CHALLENGING THE CONTOURS: CRITICAL CARTOGRAPHY, LOCAL KNOWLEDGE, AND THE PUBLIC

Julie Cidell

California State University, San Bernardino

Department of Geography and Environmental Studies

5500 University Parkway, SB 327

San Bernardino, CA 92407

Phone: 909-537-3777

E-mail: jcidell@csusb.edu

EPA 38/447

CHALLENGING THE CONTOURS: CRITICAL CARTOGRAPHY, LOCAL KNOWLEDGE, AND THE PUBLIC

Abstract: As with many environmental issues, conflicts over airport noise are often grounded in the different experiences and knowledges of those who measure it and those who suffer its effects. The ways that airport neighbors challenge noise maps reflect the critical cartography literature, which does not take the truth of maps for granted but instead considers the political and other subjectivities behind their construction. At the same time, work in science and technology studies shows that conflicts between local residents and state officials and/or scientists are in part based on their different types of knowledge about a place, with state-centered scientific knowledge generally considered to override local knowledges. This paper brings together these two literatures in an analysis of conflicts over airport noise at Minneapolis-St. Paul International Airport to show how members of the public construct their own critical cartographies.

> "I think you've tried to do a good job. I think you've sent out scientists and measured sound and tried to come up with some decent [noise] contours. And I think you've tried hard. But I do not think that it's realistic to think that you're going to be accurate" (Daniel Billings, Minneapolis, MN, 11/8/00).
>
> "I saw the map, and the map is a lot of waves and things like that, which is completely beyond my understanding. All I know is that planes fly in a straight line over my house" (Jerry Casterton, Minneapolis, MN, 7/25/01).

Introduction

Conflicts over airport noise are often grounded in the different experiences of those who measure it and those who suffer its effects. The lines that officially designate where airport noise is incompatible with residential land uses – and therefore where federal funds may be spent to mitigate noise – are drawn according to a mathematical model, not direct observation or measurement. That model produces a map of noise contours, similar to topographic isolines, that demarcate where certain levels of noise exist. In contrast, residents' complaints about airport noise come from direct experience and local knowledge as to what constitutes incompatibility, based on how their everyday activities are disrupted or curtailed by noise. As the two comments above indicate, these two different ways of "knowing" what constitutes incompatible noise levels are at the heart of conflicts over airport noise.

Both of these comments were taken from a series of public hearings on noise mitigation around Minneapolis-St. Paul International Airport (MSP) in 2000-2001. During these hearings, residents from communities neighboring the airport were reacting to a map that illustrated the noise contours for the airport as well as proposed mitigation strategies for people living inside those contours. Throughout the course of the hearings, it became apparent that residents were not merely complaining that the airplanes were too loud. Rather, they were challenging the methodology behind the contours' construction and even the nature of scientific and cartographic knowledge itself with its seeming inability to incorporate local experiences. The scientific determination of where noise was incompatible with housing conflicted with residents' knowledge of that same incompatibility based on their lived experience, leading to frustration on their part with the entire process.

The ways that residents challenged the noise contours reflect insights from the literature on critical cartography, which does not take the truth of maps for granted but instead considers the subjectivities inherent in their construction, as well as the discrepancy between individuals' knowledge and what is portrayed on a so-called scientific and/or objective map. Early contributions to this literature largely treated lay map readers as naïve and unaware of the power relations embedded in seemingly neutral maps (e.g., Harley, 1997, 2001; Wood, 1992, 1997, 2000). In recent years, work in critical GIS and related subdisciplines has demonstrated that lay map readers are not so naïve (e.g., Peluso, 1995; Walker and Peters, 2001; Elwood, 2002), but this work has mostly focused on laypersons as potential mapmakers, not as readers of maps.

At the same time, the field of science, technology, and society studies (STS) contests the very nature of knowledge, particularly scientific knowledge. Work in this field has demonstrated that conflicts between local residents and state officials and/or scientists are based in part on their different types of knowledge about a place, with state-centered scientific knowledge usually considered to override local knowledge (e.g., Robbins, 2000). While it has been established that there is no hard and fast line between "local" and "scientific" knowledge (Agarwal, 1995), Clark and Murdoch (1997) point out that it is possible to make a relative distinction between two different knowledge systems when they come into contact with each other. In the case study presented here, the “scientific” knowledge displayed in the noise contour maps comes into direct conflict with residents' observations based on their daily practices. Residents then use their local experience and knowledge to challenge the assumptions that go into the map, as well as the entire modeling/mapmaking process.

This paper brings together these two literatures, critical cartography and STS, to demonstrate how map users question the assumptions and results of mapping with regards to airport noise compatibility. While critical cartography has examined historical maps of empire in great detail to show how the subjugation of peoples around the world depended on cartographers' ink and paper (e.g., Edney, 1997; Thongchai, 1994), less attention has been paid to how the average map reader might engage critical cartographies of his or her own. Despite the growing literatures on public participation and the critical analysis of cartography and GIS (e.g, Kwan, 2002; Kyem, 2004; Pickles,

2004), few studies consider how the average person conducts critical analyses of maps. Instead, the solution to academics' problematization of maps is posited as having laypeople make new, empowering maps (Craig et al., 2002), which is certainly a start.

However, there is a great deal to be learned from how members of the public already carry out a critical cartography. By examining public comments concerning airport noise, an environmental issue whose definition and remediation depend on the location of lines on a map, I confirm that laypeople do carry out some of the elements of critical cartography without necessarily being cartographers themselves. Furthermore, using the literature on STS, I show how the validity of scientific knowledge is brought into question by members of the public who demonstrate that their lived experience is not adequately incorporated in the maps that purport to describe airport noise and residential incompatibility in their neighborhoods.

The remainder of this paper consists of five sections. I begin by explaining how noise contours are constructed and mapped around U.S. airports, followed by the methodology and research questions used in the present study. I then discuss the pertinent literature from both critical cartography and STS, providing a theoretical framework for the rest of the paper. In the fourth section of the paper, I look at the ways in which members of the public challenge the cartography of airport noise, based on observations and transcripts from public meetings concerning the Minneapolis-St. Paul International Airport. Finally, I discuss the implications of the data for a lay critical cartography.

Constructing the contours

If a U.S. airport operator (such as a city or port authority) wants to receive federal funding for noise mitigation procedures such as soundproofing or buying and removing residences, they must conduct a study as specified in the Code of Federal Regulations, Chapter 14, Part 150. Such “Part 150 studies” are not required of all airports, only those that want to make use of federal funds for mitigation[1]. The study includes a map that shows where certain levels of noise are experienced – specifically those levels that have been deemed as incompatible with residential land use. Funds may be then disbursed to

homeowners to mitigate the effects of incompatibility, as delineated by isolines known as noise contours.

In determining where noise is greatest, the Federal Aviation Administration (FAA) averages aircraft noise over a 24-hour period, resulting in a Day-Night Level of noise recorded as, for example, 65 DNL. At this level, the *average* noise is 65 dB, about the equivalent of a blender or a garbage disposal. Individual events (i.e., planes passing overhead) can be over 90 dB, about the level of a rock concert, but when averaged with periods of silence, they result in the DNL value. DNL levels are constructed via computer modeling, including data on the mix of aircraft at a particular airport, how noisy those aircraft are, how many operations there are per day, varying climatic conditions, and the height of the flight paths. Noise between 10 P.M. and 7 A.M. is given a weight of ten extra decibels; since the decibel scale is logarithmic, this means that nighttime flights (or "events") are considered ten times as noisy as daytime ones, due to less background noise and the fact that most residents are sleeping. The levels may be checked via sound monitoring, but the computer projections are usually used without ground verification.

DNL levels are determined for a grid of points and then mapped into noise contours. Part 150 legislation requires that contours be drawn only to the 65 DNL, which the FAA and the Environmental Protection Agency (EPA) consider to be "incompatible" with residential land uses, in part because that is the level of noise at which conversation becomes impossible. The World Health Organization has gone farther, demarcating 45 DNL as the level which is incompatible with residential development (Berglund and Lindvall, 1995). However, the international standard for aviation remains 65 DNL, and airport operators need special exemption from the FAA to spend mitigation funds in locations outside the 65 DNL. As of 1999, based on earlier projections, approximately 5 million people across the U.S. lived inside the 65 DNL (Bragdon, 1989). No contour higher than the 75 DNL usually extends outside of airport property, though there are exceptions around urban airports such as Boston's Logan or Chicago's Midway.

---

[1] The money for mitigation comes from passenger facility charges, or PFCs, which are levied on each flight segment. Under federal law, the maximum amount that can be charged per passenger, per flight segment, is $4.50.

Figure 1 shows the noise contours from the year 2000 for MSP. The four contours from the outside in are the 60, 65, 70, and 75 DNLs. Two features in particular are noteworthy. First, the different street patterns to the north/west and south/east of the airport indicate the different histories of settlement. Minneapolis and the 1950s-era suburb of Richfield, to the north and west respectively, were both developed prior to the era of jet aircraft. The wider contours reflect the airport's policy of fanning out departing aircraft so as to spread the noise over as wide an area as possible in this relatively dense, almost entirely residential area. To the south and east lie the three suburbs of Bloomington, Mendota Heights, and Eagan, all of which saw their main growth come in the 1970s or later. All three cities have been able to zone their land uses so that most residential neighborhoods are outside of the noisiest areas. The contours, longer and narrower in this direction, reflect the pilots' practice of maintaining the runway heading for longer after takeoff because they are flying over industrial and commercial land uses. The other item of note is that off the crosswind runway, the contours are only a small bump. The crosswind runway is used less than 5 percent of the time; because of the averaged nature of the DNL values, it appears on the map that noise does not occur in areas within only a few hundred yards of the ends of the runway.

One major problem with DNL contours is that they demarcate discrete divisions in continuous data. Because funding availability depends on whether or not a piece of property is located within a specific contour, this has material consequences for airport neighbors. Additionally, because DNLs are averages, a residence located in an area that always receives medium-level noise and one in an area that occasionally experiences very loud events will be within the same contour, though there are different effects in terms of quality of life. Part 150 legislation specifically states, “Acceptance of a noise exposure map does not constitute an FAA determination that any specific parcel of land lies within a particular noise contour” (94 Stat. 50). However, the airport operator does have to make some sort of determination as to where the lines fall. The Metropolitan Airports Commission (MAC) at MSP has made it its policy to soundproof entire blocks at a time, even if a contour line divides a block in half. As will be seen below, however, one of the major criticisms of the map is the discrete nature of the noise contours, and the fact that occasionally soundproofing will be funded on one side of the street but not the other.

Another major criticism concerns the use of a model rather than recorded data. The Integrated Noise Model (INM) has been used since 1978 as a standard means of measuring airport noise across the U.S., and is required under Part 150 (FAA, 2005). According to the MAC, there are two main reasons why the model does not use measured noise values (MSP, 2005). First, there are fewer than forty noise monitors around the airport, while the INM can calculate noise exposure for thousands of points, making contour development much more precise. Secondly, future projections are a key part of the Part 150 process, and they can not be determined solely from extrapolation, as airlines may change their fleet mix or flight patterns. Like other airports, MSP does use empirical data to check the accuracy of the INM results and adjust the model inputs as needed. Still, public comments often include dismay over the use of a computer model to determine where noise is a problem rather than the use of actually-recorded noise.

While the method of creating noise contours is the same across the United States, recent events at MSP made it an ideal site to explore the meanings of the noise contours and their maps from the point of view of nearby residents. The following section explains the methodology of this study, including the choice of research site and the research questions that were asked.

Methodology

The choice of airports to study was part of a larger project, but was determined in part by the expansion plans underway at Minneapolis-St. Paul International Airport. MSP was one of only two airports in the country planning on some form of mitigation beyond the 65 DNL and down to the 60 DNL (the other is Manchester, NH). Part of the agreement between the city of Minneapolis and the MAC that allowed a fourth runway to be built at MSP in the late 1990s was that the MAC would seek a waiver from the FAA to provide mitigation beyond the 65 DNL. That waiver was granted, and the form that mitigation should take was then open to debate.

A series of meetings during 2000 and 2001 allowed for public input on the issue. The meetings were held at the Thunderbird Motel, located across I-495 from the airport, on weekday evenings. Displayed in the back of the room on a large board before and during most meetings, the noise contour map was the main site of debate between residents and

the MAC. Individuals could (and did) locate their block on the map (an aerial photo with the current contours overlaid) or on another showing land uses within those contours, including the residential areas designated for additional mitigation.

Data for this paper were collected from transcripts of these public meetings (as written by a notary public) and personal interviews. Although there are many ways "the public" can be constructed (Mitchell, 1995; Staeheli and Thompson, 1997), and another paper could examine how that was done for the MSP hearings, for this case study "the public" consists of the residents of airport neighborhoods of Minneapolis, St. Paul, Richfield, Mendota Heights, Eagan, and Bloomington, MN, who spoke at the hearings. While I am aware of the dangers of conflating "members of the public" and "residents" (see, e.g, Marston, 1990; Staeheli and Thompson, 1997; Staeheli, 2003), everyone who spoke at the public meetings was required to identify themselves and where they lived, and all of them lived in the vicinity of the airport. Because of the social geography of the Twin Cities, most residents of these areas are relatively well-educated and middle- to upper-class, which is fairly unusual for neighborhoods adjacent to major metropolitan airports. A few residents also had some background in acoustical engineering, which meant they could challenge the noise contours on their own terms, which again is not typical of airport neighbors.

I also conducted interviews with the executive director of the MAC, the member of the MAC representing Minneapolis, city planners from neighboring municipalities, and the head of the citizen organization SMAAC (South Metro Airport Action Coalition) in order to get as broad of input as possible from actors on all sides of the issue of airport expansion. Interviews were semi-structured, with an initial list of questions that was added to or reduced depending on the individual situation. Most interviews were done in person, either at a neutral location or in the interviewee's workplace or home (one was done by phone), and most of the interviews were conducted after the public meetings had all taken place. All interviews were recorded and later transcribed.

While I attended the public meetings (as well as a few meetings of SMAAC) and took notes as an observer, the use of official transcripts made open coding of the qualitative data easier and more complete. In this method, data (whether interview transcripts or

fieldnotes; see Emerson et al. (1995) for more information) are first read over to determine the general themes and ideas that are expressed. For example, "critical cartography" might be one of the open codes developed at this stage. The next step is to write initial memos based on the codes. These memos are often only a paragraph or two long, exploring what a particular code means and what sub-categories might be identified. This method is designed not simply as a means of classifying data, but of letting the data speak for themselves: "sensitively representing in written texts what local people consider meaningful and then in making their concerns accessible to readers who are unfamiliar with their social world" (Emerson et al. 1995, p. 108), or discovering the themes and ideas that are expressed in the transcripts without imposing preconceived ideas about what people have to say.

Once an initial set of categories has been developed, the data are then re-read with those categories in mind, and a more fine-grained set of codes is developed. Known as focused coding, codes in this stage might include "critical cartography: questioning assumptions," for example. Finally, integrative memos begin to connect different codes and flesh out the categories and sub-categories with background information on the case study or the theory involved. These short writings not only help to identify the main issues involved, but when linked together, provide the basis for developing theories.

It became apparent during the initial data analysis that members of the public were collectively constructing a fairly sophisticated critical cartography of the noise contour map. I therefore developed two research questions for more closely interrogating the field data:

- How do laypersons construct and contribute to critical cartographies of airport noise contours?
- How do residents use local knowledge and experience to challenge acoustical science?

While these two research questions were not part of the original project, I was able to re-analyze the transcripts with these new questions in mind. Two different literatures provided background for the analysis: critical cartography for the first research question,

and science and technology studies for the second one. I now turn to a brief review of the relevant literatures to provide further background.

Literature review

Critical cartography and critical GIS

Though critiques of the power relations inherent in mapmaking have increased with the rise of GIS, those critiques continue to follow three major approaches: treating the map as text, including the role of the author in the map's production; showing how maps do not just represent space and place, but create them; and exploring the power dynamics that are intrinsic to any map. Commentators on critical cartography have deplored the wide gap between cartographers themselves and critical treatments of their work (Schuurman and Pratt 2002, Perkins 2003), and suggested ways that GIS and cartography might be able to incorporate other methodologies and points of view (Kwan 2002a, 2002b; McLafferty 2002; Pavlovskaya 2002). The literature on public participation and GIS (PPGIS) has suggested that the way to change the power dynamics inherent in mapping is to enable members of the community to become cartographers (Craig et al., 2002, Elwood 2002, Warren 2004).

What has been largely neglected, however, is the extent to which the lay public is critical of maps[2]. The PPGIS literature has largely skipped over the question of lay critical cartography, arguing for putting mapping technology in the hands of the community (or at least allowing more community input (Peluso 1995, Jordan 2002)) as the main strategy to overcome the power differentials of cartography and GIS. Even this strategy is not sufficient (Hodgson and Schroeder, 2002; Meredith et al., 2002); as Elwood (2002) has argued, GIS also empowers and disempowers internal groups *within* community organizations and state agencies; access to technology is not everything. As I will show below, however, elements of a lay critical cartography can be found in how members of the public react to official maps in a way that shows they are well aware of the same issues that critical cartographers have raised in the literature.

[2] I follow Rose's definition of "critical" with regards to visual images as "an approach that thinks about the visual in terms of the cultural significance, social practices and power relations in which it is embedded; and that means thinking about the power relations that produce, are articulated through, and can be challenged by, ways of seeing and imaging" (Rose 2001, 3).

The question of maps creating rather than merely representing space and place is one way to consider how power relations are embedded in maps. Harley argues that since all maps are meant to persuade, they all embody power: "The steps in making a map – selection, omission, simplification, classification, the creation of hierarchies, and 'symbolization' – are all inherently rhetorical" (Harley 1997, 237), and power is part of this rhetoric. Wood further argues that "once it is acknowledged that the map *creates* these boundaries, it can no longer be accepted as *representing* these 'realities,' which alone the map is capable of embodying" (*ibid*., 19, italics in original). Furthermore, maps actually create spaces and places because of their taken-for-grantedness: "the map *creates* this territory, the map … *brings it into being*. Outside of its inscription on this map this territory, *as such*, has only the slightest of claims to existence" (Wood 1992, 68, italics in original). The territory demarcated by the 65 DNL, for example, does not exist outside the map generated by the INM. However, if we see familiar features such as roads and airports placed on a map in correct relationship to each other and to other features, then other lines such as the noise contours are more easily accepted as accurate and stable. This is one of the ways in which power relations between the cartographer and the map reader shape the way the map is seen and interpreted.

In order to even the playing field, critical cartographers have called for rhetorical analyses of maps, as well as getting mapmaking technology into the hands of laypersons so that everyone has access to the power of mapmaking. This has been one of the main contributions of the PPGIS and counter-mapping literatures. PPGIS has raised concerns that even though GIS software has broadened the range of individuals who have the ability to make maps, the technological gap is growing between those who make maps and those who read them (e.g., Pickles, 1995). One way to not only narrow this gap, but to give members of the public more influence in decision-making, is to provide community organizations with GIS technology (e.g., Craig et al., 2002; Warren, 2004). The counter-mapping literature (e.g., Peluso, 1995; Poole, 1995) has made similar arguments, more often in the context of the developing world and often arguing that local input can be equally important as and more practical than local mapmaking (Jordan, 2002).

Both critical cartography and PPGIS have become more refined in recent years with regards to the power relations that remain even when mapmaking is done by the non-elite. For example, "the community" and "the public" are not homogeneous, and their maps are influenced by existing internal power structures (Hodgson and Schroeder, 2002; Elwood, 2002; Kyem, 2004). Additionally, it is not always the placement of lines on maps, but the *meaning* of those lines, that matters (Harwell, 2000; Walker and Peters, 2001). The solution has been to suggest that public participation at *all* stages of mapmaking is necessary to keep people involved and to keep the mapmaking process as transparent as possible in order to forestall complaints about decisions being made behind closed doors.

However, neither critical cartography nor PPGIS have devoted significant space to discovering how members of the public critique cartography as based on existing maps rather than through the production of new ones (but see Sparke, 1998). As the case study below shows, the public knows full well that "far from holding up a simple mirror of nature that is true or false, maps redescribe the world – like any other document – in terms of relations of power and of cultural practices, preferences, and priorities" (Harley, 2001, 35). The main way in which they conduct their critique is by bringing their experience and local knowledge to bear on maps that are presented to them as a product of a universalized scientific methodology. It is to this distinction between local and scientific knowledge that I now turn.

The construction of local and scientific knowledges

Constructivist political ecology (Robbins, 2004) and science and technology studies (STS) have explored the ways in which science is made to seem objective and universal, when in fact it is grounded in particular places and practices just as much as any other sphere of human activity (Callon, 1986; Latour, 1993). The use of STS by geographers has largely been concerned with how local environmental knowledge is constructed. Robbins (2004) has identified five main ways of studying this: examining discourses about a place or controversy; exploring the environmental categories or taxonomies which laypeople have developed (Robbins, 2000); using cognitive mapping or counter-mapping to determine local concepts of space and place (Peluso, 1995); ascertaining local

narratives and explanations for environmental change (Harwell, 2000); and constructing environmental histories (Willems-Braun, 1997). The goal of this constructivist approach (much like critical cartography) is to show that taken-for-granted concepts such as "forest" and "nature" are not given or natural, but have been socially constructed. Furthermore, if these concepts have been constructed by social interaction, they can be reshaped as well, in order to make a more just society.

In more recent years, STS researchers have backed away from the idea that local/situated and universalized/scientific knowledges exist in neat, binary opposition. For example, Clark and Murdoch (1997) use three case studies of controversies between First World fishers or farmers on the one hand, and ecologists and social scientists on the other hand, to illustrate how the dichotomy between local/traditional knowledges and scientific knowledge is constructed, as well as how it breaks down in socio-spatial locations. Robbins (2000) has broken the local-universal dichotomy down further by showing that the personal and educational backgrounds of forestry officials at different levels of the Indian state lead to their differing perceptions of the value and prevalence of certain forest resources. Similarly, Harris et al. (1995) remind us that "local knowledge" is itself a social construction, and that power struggles determine what counts as local knowledge just as much as "scientific" or state knowledges.

As discussed above, Clark and Murdoch (1997) argue that even if there is not a hard-and-fast binary between local and scientific knowledge, it can still be useful to make a relative distinction between two different knowledge systems which come into contact with each other. I will show that the construction of scientific knowledge plays a major role in environmental issues, here in the case of airport noise, *because* of the contrast between local and scientific ways of knowing what constitutes incompatible noise levels. I will outline how laypeople are critical of acoustic science and its practitioners as they challenge the airport's findings of where homes are or are not incompatible with airport noise, via a cartographical critique. The challenge to scientific, objective knowledge is done via maps that not only summarize information, but create the "knowledge" of where airport noise is and is not incompatible with residential land uses.

Deconstructing the contours

Based on comments at the hearings and in interviews, members of the public challenged the knowledge of airport noise as produced by the contour lines in two main ways. First, speakers questioned the assumptions that were made in drawing the lines. Such comments generally accepted the DNL noise modeling process as a valid means of producing knowledge about airport noise, but still gave issue with the inputs or parameters of the model. They also challenged the MAC's authority and its relationship with the airlines, Northwest in particular, arguing that power relations between the airport authority, the airlines, and residents distorted the modeling process.

On the other hand, some speakers challenged the methodology of modeling altogether by drawing on personal experience to show that the contour lines are not reflective of what actually happens on the ground. One strategy was to question the science behind the noise contours, challenging the competence of the FAA in drawing up regulations and the consultants in producing the map and questioning the "mask of a seemingly neutral science" (Harley, 1997, 238) behind the contour map. Additionally, residents challenged the validity of the map by contrasting what the map said, whether the placement of the contours or their meaning, with their personal lived experiences. The disjunctures between where the map said noise was not a problem and where residents said that it was meant that the entire cartographical process fell under suspicion.

Questioning assumptions

One of the simplest ways residents challenged the contour maps was by questioning the data that went into demarcating the DNL contours. As described above, the mix of aircraft at the airport is one of the factors that goes into the INM. Since the fleet of aircraft that Northwest Airlines operates at its MSP hub is one of the oldest in the country, and thus the noisiest, the projections are a matter of some contention. For example, a speaker noted a newspaper article that stated that the 65 DNL line is projected to shrink in five years due to quieter planes. However, he also noted that Northwest has said that their hushkitted Stage 2 aircraft will remain in operation for another twenty years, putting into question the statement about quieter planes[3]. A state representative

[3] Stage 2 refers to the noise level of an aircraft engine; airlines were required to reduce noise to meet Stage 3 requirements as of January 2000 as set by the International Civil Aviation Organization. This reduction could be accomplished either by buying new, quieter aircraft, or by attaching "hush kits" to existing, Stage

noted at another meeting that the MAC assumed all of Northwest's 727s would be retired by 2003 and DC-9s soon after, although they have no written agreement to that effect. In fact, the only time someone from Northwest spoke at a meeting was to stress that point, that there was no required timetable for the phase-out of hushkitted aircraft.

Perhaps even more important than the mix of aircraft is sheer numbers of flights, and here people challenged the MAC more directly. The person quoting from the newspaper also read that the increasing number of aircraft will eventually override any noise reduction from quieter aircraft. One elected official noted that the number of operations predicted in 1991 for 1996 was short by 57,000 out of 420,000, and that using the incorrect projections is "not fair or honest." A state senator at the large public meeting was more blunt, stating that "MAC appears to be avoiding its responsibility" by underestimating flights and thus noise. For example, based on projections in the early 1990s, there were already more operations in 1995 than had been predicted for the year 2000. As the meetings went on, this doubt over the veracity of flight projections grew to encompass more of the modeling process. Said a resident of St. Paul, "Even though you say only 2 percent of flights fly over our area, I think that's probably not right either, because it seems like all your other figures and estimates are off, too." As Wynne (1992) found in the case of Northumbrian sheep farmers in the UK and fallout from Chernobyl, once part of the methodology was brought into question by the locals, the entire scientific project began to be suspect.

A second category of complaints had to do with the assumptions that were made as part of the modeling process itself. Some of these have already been referred to, such as the averaging of noise over a 24-hour period and the use of discrete divisions in continuous data. One of the most common complaints was that the modeling process did not use measured noise, but projections of where noise would occur. Another resident stated that the original DNL model was based on highway and railroad noise, not airplane noise, and that even the original modeler did not think it was a valid method for modeling airport noise. Other concerns included the restriction of funding to single-family homes, despite

---

2 aircraft. Northwest has largely chosen the latter option, which, although it does bring the noise below the required levels, still results in more noise than would the purchase of new aircraft.

the presence of apartment buildings across the street from the airport, and the effects of elevation and topography on the modeling.

Local knowledge and personal experience

There were also many residents whose concerns about airport noise were based on the fact that they considered the INM as an illegitimate methodology. Most of these concerns were couched in terms of lived experience. As a Minneapolis resident put it, "All of the statistics that are being thrown around here tonight, I can't argue them, but all I can tell you is that the statistics do not quiet down my home." Residents questioned the acoustic science behind noise modeling and the designation of incompatible land uses by using personal examples concerning inability to sleep, enjoy their backyards, or watch television in order to show that their local knowledge of their environment was not accurately reflected in the noise models and subsequent contour maps. While this local knowledge is based on personal experience or observation rather than being acquired through training or education, members of the public still considered it to be a kind of knowledge that was only accessible to those who live near the airport[4].

Because the 65 DNL is the line used to demarcate where federal funds for soundproofing are available, many people took this to mean that outside of that line, noise is not a problem. For example, "I'm confused as to whether we're in that [contour] or not. We definitely are from what we're experiencing on a real life situation every day," said a resident of Mendota Heights. A resident of St. Paul echoed this idea: "Sometimes those planes fly within three football fields over the house, and the noise even drowns out lawnmowers. So I don't see how we're not in the sixty-five decibel range." Both of these comments reflect the complaint that the line on the map does not accurately reflect ground conditions. Because the map has created boundaries in the form of noise contours, it has also created the reality of where the FAA says noise is and is not a problem. By arguing that noise *is* still a problem for them, these residents are charging

[4] This is illustrated by the following quote, taken from an interview with a neighbor of a different airport in a similar situation: "And you *can not* understand what the impacts are unless you live it. You can sympathize, you can say you understand, but you don't. You don't. You don't understand what it's like unless you have lived it."

that the map is wrong. Though the model may be accurate in drawing the line on the map, its seemingly arbitrary location means that the map, and thus the model, is suspect.

Residents were aware that their type of knowledge is different from that used in the DNL models and thus that they were speaking from a disadvantaged position as far as the airport officials and consultants were concerned. Many of them offered to make their knowledge available to MAC commissioners and consultants by inviting them to their own property. "I was wondering if you'd like to come and stay at my house for a week next summer," a resident of Minneapolis asked of the consultant (who was from Washington, DC), while another suggested, "I'd like to cut this short and just invite you to my home, we'll have a party outside, and you can count the rivets [on the airplanes passing overhead] with us." These commenters and others felt that if the MAC commissioners and consultants had access to their place-based knowledge, they, too, would understand that noise and incompatibility are not adequately calculated by the INM.

In fact, residents made dismissive comments about the outsider status of the consultants: "Whoever makes those contour maps, I think they do it in some office in New York," and, later that night, "He's right, the maps are done in Boston, not New York." Both remarks were met with derisive noises from the audience. The public seemed to take the site of the map's production to indicate that the consultants didn't understand what was going on on the ground, and that if they were from Minneapolis-St. Paul or had at least come out to visit, they would understand the real issues. Of course, because of the universalized nature of acoustic science and the regulatory requirements of the Part 150 process, it doesn't matter where the maps were done; a Minneapolis-based consultant would have produced the same contour lines. However, because the so-called objective maps were produced hundreds of miles away, seemingly without regard to local specificities, residents could claim that their place-based knowledge was more valid to the MSP situation.

Residents also questioned the meaning of the maps themselves, notably of the contour lines. First, they questioned the placement of the lines, often whether or not an individual’s home should be inside the critical contour: "I live thirty feet from a house

that's all fixed up by the airport, but it doesn't cover my house. The noise absolutely stops at that gutter, the gutter across the street." A City Council member from south Minneapolis told a story about crossing the street from his house in the 65 DNL contour to visit his neighbor in the 64 DNL contour, and the “experiment” they conducted. When the doors and windows were closed, "by golly, they have the same sorts of noise problems that we in the 65 DNL suffer." While obviously sarcastic, these stories are prime examples of how the scientific process of constructing the Part 150 map and the seemingly arbitrary contour lines seems almost silly when applied at the level of the individual.

Members of the public also questioned the validity of using a hard-and-fast line to demarcate where soundproofing is and is not funded. "If you would stop the noise at the 65 DNL noise line, none of us would say you need to go outside the line to noise insulate, but you don't. The noise spills over," said the state representative for south Minneapolis. The airport's executive director, who had the opportunity to respond to comments, stressed that "no matter what program there is and no matter what is decided on, there will be lines drawn…and that will be unfair to the people who are on the other side of the line, but there seems to be no way to avoid that." He also noted that the contour line itself is actually half a block wide on the map, therefore reminding residents that maps "lie."

Finally, some residents showed that they were fully aware of the power of maps, including how easily they are taken for granted. "It's kind of deceiving due to the fact that a new resident to Mendota Heights would look at this and say the airplanes stay within that [*sic*] 65 and 60 DNL contours," said a resident of that city, reflecting Wood's argument that maps are accepted as representing reality rather than creating it. Additionally, as the opening quote from a Minneapolis resident said, "I saw the map, and the map is a lot of waves and things like that, which is completely beyond my understanding. All I know is that planes fly in a straight line over my house." This comment is representative of a number of people who felt that although their lived experience told them otherwise, what really matters in determining where noise is incompatible with housing (at least for purposes of federal funding) are the lines on the map. Nevertheless, by making these comments in a public forum, these people were

hoping to convey to the airport operators an alternate form of knowledge about where incompatibility with housing exists, and where it should be mitigated.

Critical cartography, local knowledge, and the public

In this section, I bring together the literature review and the ways in which the public deconstructed the noise contours to identify some elements of a lay critical cartography and to show how local knowledge was used to challenge scientific knowledge.

A lay critical cartography

The elements of a lay critical cartography are not all that different from the academics' version. What is important to realize, however, is that despite the literature on critical cartography that has focused on mapmaking as a way to reshape cartographic power relations, the comments from the MSP public hearings indicate that members of the public are very much aware of the potential pitfalls of map *reading*, as well as their implications for power relations. There are two main elements of critical cartography that were made visible in the public comments: maps create rather than reflect reality, and maps embody power relations.

As explained above, many residents felt that the "reality" that the contour maps portrayed did not match their lived experiences, whether the placement of the contour lines or the meaning of the lines as discrete boundaries. A Minneapolis resident commented, "Right across the creek from us they're getting noise abatement stuff. We're not, and they say there's no noise there. Well, it's terrible." She interpreted the contour line as demarcating a boundary between where noise does and does not exist, rather than where *incompatibility* does and does not exist. Houses outside the contour line are considered to be within acceptable noise levels, but not free of noise altogether. Nevertheless, the material practice of soundproofing houses in some locations and not others is a result of where those lines are drawn on the map: that reality *is* created by the map. As the city council member's sarcastic "experiment" above shows, residents know that while the lines on the map are not meaningful in terms of demarcating a discrete boundary between noise and quiet, they *are* meaningful in terms of creating the reality of where soundproofing funds are spent and where they are not.

Members of the public were also well aware of the power relations inherent in mapmaking. Many charged the MAC with allowing Northwest Airlines to have undue influence in the Part 150 process, particularly those who questioned the accuracy of future noise projections. Since the airlines and their passengers are the main source of revenue for soundproofing, residents argued that Northwest was trying to keep the area inside the contours as small as possible to avoid having to pay for a massive amount of soundproofing. Others noted that since the noise would not exist at all if the governor and state legislature had not decreed that MSP would be expanded rather than a new airport built, they were the ones responsible.

Finally, many residents made frustrated comments to the effect that the airport was determining where noise incompatibility did and did not exist, while the people who were actually affected had no input. A Minneapolis woman said, "In fact, one time a few years ago I talked to an airport person [on the phone] about this very same matter, and he said, your area isn't that bad, and we had to stop talking because we couldn't hear because of the airplanes." This example clearly shows how some everyday household activities such as talking on the phone are incompatible with aircraft passing overhead. However, according to the contour map generated by the INM, incompatibility did not exist at this location. The power relations between the FAA, the MAC, and nearby residents mean that there is no opportunity for local knowledge to enter the noise contour modeling process and resolve this contradiction.

Science and technology studies and the public

There were two main ways in which residents challenged how acoustic science determined where noise levels were and were not incompatible with housing. First, there was the questioning of objective, universalized acoustic science as being the appropriate means of determining environmental impact. Secondly, although this was not as explicit in residents' comments, there was the realization that struggles over the type of knowledge and the ability and authority to produce that knowledge matter as much as struggles over access to physical resources or power.

Clark and Murdoch's (1997) study of environmental controversies in rural First World locations found that local people, whose environmental knowledge is based on years of

observation, may show greater understanding of both the problems and potential solutions to environmental degradation than outsider scientists. While residents around MSP tried to make that same connection, they weren't as successful, in part because of the larger policies involved. For example, the Part 150 process, including the demarcation of the 65 DNL as the line inside of which residential land uses are incompatible, is supposed to be based on acoustical and psychological studies that show what level of noise affects people. However, while the FAA and EPA consider 65 decibels to be the boundary for compatibility, the World Health Organization has decreed that 45 decibels is actually the limit (Berglund and Lindvall, 1995). The higher decibel amount in the U.S. indicates that politics and economics have played as much of a role in determining the difference between noise and quiet as acoustical science has.

While not all speakers were aware of this discrepancy between the FAA and WHO (though some of the more knowledgeable activists certainly were), many people did try to make the point that the objectivity of the scientific method of drawing the noise contours was open to debate. The comments listed above about the accuracy of flight projections are one example of this. Another strategy was to use years of personal observation to counteract the scientific conclusions, like the farmers and fishers of Clark and Murdoch's study. Several people noted that they had lived in the same location for thirty or more years, including before the jet age, and noise kept getting worse over the years. Others noticed that when planes take off to the southeast, they fan out more on the north side than the south side, supposedly due to an order issued by the head of air traffic control who didn't want planes flying over his house (this was verified by a city planner from the municipality in question). While these residents' perceptions of where airplanes actually fly compared to where the contour maps say they do may be biased by their desire to have relief from noise, they are also arguing that their observations do not match the objective modeling that is carried out hundreds of miles away by unaffected consultants.

What many of the comments at the public meetings came down to was a debate over whose voices are heard in the production of knowledge, in this case knowledge of where airport noise is or is not compatible with residences. A few residents expressed gratitude that the MAC was at least willing to hear them out: "I'm glad you think it's important to hear from people who live with the noise and pollution from the Minneapolis airport

every day and not just the staff in charge of day-to-day operations at the airport," said a member of ROAR (Residents Against Airport Racket). Her comment was representative of those who criticized airport staff for being out-of-touch with the reality of airport noise in adjacent neighborhoods, even though the staff is responsible for determining where compatibility is and is not a problem. The majority of comments, in fact, were concerned with expressing how daily life was compromised by airplane noise, and how this type of knowledge was not visible in the contour maps on display at the public hearings, in large part because of who was involved in producing that knowledge.

Conclusion

In order to better understand the power relations inherent in maps, and how to change those relations, I have argued that critical cartography and critical GIS would benefit from an analysis of how lay map readers actually interpret maps. This study of noise contour maps at Minneapolis-St. Paul International Airport has shown some of the ways in which individuals challenge the power relations between the airport, the airlines, and nearby residents by questioning the methods and assumptions behind the cartography. In so doing, these individuals made visible the work that goes into mapmaking, and attempted to challenge the power relations that are articulated by those maps.

For purposes of federal funding, the contour maps that were drawn according to 14 CFR 150 demarcated certain territory as incompatible with residential land uses. At a series of public hearings, residents shared their local knowledge concerning where daily household activities such as sleeping, gardening, or talking on the telephone were made difficult or impossible by airport noise. This local knowledge of incompatibility stood in contrast to the scientific knowledge displayed on the contour maps at the back of the hearing room. However, because of the inflexibility of the federally mandated mapping process, local knowledge remained anecdotal and without significant influence. On the other hand, many of the residents who spoke made it clear that they understood that maps do merely represent material reality, but help to actively construct it, in this case in the form of the distribution of federal funding for noise mitigation.

Local residents also demonstrated some of the conclusions found in the STS literature by challenging the objective nature and relevancy of acoustic science, arguing that if their

own lived experiences were not being taken into account, there was something wrong with the "scientific" process. The nature of scientific knowledge was therefore brought into question, particularly by residents who decried the official designation of their homes as not noisy enough to require mitigation even though they were personally affected by noise. Even those who accepted the validity of the Integrated Noise Model still voiced objections over the assumptions and data that went into the model, including criticism of the MAC as the sole producers of knowledge as to where noise compatibility did or did not exist.

In contrast to many of the subjects of STS (and PPGIS) research, the neighbors of MSP are relatively highly educated and have more free time for activism. A few of the speakers even had some training in acoustical engineering, and were able to challenge the contour maps on their own ground. However, because residents' objections were largely based on their ability to carry out daily household activities, their social status and level of education probably had little effect on the nature of their arguments. Where their demographics might have mattered was in allowing them more time for activism and research, as compared to a working-class population. Furthermore, as the opening quotations show, not all members of this particular public were well-educated with regards to the meaning of the noise contours, and therefore a distinction remains between the professionals who plotted maps and the residents who read them. Nevertheless, the composition of this particular "public" complicates the distinction between local and scientific knowledge that has already been criticized in the literature, though in a new way by showing how individuals might move between the two categories.

Acknowledgments

This study was partially funded by the Center for Transportation Studies at the University of Minnesota. The author is grateful to Deborah Dixon, Sarah Elwood, Francis Harvey, and three anonymous reviewers for their helpful comments.

Works Cited

94 Stat. 50, "Aviation Safety and Noise Abatement Act of 1979" P.L. 96-193 United States Statutes at Large

Agarwal A, 1995, "Dismantling the divide between indigenous and scientific knowledge" *Development and Change* **26** 413-439

Berglund B, & Lindvall T, eds., 1995, "Community noise" Archives of the Center for Sensory Research **2** 1-195. Available at http://www.nonoise.org/library/whonoise/whonoise.htm

Bragdon C, 1989, "Control of Airport- and Aircraft-Related Noise in the United States" *Transportation Research Record* **1143** 12-16

Callon M, 1986, "Some elements of a sociology of translation: domestication of the scallops and the fisherman of St. Briuex Bay," in *Power, Action, and Belief: A New Sociology of Knowledge?* ed J Law (Routledge, London) pp. 196-229

Clark J, Murdoch J, 1997, "Local knowledge and the precarious extension of scientific networks: a reflection on three case studies" *Sociologia Ruralis* **37** 38-60

Craig W, Harris T. Weiner D, eds., 2002 *Community Participation and Geographic Information Systems* (Taylor and Francis, New York)

Edney M, 1997, *Mapping an Empire: the geographical construction of British India 1765-1943* (University of Chicago Press, Chicago)

Elwood S, 2002, "GIS use in community planning: a multidimensional analysis of empowerment" *Environment and Planning A* **34** 905-922

Emerson R, Fretz R, and Shaw L, 1995, *Writing Ethnographic Fieldnotes* (University of Chicago Press, Chicago)

FAA, 2005, "FAA - Integrated Noise Model", Federal Aviation Administration http://www.faa.gov/about/office_org/headquarters_offices/aep/models/inm_model/

Harley J, 1997, "Deconstructing the map," in *Writing Worlds: Discourse, text and metaphor in the representation of landscape* Eds T Barnes, J Duncan (Routledge, London) pp. 231-47.

Harley J, 2001, *The New Nature of Maps: Essays in the History of Cartography* (Johns Hopkins University Press, Baltimore)

Harris T, Weiner D, Warner T, Levin R, 1995, "Pursuing social goals through participatory Geographic Information Systems: Redressing South Africa's historical political ecology," in *Ground Truth: The Social Implications of Geographic Information Systems* Ed J Pickles (Guilford Press, New York) pp. 196-222

Harwell E, 2000, "Remote sensibilities: Discourses of technology and the making of Indonesia's natural disaster" *Development and Change* **31** 307-340

Hodgson D, Schroeder R, 2002, "Dilemmas of Counter-Mapping Community Resources in Tanzania," *Development and Change* **33** 79-100

Jordan G, 2002, "GIS for community forestry user groups in Nepal: putting people before the technology" In *Community Participation and Geographic Information Systems* Eds W Craig, T Harris, Weiner D (Taylor and Francis, New York) pp. 232-245

Kwan M-P, 2002a, "Feminist Visualization: Re-envisioning GIS as a method in feminist geographic research" *Annals of the Association of American Geographers* **92** 645-661

Kwan M-P, 2002b, "Is GIS for Women? Reflections on the critical discourse in the 1990s" *Gender, Place and Culture* **9** 271-279

Kyem P, 2004, "Of Intractable Conflicts and Participatory GIS Applications: The search for consensus amidst competing claims and institutional demands" *Annals of the Association of American Geographers* **94** 37-57

Latour B, 1993, *We Have Never Been Modern* Transl C Porter (Harvard University Press, Cambridge, MA)

Marston S, 1990, "Who are ‘the People’? Gender, citizenship, and the making of the American nation" *Environment and Planning D: Society and Space* **8** 449-458

McLafferty S, 2002, "Mapping Women's Worlds: Knowledge, power and the bounds of GIS" *Gender, Place and Culture* **9** 263-269

Meredith T, Yetman G, Frias G, 2002, "Mexican and Canadian case studies of community-based spatial information management for biodiversity conservation" In

Community Participation and Geographic Information Systems Eds W Craig, T Harris, Weiner D (Taylor and Francis, New York) pp 205-217

Mitchell D, 1995, "The end of public space? People's Park, definitions of the public, and democracy" *Annals of the Association of American Geographers* **85** 108-33

MSP, 2005, "Integrated Noise Model" Minneapolis-St. Paul International Airport, http://www.macnoise.com/part150/sound_insulation/inm.htm

Pavlovskaya M, 2002, "Mapping Urban Change and Changing GIS: other views of economic restructuring" *Gender, Place and Culture* **9** 281-289

Peluso N, 1995, "Whose woods are these? Counter-mapping forest territorie in Kalimantan, Indonesia" *Antipode* **27** 383-406

Pickles J, ed, 1995 *Ground Truth: The Social Implications of Geographic Information Systems* (Guilford Press, New York)

Pickles J. 2004, *A History of Spaces: Cartographic reason, mapping and the geo-coded world*. (Routledge, New York)

Poole P, ed, 1995. "Geomatics: who needs it?" *Cultural Survival Quarterly* **18** 1-77

Robbins P, 2000, "The Practical Politics of Knowing: State Environmental Knowledge and Local Political Economy" *Economic Geography* **76** 126-144

Robbins P, 2004, *Political Ecology* (Blackwell Publishing, Malden, MA)

Rose G, 2001, *Visual Methodologies* (Sage Publications, Thousand Oaks, CA)

Schuurman N, Pratt G, 2002 "Care of the Subject: feminism and critiques of GIS" *Gender, Place and Culture* **9** 291-299

Staeheli L, 2003, "The new politics of citizenship: Structuring participation by household, work, and identity" *Urban Geography* **24** 103-126

Staeheli L, Thompson A, 1997, "Citizenship, community, and struggles for public space" *Professional Geographer* **49** 28-38

Thongchai W, 1994, *Siam Mapped: A History of the Geo-Body of a Nation* (University of Hawaii Press, Honolulu)

Walker P, Peters P, 2001 "Maps, metaphors, and meanings: boundary struggles and village forest use on private state land in Malawi" *Society and Natural Resources* **14** 411-424

Warren S, 2004, "The Utopian Potential of GIS" *Cartographica* **39** 5-16

Willems-Braun B, 1997, "Buried Epistemologies: The politics of nature in (post)colonial British Columbia" *Annals of the Association of American Geographers* **87** 3-31

Wood D, 1992, "How Maps Work" *Cartographica* **29** 66-74

Wood D, 1997, *The Power of Maps* (Guilford, New York)

Wood D, 2000, "Tricksters and Cartographers: maps, science and the state in the making of a modern scientific knowledge space," In *Masons, Tricksters, and Cartographers* Ed D Turnbull (Harwood Academic Publishers, Singapore)

Wynne B, 1992, "Misunderstood misunderstanding: social identities and public uptake of science" *Public Understanding of Science* **1** 281-304

Zubrow A, 2003 "Mapping Tension: Remote sensing and the production of a statewide land cover map" *Human Ecology* **31** 281-307

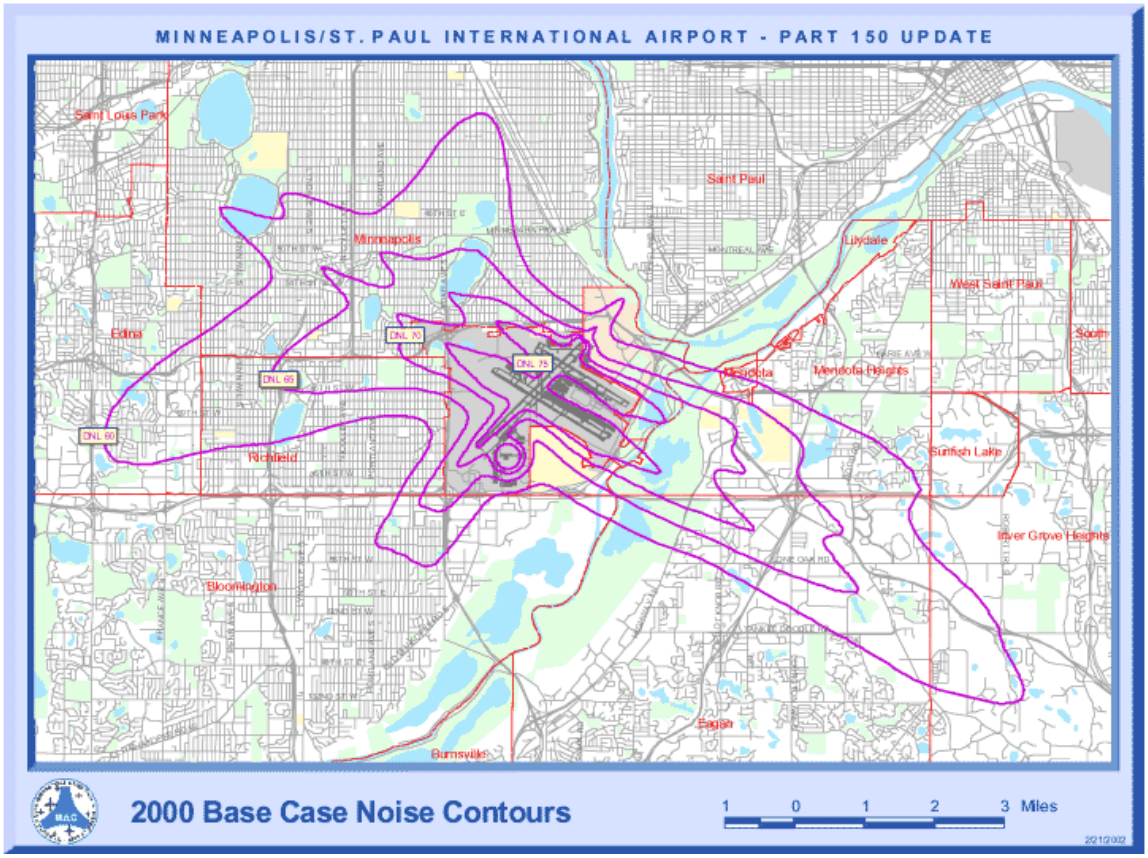

Figure 1. Minneapolis-St Paul International Airport noise contour map, 2000.