

Spatio-temporal differences in the history of health and noise complaints about Australian wind farms: evidence for the psychogenic, “communicated disease” hypothesis.

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Abstract

Background and objectives With often florid allegations about health problems arising from wind turbine exposure now widespread in parts of rural Australia and on the internet, nocebo effects potentially confound any future investigation of turbine health impact. Historical audits of health complaints across periods when such claims were rare are therefore important. We test 4 hypotheses relevant to psychogenic explanations of the variable timing and distribution of health and noise complaints about wind farms in Australia.

Setting All Australian 49 wind farms (with 1472 turbines) operating from 1993–2012.

Methods Records of complaints about noise or health obtained from wind farm companies regarding residents living near 47 Australian wind farms, expressed as proportions of estimated populations residing within 5km of wind farms, and corroborated with complaints in submissions to 3 government public enquiries and news media records.

Results There are large spatio-temporal variations in wind farm noise and health complaints. 31/49 (63%) of Australian wind farms including 17/34 (50%) with turbine size >1MW have never been subject to noise or health complaints. Western Australia has seen no complaints. Only 120 individuals across Australia representing approximately 1 in 272 residents living within 5km of wind farms appear to have complained, with 81 (68%) of these being residents near 5 wind farms which have been heavily targeted by anti wind farm groups. About 1 in 107 of those living near turbines >1MW have ever complained. The large majority (82%) of health and noise complaints commenced after 2009 when anti wind farm groups began to add health concerns to their wider opposition. In the preceding years, health or noise complaints were rare despite large and small turbined wind farms having operated for many years.

Conclusions In view of scientific consensus that the evidence for wind turbine noise and infrasound causing health problems is poor, the reported spatio-temporal variations in complaints are consistent with psychogenic hypotheses that health problems arising are “communicated diseases” with nocebo effects likely to play an important role in the aetiology of complaints.

The attribution of symptoms and disease to wind turbine exposure is a contentious “modern health worry” (1) which has seen increasing attention from governments, their regulatory agencies and courts after organized opposition, predominantly in Anglophone nations. Two broad hypotheses have been advanced about those reporting symptoms they attribute to exposure to wind turbines.

1. that both audible noise and sub-audible infrasound generated by wind turbines can be harmful to the health of those exposed.
2. that psychogenic factors – including nocebo responses to the circulation of negative information about their putative harms – are likely to be relevant to understanding why of those exposed, only small proportions claim to be adversely affected.

Despite a profusion of claims mostly by wind farm opponents about harms to exposed humans and animals (currently numbering 216 different diseases and symptoms) (2), 18 reviews of the research literature on wind turbines and health published since 2003 (3-20) have all reached the broad conclusion that the evidence for wind turbines being directly harmful to health is very poor. Among their conclusions have been:

- Small minorities of exposed people – typically less than 10% - claim to be annoyed by wind turbines (15)
- The relationship between wind turbines and human responses is “influenced by numerous variables, the majority of which are non-physical” (15)
- As with the characteristics of “New Environmental Illnesses” (21) and “Modern Health Worries” (22), pre-existing negative attitudes to wind turbines and subjective sensitivity to noise are more predictive of annoyance and adverse health effects than are objective measures of actual exposure (15)
- Being able to see wind turbines (5, 23), and negative personal attitudes toward their impact on landscape aesthetics is similarly predictive of annoyance and intention to complain (24)
- Deriving income from turbines (25) or enjoying reduced power bills can have an apparent “protective effect” against annoyance and health symptoms (“Effective public participation in and direct benefits from wind energy projects (such as receiving electricity from the neighboring wind turbines) have been shown to result in less annoyance in general and better public acceptance overall.”) (19)

Previous research has identified psychological factors such as having a “negative personality” (26), and holding beliefs about wind turbines being ugly (23) as associated with complaining or being opposed to wind farms in one’s residential area.

A large literature on nocebo effects exists about reported pain (27), but these effects have also been documented for other invisible and inaudible agents such as electro-magnetic and radio frequency radiation (28, 29). Perceived proximity to base mobile telephone base stations and powerlines, lower perceived control and increased avoidance (coping) behavior were associated with non-specific physical symptoms in

a study which found there was no association between such symptom occurrence and actual distance to these sources of electromagnetic radiation (30).

A mass psychogenic illness model may be applicable to this phenomenon. Mass Psychogenic Illness (MPI) is described (30-32) as a constellation of somatic symptoms, suggestive of an environmental cause or trigger (but with symptoms without typical features of the contaminant, varying between individuals, and not related to proximity or strength of exposure) which occurs between two or more people who share beliefs related to those symptoms and experience epidemic spread of symptoms between socially connected individuals. The rapid development of fear and anxiety is key to the transmission of disease by disruption of behaviour and activities of those involved. Transmission or contagion is increased by the general excitement related to the phenomenon, including media reports, researcher interest, and labeling with a specific clinical diagnostic term. It is enhanced by monetary factors, and related to underlying personality types or stress.

“Labeling” of an illness is one of the key features associated with spread of mass psychogenic illness, along with community and media interest (30). There have been three attempts to popularize portentous quasi scientific names for health problems caused by wind turbines: Wind Turbine Syndrome, Vibro Acoustic Disease (33) and Visceral Vibratory Vestibular Disturbance (34), although none of these have gained scientific acceptance as diagnostic terms. As described earlier, many of these features apply to “wind turbine syndrome”. Furthermore, the most reported symptoms in over one third of all MPIs of nausea/vomiting, headache, and dizziness (30), are also frequently featured as common symptom complaints arising with wind turbines, suggesting these symptoms may be plausibly explained as psychogenic in origin.

In a recent New Zealand study (35), healthy volunteers exposed to both sham and true, recorded infrasound who had been previously given information about possible adverse physiological effects of infrasound exposure, reported symptoms aligned with that information. The adverse effects information provided to subjects was sourced from anti wind farm internet sites which the authors concluded indicated “the potential for symptom expectations to be created outside of the laboratory, in real world settings.”

Wind farm opponent groups have been very active in the last five years in three Australian states (Victoria, NSW and South Australia) publicizing the alleged health impacts of turbines. This has created insurmountable problems for researching the psychogenic and nocebo hypotheses using either cross-sectional or prospective research designs because it is unlikely that any communities near wind farms now exist who have not been exposed to extensive negative information. For this reason, audits of the history of complaints are essential because these allow consideration of whether health and noise complaints arose during years prior to the “contagion” of communities with fearful messages about turbines.

Earliest reports of health problems in Australia

Australia's first still operational wind farm commenced operation in 1993 at 10 Mile Lagoon near Esperance, Western Australia. However, objections to wind farms in Australia appear to date from the early years of the 2000s when press reports mentioned negative reactions of some in rural communities to their intrusiveness in bucolic country landscapes ("behemoths" (36)), bird and bat strikes, the divisiveness engendered in communities by the perceived unfairness of some landowners being paid hosting fees of up to \$15,000 per year per turbine while neighbours got nothing, and debates about the economics of green energy. Unguarded, frank NIMBYism "I'm quite happy to admit that this is a not-in-my-backyard thing, because my backyard is very special" was also evident in 2002 (36).

Groups explicitly opposing wind farms ostensibly because of agendas about preserving pristine bush and rural environments were active from these early years and included many "branches" of the Australian Landscape Guardians (for example Prom Coast (2002), Spa Country (37), Grampians-GlenThompson (38), Western Plains, Daylesford and District). Key figures in the Landscape Guardians have links with mining and fossil fuel industries (39). Interests with overt climate change denial agendas also actively opposed wind farm developments, particularly in Victoria. Chief among these were the Australian Environment Foundation, registered in February 2005.

However, health concerns were marginal in these years, with one early report from September 2004 (37) noting "some objectors have done themselves few favours by playing up dubious claims about reflecting sunlight, mental health effects and stress to cattle."

An unpublished British report said to refer to data gathered in 2003 on symptoms in 36 residents near unnamed English wind farms is frequently noted by global wind turbine opponents as the first known report of health effects from wind turbines, although curiously, it does not appear to have produced until 2007 (40). The author, Amanda Harry, contacted the subjects, all of whom claimed to be suffering health problems as a result of their exposure. Her report gives no details about how these subjects were selected, although because all said they experienced adverse effects, it would appear they were purposefully, not randomly selected. The Daylesford and Districts Landscape Guardians referred to Harry's work in a 2007 submission opposing a wind farm at Leonards Hill (41).

In Australia, a rural doctor from Toora, Victoria, David Iser, produced another unpublished report (42) in April 2004 following his distribution of 25 questionnaires to households within 2km of the local 12 turbine, 21MW wind farm, which had commenced operation in October 2002. Twenty questionnaires were returned, with 12 reporting no health problems. Three reported what Iser classified as "major health problems, including sleep disturbances, stress and dizziness". Like that of Harry, Iser's report provides no details of questions asked; sample selection; whether written or verbal information accompanying the delivery of the

questionnaire may have primed respondents to make a connection between the wind turbines and health issues; whether those reporting effects had previous histories of the reported problems; nor whether the self-reported prevalence of these common problems were different to those which would be found in any age-matched population.

For example, sleeping problems are very common, with recent Australian and New Zealand estimates ranging from 34% (43), to moderately poor (26.4%) and very poor sleep quality (8.5%) (44). A German study undertaken to obtain benchmark reference data on common symptoms and illnesses experienced in the past 7 days in the general population for comparison with those experienced by clinical trial enrollees presents data on several problems most often attributed to wind turbines. These include headache (45.3%), insomnia (25.6%), fatigue and loss of energy (19.1%), agitation (18.4%), dizziness (17%) and palpitations (8.6%) (45).

While modern wind farms have operated since the early 1980s (46), the earliest claims alleging that wind turbines might cause health problems in those exposed appear to date from 2003 (see above); this increased rapidly after 2008 (Figure 1), following publicity given to a self-published book, “Wind Turbine Syndrome” (47), by US physician Nina Pierpont, who now runs a virulent anti wind farm website (48). Google Trends data of web-based searches for “Wind Turbine Syndrome” and the more general “wind turbine health” both rose together (Figure 1), suggesting the book generated this sudden interest in the phenomenon, rather than riding a wave of interest. This coverage rose some 24/18 months after a similar peak in interest was recorded for “wind turbine noise (s)”.

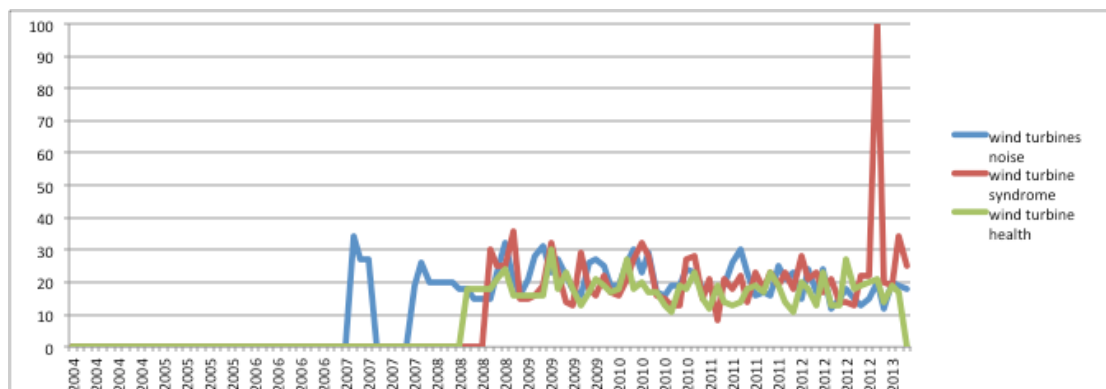


Figure 1: Global data from Google Trends on 3 search terms – “Wind turbines noise” (blue) “Wind turbine health” (gold) and “wind turbine syndrome” (red) over 2004 – 2013 (accessed March 9, 2013).

Acute effects Wind farm complainants name both acute and chronic adverse effects. Acute effects are of particular interest to the psychogenic hypothesis because it is often claimed that even brief exposure to wind turbines can cause almost immediate onset of symptoms. For example, a recent report describes a visit to turbine-exposed houses where people become immediately affected: “The onset of adverse health effects was swift, within twenty minutes, and persisted for some time after leaving the study area (49). Symptoms are said to disappear when those affected move

away temporarily, only to return as soon as they come back. A highly publicized Lake Bonney complainant who had hosted turbines on his previous property without complaint for six years today claims he and his wife are affected but that symptoms disappear as soon as they leave their new home for one or two days (50).

If wind turbine exposure can cause such “instant” problems, any history of delayed or non-reporting of such complaints or and the absence of any reports about such complaints in the news media, months or sometimes years after various wind farms began operating creates serious coherency problems for such claims. Such delays would be incompatible with there being widespread or important “acute” effects from exposure.

To date, there has been no study of the history and distribution of noise and health complaints about wind turbines in Australia. We sought to test 4 hypotheses relevant to the psychogenic argument.

1. Many wind farms of comparable power would have no history of health or noise complaints from nearby residents (suggesting that exogenous factors to the turbines may explain the presence or absence of complaints)
2. Wind farms which have been subject to complaints would have only a small number of such complaining residents among those living near the farms (suggesting that individual or social factors may be required to explain different “susceptibility”)
3. Few wind farms would have any history of complaints consistent with claims that turbines cause acute health problems (suggesting that explanations beyond turbines are needed to explain why acute problems are reported).
4. Most health and noise complaints would date from after the advent of anti wind farm groups beginning to foment concerns about health (from around 2009) and that wind farms subject to organized opposition would be more likely to have histories of complaint than those not exposed to such opposition (suggesting that health concerns may reflect “communicated” anxieties).

Methods

Information on the commencement of turbine operation, the number of turbines operating, average turbine size and the megawatt (MW) capacity of each wind farm was located from public sources such as wind farm websites.

Wind farm operators have clear interest in any reactions of nearby residents to the farms they operate. In the planning, construction and power generation phases of wind farm operation they monitor local community support and complaints submitted to them, in news media and via notifications from local government. In Victoria, companies are required by law to register all complaints with the state government. In September 2012 all wind farm owners in Australia were asked to provide information on:

- the actual or estimated number of residents within a 5km radius of each wind farm they operated. Google Maps and census data were also used to obtain this data.
- whether the company had received or was aware of any health and/or noise complaints, including sleeping problems, that were being attributed to the operation of their wind farms.
- the number of individuals who had made such complaints (direct complaints to the companies, those voiced in local media, to local government or state or national enquiries).
- the date at which the first complaint occurred after.
- whether there had been any anti-wind farm activity in the local area such as public meetings addressed by opponents, demonstrations or advertising in local media.

Any documentation of complaints such as internet links or news clips about public was requested. Companies were explicitly asked to not send details of any private complaints which could identify those complaining, unless these complaints had been made public by the complainants.

It is possible that wind companies may nonetheless be unaware of health and noise complaints about their operations or that they might downplay the extent of complaints and provide underestimates of such complaints. To corroborate the information on the number of complainants provided by the companies, we therefore reviewed all 1,594 submissions made to three government enquiries on wind farms: the 2011–2012 Senate enquiry into the Social and Economic Impact of Rural Wind Farms (1,818 submissions) (51); the 2012 NSW Government's Draft NSW Planning Guidelines for Wind Farms (359 submissions) (52); and the Renewable Energy (Electricity) Amendment (Excessive Noise from Wind Farms) Bill 2012 (217 submissions) (53). We searched all submissions for any mentions by residents living in the vicinity of operating wind farms (as opposed to those being planned) of their health or sleep being adversely affected or that they were annoyed by the sound of the turbines.

We also searched daily media monitoring records supplied to the Clean Energy Council by a commercial monitoring company from August 2011 (when the monitoring contract began) until January 2013. This monitoring covered print news items, commentary and letters published in Australian national, state and regional newspapers mentioning any wind farm, as well as television and radio summaries about all mentions of wind farms. It was important to use this source of monitoring rather than use on-line databases like Factiva, as the latter do not cover all rural news media which is where much coverage of debate about rural wind farms was likely to be found.

In reviewing the submissions and media monitoring, only complaints from those claiming to be personally affected by the operation of an existing wind farm in Australia were noted. Expressed concerns about possible future adverse effects or that wind turbines *could* be harmful were not classified as evidence of personal

experience of harm or annoyance. There were many of these. Third party statements, such as comments about unnamed neighbours with problems, were not accepted as evidence of harm.

Where the numbers of complainants determined from this corroborative public source searching exceeded the numbers provided to us by the wind companies, we chose the larger number. Where the numbers determined from public sources were less, we used the larger number provided by the companies. Nearly all those who complained did not seek anonymity, being named in media reports or not electing to have their parliamentary submissions anonymised. However, we have chosen not to list their names in this report.

The companies provided estimates of the number of residents currently living within 5km of each wind farm. Again, some companies provided estimates of the number of individuals, while others provided data on the number of houses. In Table 1, we have multiplied cells showing the number of *houses* by 2.6, this being the average number of residents per household in Australia today, to give a total estimate of surrounding residents.

Results

Table 1 shows the history of complaints from all 49 Australian wind farms. Complaints came either from individuals or from households with several occupants each complaining. Some wind companies initially reported the number of complainants as *households*, while others reported individual complainant numbers. In these cases we sought clarification from companies about whether complaints came from single individuals, couples or more than two members of a family so as to report total the estimated total number of individual complainants.

Hypothesis 1: Many wind farms would have no history of complaints

Of all 49 wind farms, 31 (63%) had never been subject to health or noise complaints (Table 1), with 18 (37%) receiving at least one complaint since operations commenced. The 31 farms with no histories of complaints, and which today have some 21,530 residents within 5km of their turbines have operated for a cumulative total of 256 years.

Of the 18 wind farms which had received complaints, 16 were larger wind farms (≥ 10 MW capacity) and 2 small (< 10 MW). In summary, 16/33 (52%) of larger wind farms, and 15/17 (88%) of small farms have never experienced complaints. Wind farm opponents sometimes argue that it is only very large, “industrial” wind turbines which generate sufficient audible noise and infrasound to cause annoyance and health problems. If 1MW is taken to define a “large” turbine, 16/33 (48%) of farms with large turbines had ever attracted complaints while 15/17 (88%) of farms using smaller turbines had no histories of complaints.

The distribution of farms ever having received complaints is highly variable across Australia. Figure 2 shows no consistency between the percentages of farms receiving complaints in different states, whether they have many or few wind farms. Western Australia has 13 wind farms (3 with large turbines), including some of the longest running in Australia (Esperance 10 Mile Lagoon 1993, Denham 1998). No complaints have been received at any of these wind farms. Verve, which operates 8 farms in the state replied “we have never received any form of notification of health complaints in the vicinity of our wind farms.”

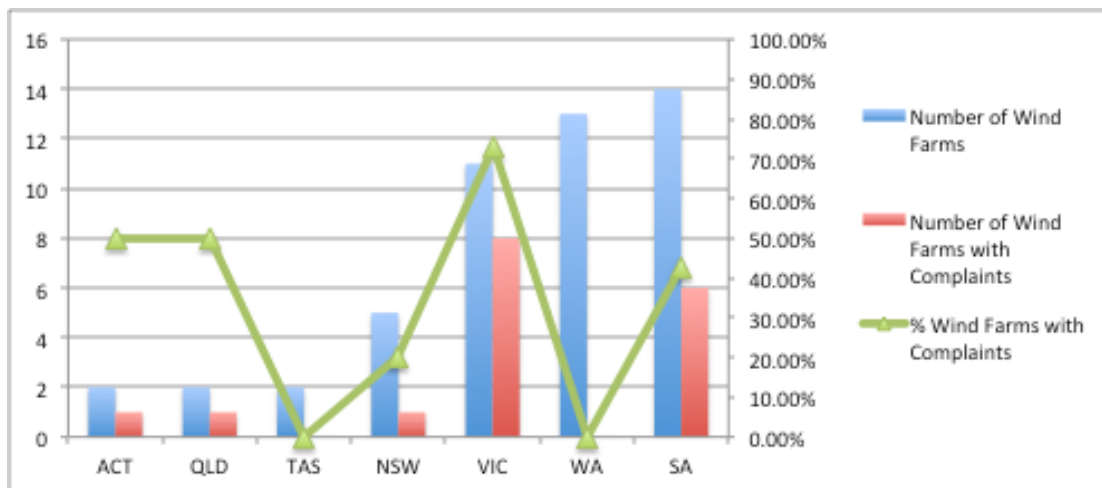


Figure 2: Wind Turbine Complaints by State or Territory.

Our hypothesis about many wind farms – including those with large turbines – having no history of complaints, with strong spatial (state) factors being associated with farms receiving complaints was thus strongly confirmed.

Hypothesis 2: A small number of complaining residents

Nationally, a total of 120 individuals in Australia appear to have ever formally or publicly complained about wind farm noise or health problems affecting them. Of these, well over half (81 or 68%) came from residents living near just five wind farms (Waubra=29, McArthur=21, Waterloo=11, Capital=10 and Wonthaggi ~10). Of the remaining farms which have experienced complaints, 9 had between 2 and 6 complainants, and 4 had only single complainants. Of 18 wind farms which had attracted complaints, 11 (72%) have had 6 or less complainants.

There are an estimated 32,677 people living within 5km of the 47 wind farms for which we obtained estimates. Most (20,379 or 62%) live near the 16 smaller wind farms, while 12,298 live within 5km of the 33 larger wind farms. In summary, nationally, an estimated 120 individuals have complained out of an estimated 32,677 nearby residents: a rate of about 0.3% or 1 in 272. Of the 33 wind farms with larger (>1MW) turbines, their 115 complainants represented some 1 in 107 of the surrounding 12,330 residents, with 5 of the main complaint attracting farms being responsible for 81/115 (70%) of these complaints. Large wind farms with relatively large surrounding rural populations and no histories of complaint include Wattle Point (560), Albany, Starfish Hill (each 200) and Chalicum Hills (143).

Again, our hypothesis that the number of complainants living near those wind farms with any history of complaints would be small, was strongly confirmed.

Hypothesis 3: Few wind farms would have any history of complaints consistent with claims that turbines cause acute effects

First complaint timing ranged from immediately after turbines commenced operation (sometimes at only a fraction of full capacity) to several years later (eg: Crookwell, 13.5 years, Lake Bonney, over 7 years later). Of the 6 turbines recording their first complaint over one month after operation, 3 of these were over one year after operation. In five cases (Clements Gap, Hallet 2 & 4, Leonards Hill, Waubra), wind companies advised that complaints anticipating health problems were received before the farms commenced operation (see Box case study). Early complaints from a few turbines could be consistent with acute effects but also with nocebo effects caused by anticipation of adverse impacts(35). However, gaps of months or sometimes years between the commencement of turbine operation and complaints are inconsistent with turbines causing acute effects. If such effects were serious or common, clinical case reports would have almost certainly have appeared in peer reviewed journals, given how long turbines have operated.

Case Study: Leonards Hill, Victoria

Health concerns were publicised in the vicinity of Leonards Hill prior to the construction of the twin turbine wind farm. A small number of individuals (6 out of 232 population) claimed noise or health effects, one before wind farm operations began.

- Jun 2007: Health concerns raised in submission to planning appeal.
- Oct 5, 2010: Sarah Laurie of the Waubra Foundation gave a presentation on “Wind farms and their associated Health Effects” at a forum near Leonards Hill.
- Oct 8, 2010: The Australian Environment Foundation and Landscape Guardians held a protest at Leonards Hill. Two residents attended: P1 and P2 (President of local Landscape Guardians).
- Oct 14, 2010: P1 raised health concerns in a letter to the wind farm proponent.
- Nov 10, 2010: Sarah Laurie raises health concerns in front page article of local newspaper.
- Dec 3, 2010: P2 reported in national newspaper as taking medication in response to wind farm, prior to construction.
- Jun 24, 2011: Less than 2 days after commencing operation of single turbine at 25% load, on national television, P2 claims adverse affects over previous 3 nights.
- Aug 19, 2011: P1 claims adverse health effects in regional newspaper.

Hypothesis 4: Most complaints would date from 2009 or later, when opposition groups began to publicise health and noise effects

The nocebo hypothesis would predict that the spread of negative, often emotive information would be followed by increases complaints and that without such suggestions, complaints would be less. In the 10 years between the commencement of operation of the first Esperance wind farm and the end of 2003 when the Harry and Iser health impact reports(40, 42) began being highlighted by turbine opposition groups, 12 more wind farms commenced operation in Australia. In that decade, besides two complainants from Toora, we aware of only one other person living near the north Queensland Windy Hill wind farm who complained of noise and later health soon after operation commenced in 2000. In that decade, the large turbined Albany, Challicum Hills, Codrington, Starfish Hill and Woollnorth Bluff Point farms commenced operation but never received complaints.

With the exception of Wonthaggi (~10 complainants in 2006, but none today) all other complaints date from after March 2009, and particularly from the most recent years when anti wind farm publicity focused on health from opposition groups has grown. Again, the nocebo hypothesis and models of mass psychogenic illness would predict this changed pattern and contagion of complaints, driven by increasing community concern rather than an increase in wind turbines. Nearly 70% of wind farms began operating prior to 2009 while the majority of complaints (82%) were recorded after this date.

Responding to the nocebo hypothesis and the view that opposition groups were fomenting a “communicated disease”, the Waubra Foundation’s Sarah Laurie stated: “There is also plenty of evidence that the reporting of symptoms for many residents at wind developments in Victoria such as Toora, Waubra and Cape Bridgewater *preceded the establishment of the Waubra Foundation* (emphasis in original). In the case of Dr David Iser’s patients at Toora the time elapsed is some 6 years.”(54)

This statement neglects to note that the Waubra Foundation’s registration in July 2010 was preceded by several years of virulent wind turbine opposition – which included health claims -- by the Landscape Guardians and the Australian Environment Foundation, as discussed earlier in the paper. For example, in November 2009, 8 months before the formation of the Waubra Foundation the Western Plains Landscape Guardians published a full-page advertisement in the local Pyrenees Advocate newspaper headed “Coming to a house, farm or school near you? Wind Turbine Syndrome also known as Waubra Disease”. It listed 12 common symptoms (eg: sleeping problems, headaches, dizziness, concentration problems). Peter Mitchell is the founding chairman of the Waubra Foundation and in 2009 and at least until February 2011, was also actively advocating for the Landscape Guardians(55).

Of the 18 wind farms which have seen complaints, 13 (72%) have experienced local opposition from anti wind farm groups such as local branches of the Australian

Landscape Guardians or the Waubra Foundation. No wind farm with any history of wind turbine opposition avoided at least one health or noise complaint.

Discussion

We purposefully took a liberal view of what a “complainant” was, by including those who had voiced their displeasure about noise, sleep or health in news media or submissions even if they had never lodged a formal complaint with the relevant wind farm company. Despite this, the numbers complaining in Australia were very low and largely concentrated in a small number of “hotbeds” of anti wind farm activism.

Our historical audit of complaints provides field evidence, complementing recent experimental evidence (35), that is strongly consistent with the view that “wind turbine syndrome” and the seemingly boundless range of symptoms associated with it is a psychogenic nocebo phenomenon (2). While wind turbines have operated in Australia since 1993, including farms with >1MW turbines from 2001 (Codrington), health and noise complaints were very rare until after 2009, with the exception of Wonthaggi which saw about 10 complainants in 2006, all of whom have now ceased complaining.

As anti wind farm interest groups began to stress health problems in their advocacy, and to target new wind farm developments, complaints grew. Significantly though, no older farms with non-complaining residents appear to have been targeted by opponents. The dominant opposition model appears to be to foment health anxiety among residents in the planning and construction phases. Health complaints can then appear soon after power generation commences. Residents are encouraged to interpret common health problems like high blood pressure and sleeping difficulties as being caused by turbines.

This study shows there are large spatio-temporal differences in the distribution of complainants to wind farms in Australia. There are many wind farms, large and small, with no histories of complaints and a small number where the large bulk of complaints have occurred. Just over half of wind farms with larger turbines have seen complaints, but nearly just as many have not. These differences invite explanations that lie beyond the turbines themselves.

Several wind farm operators reported that many former complainants had now desisted. For example, Waubra management advised that not all complainants identified by our public searches had complained to them, and that more than half of the 17 complainant households who had complained to them, had had their complaints resolved. Similarly, Wonthaggi management said that none of some 10 complainants from 2006/2007 were still complaining today. Some of these former complainants had had their houses noise tested with the results showing they conformed to the relevant noise standard, some received noise mitigation (eg:double glazing), while others simply stopped complaining.

Opponents sometimes claim that only “susceptible” individuals are adversely affected by wind turbines, using the analogy of motion sickness. Our data produce problems for that explanation: it is implausible that no susceptible people would live around any wind farm in Western Australia, around almost all older farms, nor around nearly half of the more recent farms. No credible hypotheses other than those implicating psycho-social factors have been advanced to explain this variability.

Wind farm opponents frequently argue complainants are legally “gagged” from speaking publicly about health problems, thus underestimating true prevalence. This is said to apply to turbine hosts and to non-hosts who are contractually gagged or who have reached compensation settlements with wind companies after claiming harm. The first claim is difficult to reconcile with the example provided by a high profile Lake Bonney wind farm host who continues to complain publicly without attracting any legal consequences(27). Confidentiality clauses are routinely invoked in any legal settlement to protect parties’ future negotiating positions. They usually refer to the settlement figure rather than to the reasons for it.

Limitations

The data we obtained on the number of individuals or occupied houses near the farms were current estimates. These numbers may have varied in different directions for different farms over the 20 year period that wind farms have operated in Australia. But no data are available on that variation. Our estimates of the ratios of complaints to population are therefore unavoidably fixed around the most current population estimates.

It is possible that there were other complainants who complained earlier than in the periods covered by our corroborative checks. However, this seems highly unlikely: Australian anti wind farm groups would have strong interests in widely publicizing such complainants, had they existed. The Waubra Foundation for example, repeatedly refers to the 2004 Iser report(42), in its efforts to emphasise that concerns had been raised before the Waubra Foundation became established(54) As wind farm opponents have not highlighted more complainants than we have identified, this strongly suggests there were no earlier health or noise complainants.

It is also possible that some of the health complainants are disingenuous, thereby inflating the true number of people actually claiming to experience turbine-related health problems. Controversy arose when an anti wind farm activist who lives 17km from the Waterloo wind farm was recently accused of “coaching” residents who disliked the local wind farm to explicitly mention health issues (56).

We selected the 5km distance from turbines as a compromise between the 2km minimum setback distance designated by the Victorian government for future wind farm approvals, and the 10km often named by the Waubra Foundation as the advisable minimum distance. We also note here, that one prominent critic of wind

farms claims to be affected by infrasound up to distances of 100km (57). Had we chosen the 10km distance counseled by the Waubra Foundation, this would have significantly increased the numbers of people exposed but not complaining.

The estimates provided by the wind companies of the number of residents within 5km of wind farms need to be seen as approximations. Census data is available by local government areas and by the Australian Bureau of Statistics statistical regions. However, these do not correspond with the 5km zone of residence of interest here. The wind companies which provided this data obtained it from their own knowledge of the number of residences near their wind farms and we checked local township sizes from Australian census data. This information is typically obtained during the planning stages of wind farm development when development applications often require such estimations to be provided. At least one company used Google Earth photography to calculate their estimate of the number of dwellings. However, such estimates will always be imprecise and approximations only. They nonetheless provide “ballpark” denominators against which the known number of complainants can be compared.

Acknowledgements: Mia Rose for research assistance; wind farm proprietors for data in Table 1.

Table 1: Complainant numbers at 49 Australian wind farms, 1993-2013.

Farm name (state) owner	Installed Capacity (MW) + (number of turbines) + Av.turbine size MW	Commenced operation & total years (to Dec 2012)	Approx. population within 5km	Health or noise complaints (Y/N) & number	Date of first complaint (months since opened)	Local or visiting opposition group activity?
A: Farms with total > 10mw capacity						
Albany/Grasmere (WA) Verve	35.4 (18) 1.96	Oct 2001 (11y2m)	200	N	-	N
Bungendore /Capital/WoodlawnT (ACT) Infingen	140.7 (67) 2.1	Nov 2009 (3y1m)	76 houses 198	Y:10	Dec 2009 (1m)	Y
Canunda (SA) International Power	46 (23) 2.0	Mar 2005 (7y10m)	20 houses 52	N	-	N
Cape Bridgewater (Vic) Pacific Hydro	58 (29) 2.0	Nov 2008 (4y1m)	68 houses 177	Y:6	2 Feb 2010 (16m)	Y
Cape Nelson South (Vic) Pacific Hydro	44 (22) 2.0	Jun 2009 (3y6m)	170 houses 425	Y:2	10 Feb 2010 (8m)	Y
Cathedral Rocks (SA) TRUenergy, Acciona & EHN	66 (33) 2.0	Sep 2005 (7y3m)	0	N	-	N
Challicum Hills (Vic) Pacific Hydro	52.5 (35) 1.5	Aug 2003 (9y4m)	55 houses 143	N	-	N
Clements Gap (SA)	56.7 (27)	Feb 2010	41	Y:3	On-going from	Y

Farm name (state) owner	Installed Capacity (MW) + (number of turbines) + Av.turbine size MW	Commenced operation & total years (to Dec 2012)	Approx. population within 5km	Health or noise complaints (Y/N) & number	Date of first complaint (months since opened)	Local or visiting opposition group activity?
Pacific Hydro	2.1	(2y10m)			earlier	
Codrington (Vic) Pacific Hydro	18.2 (14) 1.3	Jun 2001 (11yr6m)	50	N	-	N
Collgar/Merriden (WA) Collgar	206 (111) 1.85	May 2011 (1yr7m)	15	N	-	N
Cullerin Range (NSW) Origin	30 (15) 2.0	Jul 2009 (3y5m)	50	N	-	N
Emu Downs (WA) APA	80 (48) 1.66	Oct 2006 (6y2m)	50	N	-	N
Gunning/Walwa (ACT) Acciona	46.5 (31) 1.5	May 2011 (1yr7m)	25 houses 65	Y:1	Jan 2012 (8m)	N
Hallett 1/Brown Hill (SA) AGL	95 (45) 2.11	Sep 2008 (4y3m)	120	N	-	Y
Hallett 2/Hallett Hill (SA) AGL	71.4 (34) 2.1	Mar 2010 (2y9m)	120	Y:2	On-going from earlier	Y
Hallett 4/North Brown Hill (SA) AGL	132 (63) 2.1	May 2011 (1y7m)	200	Y:1	On-going from earlier	Y
Hallett 5/Bluff Range (SA) Erus	53 (25) 2.1	Mar 2012 (9m)	140	Y:1	Apr 2012 (1m)	Y
Lake Bonney (SA)	278 (99) 2.8	Mar 2005 (7y9m)	255	Y:2	June 2012 (7y3m)	N

Farm name (state) owner	Installed Capacity (MW) + (number of turbines) + Av.turbine size MW	Commenced operation & total years (to Dec 2012)	Approx. population within 5km	Health or noise complaints (Y/N) & number	Date of first complaint (months since opened)	Local or visiting opposition group activity?
MacArthur (Vic) AGL/Meridian	420 (140) 3.0	Sep 2012 (3m)	150	Y:8 houses= 21	2 days after 2/140 turbines commenced operation	Y
Mt Millar (SA) Meridian	70 (35) 2.0	Feb 2006 (6y10m)	10 houses 26	N	-	N
Oaklands Hill (Vic) AGL	67.2 (32) 2.1	Feb 2012 (10m)	250	Y:6	On-going from earlier	Y
Snowtown (SA) Trust Power	100.8 (47) 2.14	Nov 2008 (4y1m)	4 houses 10	N	-	N
Starfish Hill (SA) Ratch	34.5 (23) 1.5	Sep 2003 (9y3m)	200	N	-	N
Toora (Vic) Ratch	21 (12) 1.75	Jul 2002 (10y5m)	674	Y:2	Early (precise date not known)	Y
Walkaway (Alinta) (WA) Infigen	89.1 (54) 1.65	Apr 2006 (6y8m)	3 houses 8	N	-	N
Waterloo (SA) TRUenergy	111 (37) 3.0	Dec 2010 (2y)	75 houses 195	Y:11	Feb 2011 (2m)	Y
Wattle Point (SA) AGL Hydro	91 (55) 1.65	Nov 2005 (7y1m)	560	N	-	N
Waubra (Vic) Acciona	192 (128)	Mar 2009	283 houses	Y:29	13 Mar 2009	Y

Farm name (state) owner	Installed Capacity (MW) + (number of turbines) + Av.turbine size MW	Commenced operation & total years (to Dec 2012)	Approx. population within 5km	Health or noise complaints (Y/N) & number	Date of first complaint (months since opened)	Local or visiting opposition group activity?
Windy Hill (Qld) Ratch	1.5 12 (20)	(3y10m) Feb 2000	736 200		(immediate)	
Wonthaggi (Vic) Transfield	0.6 12 (6)	(12y10m) Dec 2005		Y:1	Early (precise date not known)	N
Woolnorth:Bluff Point (Tas) Roaring 40s & Hydro Tas.	2.0 65 (37)	(7y) Aug 2002	6900 NI	Y:~10	Feb 2006 (2m)	Y
Woolnorth:Studland Bay (Tas) Roaring 40s & Hydro Tas.	1.76 75 (25)	(10y4m) May 2007	NI	N	-	N
Yambuk (Vic) Pacific Hydro	3.0 192 (128)	(5yr7m) Jan 2007	88	N	-	N
	1.5	(5y11m)				
Sub-total:33 farms	3062mw (1518 turbines)		12298	16 farms with 110 complainants		11
B: Farms with <10mw capacity						
Blayney (NSW) Eraring Energy	9.9 (15) 0.66	Oct 2000 (12y2m)	37	N	-	N
Bremer Bay (WA) Verve	0.6 (1) 0.6	Jun 2005 (7y6m)	250	N	-	N
Coober Pedy (SA) Energy Generation	0.15 (1) 0.15	1999 (13y)	3500 (turbine is 2.5km from	N	-	N

Farm name (state) owner	Installed Capacity (MW) + (number of turbines) + Av.turbine size MW	Commenced operation & total years (to Dec 2012)	Approx. population within 5km	Health or noise complaints (Y/N) & number	Date of first complaint (months since opened)	Local or visiting opposition group activity?
Coral Bay (WA) Verve	0.825 (3) 0.275	Oct 2006 (6y2m)	200 town)	N	-	N
Crookwell (NSW) Union Fenosa/Eraring	4.8 (8) 0.6	Jul 1998 (14y5m)	200	Y:4	Jan 2012 (13y6m)	Y
Denham (WA) Verve	1.6 (4) 0.4	Jun 1998 (14y6m)	600	N	-	N
Esperance, 9 Mile Beach (WA) Verve	3.6 (6) 0.6	2003 (8y)	50	N	-	N
Esperance, 10 Mile Lagoon (WA) Verve	2.025 (9) 0.225	1993 (19y)	50	N	-	N
Hampton Park (NSW) Wind Corp.	1.32 (2) 0.66	Sep 2001 (11y3m)	150	N	-	N
Hopetoun (WA) Verve	1.2 (2) 0.6	Mar 2004 (8y9m)	600	N	-	N
Kalbarri (WA) Verve	1.6 (2) 0.8	Jul 2008 (4y5m)	10	N	-	N
Kooragang, Newcastle (NSW) Energy Australia	0.6 (1) 0.6	1997 (15y)	3-4km from Mayfield 9900	N	-	N
Leonards Hill (Vic) Community owned	4.1 (2) 4.1	Jun 2011 (1y6m)	232	Y:6	On-going from earlier	Y

Farm name (state) owner	Installed Capacity (MW) + (number of turbines) + Av.turbine size MW	Commenced operation & total years (to Dec 2012)	Approx. population within 5km	Health or noise complaints (Y/N) & number	Date of first complaint (months since opened)	Local or visiting opposition group activity?
Mt Barker (WA) Mt Barker Power	2.4 (3) 0.8	Mar 2011 (1y9m)	2000	N	-	N
Rottnest Island (WA) Rottnest Island	0.6 (1) 0.6	Sep 2006 (6y3m)	150	N	-	N
Thursday Island (Qld) Egon Energy	0.225 (2) 0.113	Aug 1997 (15y5m)	2500	N	-	N
Sub-total:16 farms	23.82MW 62 turbines		20379	2:10		2
Total:49 farms	2923.82MW 1472 turbines		32677	18 farms with 120 complainants		13

NI= no information

Average residents per house in 2011: 2.6 http://www.censusdata.abs.gov.au/census_services/getproduct/census/2011/quickstat/0

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