consequences on health of low-level ambient stressors such as those described in this study. The occurrence of several low-level stressors from the same source with no possibility to control any of them may pose a mental load that over time could have a negative impact on health and well-being. The observed strain that some of the informants revealed when talking about the consequences of living close to a wind turbine could be an indication of such a negative load. The individual's costs for coping with the stressors are known to depend partly on individual resources available. Individual resources were not evaluated in this study, but could be a variable of interest in future research regarding the impact of wind turbines.

Conclusions

This study revealed some important factors that can explain the feelings and reactions observed among people living in the vicinity of wind turbines. Some of the informants appraised the wind turbines as intruders, a finding that to our knowledge has not been reported elsewhere. This finding will help us to better understand the severe reactions wind turbines sometimes evoke but could presumably also contribute to community noise studies of other sources. Air planes landing and taking off from an airport, visually prominent and generating noise while flying over your garden, could be a situation where the concept of intrusion would add to the understanding of the reactions. The results presented here indicate that the individual's values about the living environment are of importance when the impacts of wind turbines are assessed; values assumable firmly rooted within a personality and therefore difficult to change. Negative feelings brought on by contacts with local authorities and owners of wind turbines also seem to influence the reaction but could be feasible to avoid. Future studies should concentrate on how further wind power developments should be planned and carried out so that wind turbines do not intrude into peoples living environment and lead to unnecessary adverse effects.

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References

- Altman, I. 1975: *The environment and social behavior*. Monterey, CA: Brooks, Cole.
- Bell, P.A., Greene, T.C., Fisher, J.D. and Baum, A. 2001: *Environmental psychology*, 5th ed. Fort Worth, TX: Harcourt Brace.
- Brown, B.B. 1987: Territoriality. In Stokols, D. and Altman, I., editors, *Handbook of environmental psychology*. New York: Wiley.
- Campbell, J.M. 1983: Ambient stressors. *Environment and Behavior* 15, 355–380.
- Devine-Wright, P. 2005: Beyond NIMBYism: towards an integrated framework for understanding public perceptions of wind energy. *Wind Energy* 8, 125–139.
- Ghosh, K. 1995: Environmental aspects of wind energy. *Energy Environment Monitor* 11, 13–19.
- Giuliani, M.V. and Feldman, R. 1993: Place attachment in a developmental and cultural context. *Journal of Environmental Psychology* 13, 267–274.
- Glaser, B.G. and Strauss, A.L. 1967: *The discovery of grounded theory: strategies for qualitative research*. Chicago: Aldine.
- Lazarus, R.S. and Cohen, J.B. 1977: Environmental stress. In Altman, I. and Wohlwill, J.F., editors, *Human behavior and environment: advances in theory and research*. Vol. 2. New York: Plenum Press.
- Lazarus, R.S. and Folkman, S. 1984: *Stress, appraisal and coping*. New York: Springer.
- Manzo, L.C. 2003: Beyond house and haven: toward a revisioning of emotional relationships with places. *Journal of Environmental Psychology* 23, 47–61.
- Miedema, H.M.E. and Vos, H. 1998: Exposure-response relationships for transportation noise. *Journal of the Acoustical Society of America* 104, 3432–3445.
- Pedersen, E., and Persson Waye, K. 2003: Audio-visual reactions to wind turbines. In Brambilla, G., Ianiello, C. and Maffei, L., editors, *Proceedings of the 5th European Conference on Noise Control, Naples, Italy*. Paper ID: 43. Rome: Associazione Italiana di Acustica.
- Pedersen, E. and Persson Waye, K. 2004: Perception and annoyance due to wind turbine noise: a dose–response relationship. *Journal of the Acoustical Society of America* 116, 3460–3470.

- Scott, A.L. 1993: A beginning theory of personal space boundaries. *Perspectives in Psychiatric Care* 29, 12–21.
- Smith, S.G. 1994: The essential qualities of home. *Journal of Environmental Psychology* 14, 31–46.
- Wolsink, M., Sprengers, M., Keuper, A., Pedersen, T.H. and Westra, C.A. 1993: Annoyance from wind turbine noise on sixteen sites in three countries. In *Proceedings of European community wind energy conference 8–12 March, Lübeck, Travemünde, Germany*, 273–276.
- Wolsink, M. 2006: Wind power implementation: The nature of public attitudes: Equality and fairness instead of ‘backyard motives’. *Renewable & Sustainable Energy Reviews*. In press.
- Worchel, S. and Teddlie, C. 1976: The experience of crowding: a two-factor theory. *Journal of Personality and Social Psychology* 34, 30–40.

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