Environmental Justice Analysis

Challenges for Metropolitan Transportation Planning

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This research focuses on three major challenges of incorporating environmental justice into metropolitan transportation planning. The data needed are compared with the data currently available on the spatial distributions of race and income, the spatial distributions of trip ends, trip tables, network performance, and cost estimates of improvements. Several conflicting definitions of equity are offered, as are applications for each within the context of environmental justice. The importance of choosing a correct unit of analysis is discussed, with particular emphasis on how the geographic unit of analysis is a poor proxy for the group unit, which is theoretically required, as the analysis's purpose is to compare performance measures across groups. The primary goal of this paper is to explore challenging topics such as these raising questions and concerns. The answers to the questions raised will differ depending on each implementing agency's objectives and resources.

In the 12 years since Executive Order 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations (*1*), was issued, much progress has been made in formalizing environmental justice (EJ) analyses within transportation planning. However, as metropolitan planning organizations (MPOs) produce long-range plans approximately every 5 years, formal EJ analyses of these plans are still in their infancy.

To date, most of the research on EJ analyses in transportation planning has focused on specific analysis techniques (*2, 3*) or the equity impacts of specific projects (*4–7*), modes (*8–10*), and funding structures (*11, 12*). Although such discussions are of obvious importance, this paper focuses on three major challenges that have received limited attention in the context of long-range planning:

1. Collecting the needed data,
2. Coming to a consensus on how equity should be defined and applied in the context of EJ, and
3. Using an appropriate unit of analysis

The goal of this paper is to explore these challenging topics, raising questions and concerns; it is not to offer specific recommendations to public agencies. The following sections are devoted to addressing the three challenges mentioned above, and the paper concludes with a summary and a discussion of research needs.

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DATA NEEDS AND AVAILABILITY

Collecting the appropriate types of data in sufficient quantities for rigorous analysis is a challenge that pervades all of transportation planning. This section looks at five types of data that are needed for determining the EJ implications of a long-range plan, comparing what is currently available with what is ideally needed for both a base year and future years. The data types considered are the spatial distributions of race and income, the spatial distributions of trip ends, trip tables, network performance, and cost estimates of improvements.

When any type of data are obtained, their accuracy should be questioned. Long-range plans, or metropolitan transportation plans (MTPs), forecast anywhere from 20 to 50 years into the future. Demographics forecasts are known to be subject to much uncertainty (*13*), and the finer the level of data required (i.e., locations of retail businesses instead of locations of total businesses) and the longer the amount of time between the base and forecast years, the more uncertainty there is. Hirschman details the assumptions in projections of demographics by race and ethnicity (*14*), and Smith and Nogle study projections of the Hispanic population and conclude that the errors tend to be larger for this group than for the total population (*15*).

Spatial Distribution of Race and Income

The decennial census provides information on the race of each person and the income level of each household at the block group level. For most MPOs, demographic forecasts output total residents and total employment by type in each zone or district, but they do not forecast the spatial distribution of race or income. Without predictions of the spatial distributions of race and income, the distributions in future years are typically assumed to be the same as those in the base year. A comparison of the 1990 and the 2000 census data for many regions shows that this assumption is a poor one, but there are few alternatives. Purvis describes the difficulty in obtaining predictions of race and income for EJ analyses, commenting that federal and state forecasts typically continue past trends (*16*).

Spatial Distribution of Trip Ends

In a growing region, keeping abreast of new developments (i.e., subdivisions and shopping centers) can be a full-time job, and predicting the location of development years into the future is nearly impossible. Despite the availability of data on existing developments, trends, topography, and land use restrictions, the locations chosen by developers are not predictable with any degree of accuracy. The uncertainty about future development is important not only for determining future trip tables but also for determining future

accessibility to important locations. Several MPOs compare access to critical nonwork locations, such as schools and health care facilities, by protected and unprotected classes. As residential and commercial developments sprawl, so do schools and hospitals. However, without more information, the locations of these facilities are assumed to remain unchanged in the future. Increased cooperation between transportation and land use planners and school and hospital administrators could reduce the level of surprise at new developments. Even current year data can be difficult to work with in some cases because not all health care facilities accept low-income people, not every job is suited for every person, and not all children can attend their neighborhood school.

Trip Tables

Accurate trip tables are important for the many EJ performance measures related to accessibility, as they can be used to compare travel times to employment and other critical locations. [A comprehensive overview of such measures has been presented previously (*17*).] If trip tables were available by minority and income classes, much more could be done to measure accessibility. Segmented trip tables would allow the analysis of selected links to determine how many people from each class will benefit from a particular roadway or transit project. Without this, accessibility measures must assume that the percentage of trips between each origin–destination pair made by a specific class is equal to the percentage of residents at the origin that are a member of the class. This assumption is rather arbitrary and could be improved by the use of information from household survey data.

A second issue with future-year trip tables related to EJ is the potential to reinforce existing inequities. According to Deka, "if workers who live in predominantly low-income and minority areas have short commutes at present, computer models will predict a short commute for them in the future as well, regardless of their true commuting needs" (*18*). This observation implies that network improvements may be based on the paths where people currently are traveling, not on the paths where they would like to travel. By making it easier for them to travel on their current path, they are being helped with continuing the status quo rather than helped with getting where they would like to go. This concern is much greater with gravity-based models than with models that use destination choice.

Network Performance

Measures of network performance based on the results from a travel model are limited mostly to expected volumes, delays, and travel times. As models are calibrated to expected conditions, the model results, including EJ-related performance measures, are approximates of the expected performance. Unfortunately, this process leaves out one important measure of performance: reliability. Performance measures that capture the reliability of travel times would aid not only EJ analysis but also other transportation analyses. The resulting performance measures may be misleading if average measures are used because two groups may have the same average time, but one group's access may vary much more from day to day. Data collected from intelligent transportation systems can aid with the collection of the large amounts of data required to obtain an accurate representation of current reliability. Future reliability may be more difficult to discern, but as research is conducted on trends that have led to the current levels of reliability, the ability to predict future levels of reliability will be improved.

Cost Estimates of Improvements

As will be discussed in the following section, EJ can be defined in terms of the impacts (i.e., travel time changes) on each population or in terms of the funding spent on improving conditions for each population. To estimate equity in funding, accurate cost estimates must be obtained for each improvement specified in the long-range plan. The difficulties with this method are the assumptions made for inflation rates and the costs of construction in future years. Also, the MTP may specify categories of spending instead of specific projects, making the benefit to each population group impossible to discern.

State-of-the-art travel models that rely on microsimulation to track activity patterns promise to alleviate some of these data issues. Household survey data could perhaps be used more extensively to synthesize trip tables and the behavior specific to each population group. There is, however, the danger that such tools will improve the precision of the results without improving the accuracy. The following section describes the various ways in which equity may be defined in the context of EJ.

EQUITY

This section reviews several definitions of equity presented in the literature, three main applications of equity in long-range planning, and multiple methods for approaching the time frame and scope of analysis. The purpose of this section is to stress that the calculation of performance measures is a futile effort unless it is certain what type of equity is achieved, because after the calculations are complete, there will be numbers that cannot provide a sense of whether or not an injustice has occurred.

Defining Equity

Reaching an agreement as to which type of equity should be applied in an EJ analysis is not easy, and all of the options should be weighed. More definitions of equity than can be concisely presented here can be found in the literature. Four types of equity most applicable to transportation planning are presented and are referred to here as "opportunity," "equality," "market based," and "basic needs." FHWA does not provide clear guidance on how to define equity, so the decision is left up to the MPOs.

Opportunity

Equity of opportunity is most often defined as each person or group having equal access to the planning process and having their opinions taken into account in an equal manner. The first step that many MPOs take toward fulfilling the EJ requirements is outreach to the traditionally underserved populations. Outreach can take several forms, including hosting public meetings in protected areas at times of day convenient for working people, ensuring easy access to the meeting by nonautomobile modes of travel, and providing translators for people who are not fluent in English.

Equality

Equality—which is typically thought of as a synonym for equity—entails the comparison of performance measures with the goal of

providing equal benefits for each population. Within the context of equality, one can consider equal benefits in a future year or an equal change in benefits over time. As the needs and desires of people differ, equity in benefits may be achieved even if the actual benefits received by each group are different. Equality can also be considered in terms of the allocation of funding.

Market Based

Market-based equity means "you get what you pay for." Several studies have evaluated how well market-based equity is achieved in transportation financing (*11*, *12*) by comparing how much a group pays in taxes and fees with the resources and benefits that it receives. Taylor (*19*) also refers to this as market equity; Litman (*20*), Khisty (*21*), and Lee (*22*) refer to this as horizontal equity.

Basic Needs

Meeting basic needs is a compromise between the first two types of equity. First, the basic needs of each person are met, and then any remaining resources and benefits are distributed according to market equity. Khisty describes it best as "bread for all, before butter for some" (*21*).

Challenge of Defining Equity

Deciding which type of equity to strive for does not, by itself, make the selection of plans or projects among alternatives straightforward. If Plan A offers each of two groups $10 in benefits and Plan B offers the first group $10 and the second group $15, should Plan A be chosen on the grounds of equity? Khisty uses a small network to demonstrate how the optimal network improvements differ depending on the type of equity considered (*21*).

The guidance from FHWA on the distribution of funding and its impacts is conflicting. A memorandum issued in January 2000 states that one of the three basic principles of EJ is to "assure low-income and minority groups receive proportionate share of benefits" (*23*). However, the current FHWA policy, as stated on its website (*24*), is that beyond the requirement to mitigate disparate impacts, "there is no presumed distribution of resources to sustain compliance with the environmental justice provisions."

Applications of Equity

Equity determinations are threefold, examining first the equity in public participation, then the equity in funding, and lastly the equity in impacts. Because the focus of this paper is on technical methods, this section looks primarily at equity in funding and equity in impacts. Giving each population group equal access to the planning process is extremely important; however, unlike funding and impacts, it is not easily measured by quantitative tools. First, it should be noted that equitable funding does not imply equitable impacts. For example, Group A and Group B could be allocated equal funds, but if Group A decides to use its funds to run a highway through the center of Group B's community, the resulting impacts will likely be inequitable.

The distribution of impacts and funding into the future is difficult to measure because MTPs cannot, because of their long time frame, specify projects in great detail. Much of the money allocated in MTPs goes toward programs that act as funding mechanisms for projects that will be specified at a later date. Some entries in the MTP, such as capacity improvements on a corridor, may contain more detail than other entries, such as a program for funding intelligent transportation systems. Until the projects are selected, there is no accurate way of evaluating the impact that will be felt by each population. Any calculation of program benefits that occurs before the projects are selected will be a rough regional estimate and will be unsuited for a group-level analysis. It is similarly difficult to determine years in advance the distribution of funding among population groups, as it is not specified as such in the plan.

Although future funding can be estimated, the exact amount of money available for a particular MTP is also not known with certainty. Revenue from fuel taxes depends on vehicle usage and efficiency, and political pressures exist to keep them from rising with inflation. Toll roads may bring in another source of revenue, albeit an uncertain source, as their popularity increases. Private investment in toll roads is an increasingly enticing option for regions in need of upfront money for new projects. Money available for transit depends not only on fares but also on the political climate and public sentiment. Despite all the funding uncertainty, however, if the planned funding is distributed equitably and the removed or additional funding is removed or added equitably, then the final funding distribution should be equitable.

Static Versus Changing Time Frames

Perhaps the most controversial aspect of impact evaluation is the time frame considered. Impacts can be assessed in the future year or through the change in impacts from the base year to the future year. At the core of this debate is whether or not EJ should redress past injustices. For example, if the MTP improves travel times for Groups A and B by 10 min each, but Group A's base year travel time is 30 min longer than Group B's, is the MTP equitable? Most MPOs, by focusing on the change in measures during the planning period, would say "yes," claiming that as long as their current and future actions affect each group proportionately, they are within the federal guidelines. Although MPOs may be within their legal limits to evaluate impacts in this way, as long as disparities exist in transportation benefits and costs, sectors of the population will continue to believe that the system is not just. Equating future-year performance measures, however, has its problems, too. One issue with using future-year travel times as a performance measure is that some populations, particularly those with higher incomes, may choose a longer commute in return for other benefits, such as a larger house or better schools. It is unreasonable to try to equate such a population's long commute time with the commute time of a lower-income population that lives in close proximity to its destinations.

Scope of Analysis

As stated above, the purpose of considering EJ in the MTP is to ensure that no group is disproportionately adversely affected. Before an MPO can determine whether or not the plan is equitable, a decision must be made as to whether each performance measure is going to be looked at individually or whether a holistic view will be taken in the analysis. Most practitioners and researchers would argue that the point of analyzing EJ in the MTP is so that the system can be evaluated as a whole; the total benefits, costs, and funding should

be compared across groups. Despite this apparent consensus, it is not uncommon for an EJ analysis to present many types of performance measures without concluding whether or not a group is disproportionately adversely affected. This issue is more one of impact equity than funding equity, as combining monetary units is simpler and requires fewer value judgments than combining various impact measures.

The difficulty in creating a system-level EJ determination is in how to combine the individual performance measure results. A survey of the population could tell the analyst which performance measures are the most important and allow the creation of a generalized utility term. One could make the problem even more difficult by allowing each sector of the population to have a different set of preferences. If each group is assumed to have the same transportation needs, then the evaluation of disparate impacts within programs or single performance measures is appropriate. If the needs of each group are different, however, a system-level analysis is the only way to determine EJ results. To find out the needs of the EJ populations, some MPOs have formed task forces composed of representatives from each group. Other MPOs, fearing that an EJ task force will slow the planning process without being truly representative of the traditionally underserved groups, have increased their public outreach efforts.

Once the needs of each group are defined, the trick is to evaluate equity in terms of how well each group's needs are met. If Group A is primarily concerned with pedestrian access to destinations and Group B cares about automobile commute times, an equity analysis would measure how well Group A's need for better sidewalk connectivity is being met compared with how well Group B's desire for increased freeway capacity is being fulfilled. This example also illustrates a case in which impact equity will lead to funding inequity, because sidewalk connectivity is cheaper to provide than roadway capacity. Although a system-level equity analysis requires more thought and public input than evaluation of program-level or performance-measure disparities, it is much more intuitive and has the added benefit of ensuring that the transportation services provided are actually meeting the needs of the public.

Funding Equity at Federal and State Levels

This paper focuses on equity related to EJ in long-range planning; however, the topic of equity brings much debate in other areas of transportation. Most notable is the discussion of equity in the distribution of federal funds to states. When states argue that they are not getting their fair share of funds, they are usually implying that they are the subjects of market inequity. Currently, the allocation of federal funds from the Highway Trust Fund ensures a pseudo–market equity in which each state receives at least a 90.5% rate of return on the basis of its tax receipt contribution (*11*).

The distribution of funding within states has also caused controversy. In recent years the Denver Regional Council of Governments has worked with the State of Colorado to remedy a market inequity in which the Denver metropolitan area was receiving $0.54 in funding for every $1 that it contributed (*25*). Washington State created a statewide Transportation Improvement Account to funnel gas tax revenue to urban areas after it was discovered that Seattle raised 51% of the state's revenues and received only 39% in return (*11*). Tennessee, Arkansas, Ohio, and Alabama distribute portions of their transportation funds evenly to each county in the state, regardless of the population and the need (*11*). It is argued that this type of geographic equity facilitates sprawl because of the spending of proportionally more money in rural areas.

UNIT OF ANALYSIS

EJ compliance determinations can be made by use of one of the following units of analysis: individual, group, or geographic. The unit of analysis is the basis for the comparison of performance measures. Most equity analyses for applications other than EJ use the individual unit of analysis. For example, Levinson (*26*) uses the Gini coefficient to measure the equity of ramp metering, and Connors et al. (*27*) seek toll rates that maximize the Theil entropy index used to measure social welfare. In theory, EJ uses the group unit of analysis and compares the impacts across groups defined by race, ethnicity, and income. Because adequate data at the group level (i.e., trip tables disaggregated by group) are rarely available, most EJ analyses are done by the use of geographic units. There are, however, several problems with this approach.

A traffic survey zone is defined as protected or unprotected on the basis of its percentage of minority or low-income residents. Such a classification accounts for neither the number of residents in a zone nor the size of the zone. This means that Zone A is protected if it has only one resident and this person's income is below the poverty line, but an adjacent Zone B with 10 low-income residents and 90 high-income residents will be unprotected if the threshold for classifying a zone as "low-income protected" is greater than 10%. This arbitrary distinction could be interpreted to mean that the one person in Zone A is somehow valued more than the 10 low-income residents in Zone B. If the zonal boundaries change, perhaps neither zone would be protected. Also, the classification of a zone as protected or unprotected may change depending on how the groups are defined. For example, a racially and ethnically diverse zone may be protected under a "minority" designation but unprotected if separate designations are used for each racial and ethnic class.

Use of the geographic unit as a proxy for the group unit does not work well for groups that do not congregate spatially. Although members of some minority groups may tend to reside in geographic proximity to one another, members of other minority groups may be more dispersed. This problem is especially evident when groups such as disabled and elderly populations are considered. Each zone may have an approximately equal percentage of members of a spatially distributed group, making determination of protected and unprotected zones arbitrary.

CONCLUSION

Three challenges faced by EJ analyses in transportation planning are discussed in this paper. Data needs are identified, definitions and applications of equity are offered, and technical issues associated with the unit of analysis are presented. The increased use of household travel survey data, activity-based models, and microsimulation may alleviate some of the data needs. Before starting an EJ analysis, an MPO must decide what type of equity it is trying to achieve and how it will treat the potentially different needs of its population groups. The choice between group and geographic unit must be made carefully, as each has advantages and pitfalls.

As transportation planners explore new types of projects and new sources of funding, equity analyses will become more complex. For example, it is becoming more common for metropolitan planning agencies to devote funding to land use improvements with the goal of reducing automobile use or efficiently using the existing transportation network. The impact of land use improvements, such as transit-oriented development, on various sectors of the population has not yet been studied extensively. The equitable distribution of these projects

across a region does not ensure equitable impacts, as low-income populations may be "priced out" if gentrification occurs.

The increasing popularity of toll roads, managed lanes, and comprehensive development agreements with private developers poses new challenges for equity analyses. The distinction between public and private goods in transportation has always been blurry, as people must purchase the appropriate equipment (i.e., an automobile, bicycle, or shoes) to use most modes of travel and the marginal impact of each person on most systems is not constant (*20*). MPOs, with the assistance of the public and stakeholders, must make difficult decisions on how to meet the transportation needs of their regions without limiting access and benefits for specific groups.

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