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Socioeconomic Impact Monitoring Systems: A Review and Evaluation

F. Larry Leistritz and Robert A. Chase

Department of Agricultural Economics, North Dakota State University, Fargo, North Dakota 58105, *U.S.A.*

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The growing recognition that monitoring systems hold a pivotal position in the socioeconomic impact management process is based on the need for accurate and timely information regarding key project parameters (e.g. work-force levels and characteristics) and principal community indicators. In addition, monitoring systems have been used to identify emerging problems and update impact assessments. Criteria for evaluating the relative strengths of alternative monitoring systems are presented, with particular attention to data collection techniques, procedures for reformulating impact projections, and reporting formats. These criteria are further used in a review of the design characteristics and operational procedures of several monitoring systems. Based on this evaluation of existing systems, an effective monitoring system should contain three essential components: work force information, community impact information, and reassessment capability. A concluding section on the state-of-the-art indicates a need for closer integration of monitoring with the assessment and mitigation phases of impact management.

Keywords: socioeconomic, impacts, socioeconomic impact management, monitoring, anticipatory assessments, impact mitigation.

1. Introduction

Recent reviews of the state-of-the-art in environmental assessment methods indicate the need for a greater emphasis on monitoring environmental change, both during the period of project development and after completion (Hollick, 1981; Bisset, 1980; Marcus, 1979). In particular, Hollick (1981) discusses the substantial level of uncertainty associated with making environmental predictions and, hence, the need for greater emphasis on monitoring as a basis for evaluating the adequacy of environmental control measures. Information obtained from such monitoring efforts can not only enhance the environmental management of the existing project, but may also help to improve future impact studies.

This need to incorporate monitoring systems as an integral part of the impact

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assessment and management process is particularly great with respect to the economic, demographic and social effects of large-scale resource development projects. These effects, often termed *socioeconomic* impacts (Murdock and Leistritz, 1980), are a subject of growing concern to managers and decision-makers in both public and private sectors (Albrecht, 1978; Watson, 1977). Increasingly, stringent regulatory requirements at the federal, state and local levels have made detailed socioeconomic impact assessments and impact mitigation plans mandatory for many types of projects (Gilmore *et al.*, 1981; Leistritz and Murdock, 1981). However, the management of these large-scale resource developments is often complicated by such uncertainties as project timetable, labor-force requirements, worker demographic characteristics, and labor-force settlement patterns, with the result that anticipatory impact assessments provide a rather imperfect guide to project management (Gilmore, 1980).

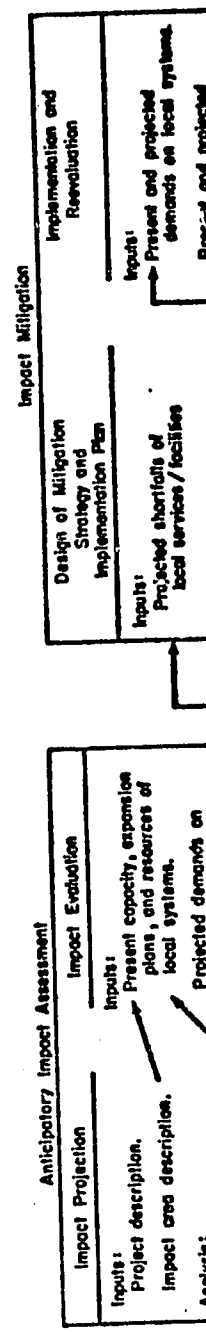
In response to this need for impact management programs developed from accurate information, several socioeconomic impact monitoring systems have been implemented, which provide for the periodic review of changes in economic and social indicators as they actually occur. The incorporation of monitoring within the impact management process has provided a basis for evaluating initial (or anticipatory) impact projections and modifying mitigation plans as appropriate in the light of changing conditions. Impact monitoring systems differ substantially, however, in the indicators evaluated, the mechanisms for, and frequency of, data collection, the selection of communities to be monitored, and the frequency of reporting, as well as in other respects. The relative advantages of various monitoring system features, however, are often difficult to discern. As a result, some environmental managers may be reluctant to support the design and implementation of such systems, despite their obvious advantages, because they have no means for evaluating the relative merits of alternative systems. As a consequence, a valuable source of information may not be utilized in the impact management process.

The purpose of this paper is to present criteria that may be employed in evaluating the relative strengths of alternative socioeconomic monitoring systems and to evaluate a number of such systems in terms of these criteria. The remainder of this paper is organized into five major sections. First, the role of the monitoring system within the overall socioeconomic impact management process is examined. Second, specific system evaluation criteria are specified and discussed. Third, a number of monitoring systems implemented in recent years are compared in terms of these criteria. Fourth, the adequacy of existing monitoring systems for meeting the needs of impact management is evaluated, and those areas where additional refinement appears necessary are identified. Finally, conclusions concerning the state-of-the-art in socioeconomic impact monitoring are presented.

2. Role of Monitoring within Socioeconomic Impact Management

The primary purpose of a monitoring system is to provide accurate and timely socioeconomic information for decision-makers involved in both impact assessment and/or mitigation activities. These efforts of monitoring, assessment, and mitigation are the integral components within an impact management framework (see Figure 1). The basic intent of this comprehensive system is to analyze and evaluate the potential and actual socioeconomic impacts, as well as the development of specific strategies and measures, and to ensure that benefits associated with large-scale resource projects are realized (and even accentuated), while adverse effects are alleviated.

Initial guidance for impact management efforts is provided by the anticipatory im-



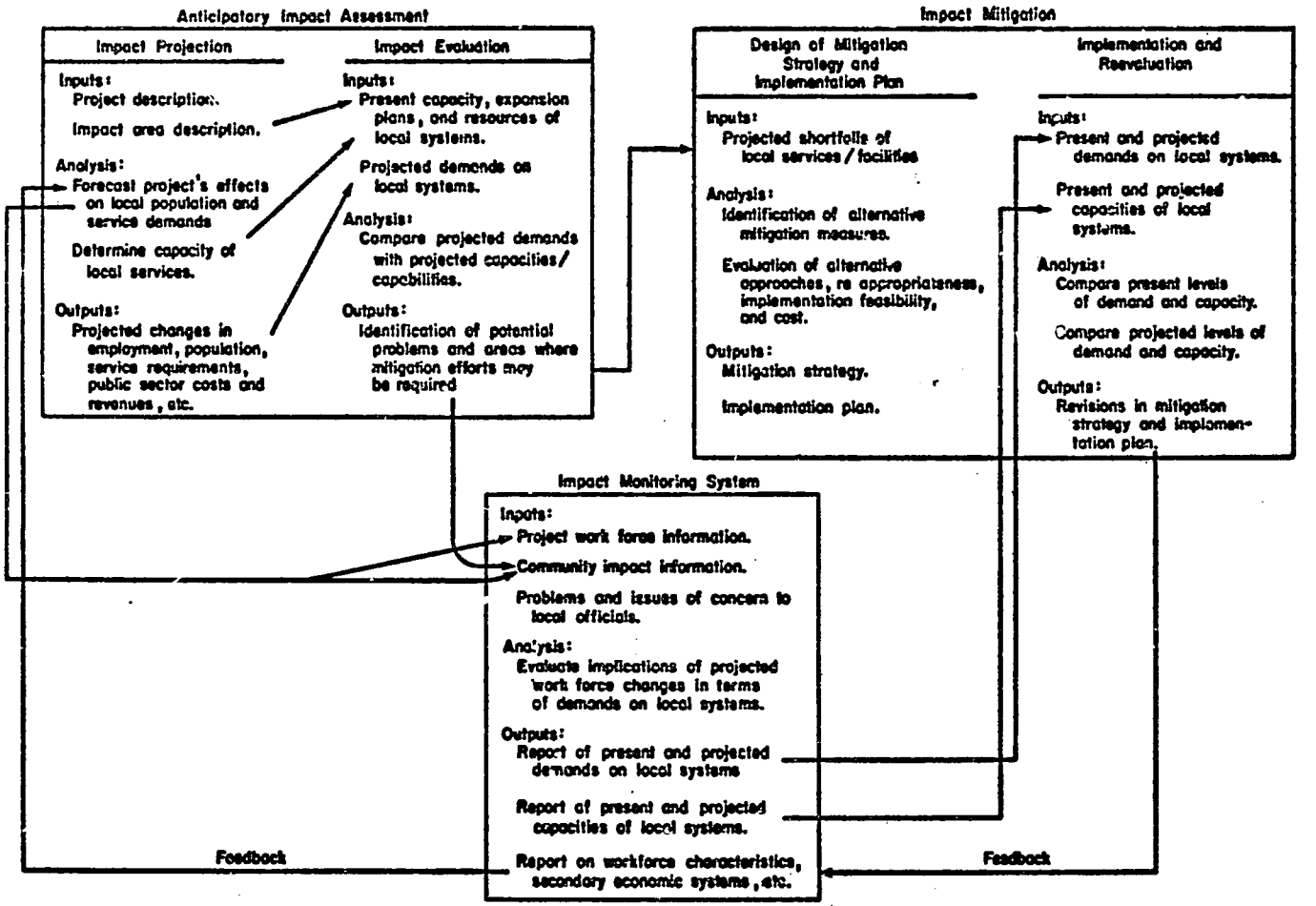


Figure 1. The role of an impact monitoring system in socioeconomic impact management.

pact assessment component. The information obtained from these socioeconomic impact assessments is further used to identify potential problems and to formulate the appropriate mitigative strategies in advance. However, because of the nature of such anticipatory assessments (i.e. often prepared several months before actual project construction), these estimates of economic and social changes offer only a general guide for impact management. In fact, the reliability of these initial estimates may be seriously questioned, with subsequent changes in the project construction schedule and work force requirements (Braid, 1980). Further, difficulties in forecasting accurately such key impact parameters as worker settlement-commuting patterns have resulted in unrealistic projections (Gilmore *et al.*, 1981). Mitigation strategies based upon such unrealistic impact assessments are rather unlikely to be successful. The inclusion of monitoring within such an impact management framework removes many of these inherent deficiencies by providing project officials and community leaders with up-to-date information with which to reassess periodically community needs and to revise associated mitigation plans.

In addition to providing information on current demands and capacities of local services and facilities, the monitoring system serves as the basis for developing revised impact projections. In fact, substantial interdependencies exist between the anticipatory assessment and monitoring phases of the impact management process. For instance, the anticipatory assessment suggests which communities are likely to experience significant economic and social changes as a result of project development. These estimates will influence data collection priorities during the initial phases of monitoring. In turn, subsequent revisions in the anticipatory assessment may prove necessary, based on information from the monitoring system. Similarly, if the assessment methods used in the anticipatory analysis are also employed for subsequent updates (as is generally the case), the nature and form of data collection during the monitoring phase will be influenced by the requirements of the particular assessment techniques used. Finally, the monitoring system can serve as a valuable source of information for anticipatory impact assessments for future projects (Wright, 1977; Fookes, 1977).

Thus, at any given time, the monitoring system allows policy personnel to evaluate the effectiveness of impact management activities to date, while providing them with information necessary for future mitigation efforts. This iterative process of impact evaluation and reassessment continues throughout the project development period.

3. Criteria for Evaluation

Although the needs, and thus the criteria, for design and evaluation of socioeconomic impact monitoring systems are likely to vary for particular circumstances and decision-makers, several general considerations must influence system design and evaluation in virtually all circumstances. These criteria should include consideration of: (1) data collection scope and procedures, (2) procedures for reformulating (updating) impact projections, and (3) reporting procedures and formats.

3.1. DATA COLLECTION SCOPE AND PROCEDURES

A socioeconomic impact monitoring system is essentially a standardized process for the periodic collection and analysis of data reflecting key indicators of economic and social change. Generally, the indicators monitored should correspond to those for which projections were made in the anticipatory impact assessment. The indicators included in a monitoring system are generally categorized as: (1) those reflecting project characteristics and (2) those reflecting changes in the communities affected by the project. Key

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project characteristics generally considered for inclusion in a monitoring system include the number of workers, worker characteristics (e.g. local vs non-local origin, place of residence, number and ages of dependents, etc.), and percentage of project completion. Community characteristics generally included in monitoring efforts are those indicators of the demands placed on local facilities and services and of the capacity of local systems. Examples of such indicators include population, school enrollments, housing units available or under construction, capacity of sewer and water systems, capacity (space and personnel) of local schools, law enforcement activity (number of calls and arrests) and capacity (staff and equipment), and revenues and expenditures of local governments. Selecting indicators that accurately reflect key impact dimensions, and which, at the same time, can be monitored readily, is a major task in designing a monitoring system.

The choice of specific indicators to be monitored can be difficult, as a wide range of variables are relevant to various aspects of impact assessment and mitigation. Further, the variables ultimately selected can be expected to differ somewhat between projects because of differences in the nature of expected impacts (e.g. worker relocation vs commuting), as well as differences in various areas' experiences with past projects. In determining which variables to include, it is important to remember that the primary purpose of the system is to provide current information that will be useful in guiding impact mitigation decisions. The types of data collected should be closely linked to expected impacts and priority issues. A monitoring system cannot be "all things to all people". An overly inclusive approach to system design may result in excessive costs for data collection and processing, frustration on the part of community and company officials who are expected to supply the data, and "information overload" for the decision-makers who are the clientele of the monitoring effort. A major goal in designing a monitoring system, then, must be to arrive at a relatively small set of impact indicators that both company and community representatives consider important.

While selectivity must be a key consideration in choosing variables to be included, however, the system must be sufficiently comprehensive to achieve its purposes. Thus, if monitored information is to be used in developing updated impact projections, data collection activities must include measurement of key impact parameters which will be required as inputs to the impact projection model (e.g. data concerning projected work force levels, rate of local hiring, worker family size, and residential patterns). Similarly, if local officials are to use data from the monitoring system as justification for grant applications, the system must be designed with this intention in mind. Trade-offs are thus inherent in determining variables to be included.

Another major system design decision with obvious trade-offs relates to the frequency of monitoring. Frequent monitoring is desirable as it offers rapid feedback regarding changing conditions and emerging problems to both company and community decision-makers. These officials, in turn, have the opportunity to respond rapidly in adjusting their impact management planning. The more frequent the monitoring, however, the higher the costs. Selection of communities to be monitored involves trade-offs similar to those associated with determining the frequency of monitoring. While it is desirable to collect information for all communities that may experience significant impacts, monitoring costs obviously increase with additional communities monitored.

Mechanisms for data collection also require careful consideration. Generally, the greater the degree to which the system can rely on information produced through the standard record keeping/reporting processes of the developer's organization, local governments, and state agencies, the less will be the overall cost of the monitoring effort. In some cases, however, existing data sources are not adequate to provide information in

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the required form or with sufficient speed to meet the needs of impact management. In these cases, special data collection efforts will be required.

Determining data collection and analysis procedures involves decisions concerning the forms of data collection instruments required, the most appropriate analytical procedures, and the most efficacious allocation of responsibilities among participating organizations. Such decisions will often require considerable input from social scientists. While many of the considerations involved are in fact quite technical and require concerted attention from individuals with appropriate disciplinary backgrounds and impact assessment/management experience, it is important that company and community decision-makers are also involved in these determinations. The choice of data collection procedures will have a substantial influence on the types of information the system can provide, the frequency with which it can be provided, the validity of the resulting estimates, and the cost of the overall monitoring effort. Decision-makers must be made aware of these implications.

Determining organizational responsibilities for various aspects of the monitoring effort also involves important decisions. In some cases, new organizations may be needed. For example, when a substantial number of jurisdictions are expected to be affected by a project, there may be a need for a local entity to co-ordinate impact monitoring and management activities. When a number of projects are expected to affect the same area concurrently, an inter-industry group or similar entity may be desirable to co-ordinate the impact monitoring and management efforts of the developers. Determining the overall implications of changing construction schedules and other factors when multiple projects have overlapping impact areas may require information and technical impact assessment capabilities which no individual developer or jurisdiction alone possesses. An area Council of Governments or state agency may be an appropriate entity to provide comprehensive regional impact assessments and updates in such cases; or an inter-industry group might perform the same function. While the most appropriate division of responsibilities among participating parties may differ greatly, depending on the nature of the local situation, a general consideration to keep in mind is that the responsibilities assigned to a given organization should be commensurate with that entity's resources (informational, technical, and financial).

3.2. PROCEDURES FOR UPDATING IMPACT PROJECTIONS

A second general requirement for an adequate monitoring program is the capability to utilize monitored information for updating impact projections. As noted earlier, a number of factors can cause actual impacts to differ substantially from those projected. In particular, if the project's work force requirements, worker characteristics, or indirect employment effects differ significantly from those assumed in the anticipatory assessment, the actual magnitude, timing, and distribution of impacts may be quite different from those projected (Gilmore *et al.*, 1981; Coon *et al.*, 1976). The monitoring system should, therefore, include an impact projection capability as an integral component. The system should be designed to detect rapidly departures of project schedules, work-force levels, worker characteristics, and other key impact parameters from assumed levels, and to reflect these changes in revised projections. Thus, it is important to view impact assessment techniques not merely as mechanisms for developing one-time anticipatory projections, but rather as impact management tools to be used throughout the project development process (Leistritz and Murdock, 1981).

Several factors, which go beyond the intrinsic merits of alternative modeling techniques, must be considered in choosing an impact projection procedure for updating a

monitoring system. In particular, the frequency at which updated projections may be required and the number of jurisdictions for which projections must be developed are critical considerations in designing this component of a monitoring system. If revised projections are likely to be required infrequently (e.g. at intervals of several years) and for only a few jurisdictions, a manual or semi-automated system may be most desirable. On the other hand, if updates may be required frequently and for a number of jurisdictions, development or adaptation of a computerized impact assessment model, while requiring a significant initial investment, may prove to be quite cost-effective when considered over the entire monitoring period (Leistritz and Murdock, 1981). In any case, a major criterion for selecting or designing the impact reassessment component of a monitoring system must be the capability of the proposed assessment approach to provide projections at the necessary levels of temporal and jurisdictional detail.

3.3. REPORTING PROCEDURES AND FORMATS

A final and very important dimension to be considered in designing and evaluating monitoring systems concerns the nature of reporting results. If a monitoring system is to provide an effective input into the impact management process, data and analyses must be translated into a series of concise, decision-oriented reports. While the needs of decision-makers, and hence the most appropriate reporting format, may vary, several considerations should be kept in mind in designing and/or evaluating reporting procedures. First, information should be reported in a form reflecting changes at the level of individual jurisdictions whenever possible. It is important, for example, that the reporting of project work force levels and characteristics include information on the place of residence for workers. Second, information should be reported in a format facilitating comparisons of present and projected service demands with existing and projected facility capacity. Differences between observed and predicted changes in both demands and capacities should be highlighted. Finally, the monitoring system should be designed to be compatible with the existing administrative procedures of the affected entities whenever possible. For example, the utility of the monitoring program to local officials will be enhanced if the system provides information usable in state and federal grant applications.

4. System Comparison

In this section, several monitoring systems implemented in recent years are compared in terms of the criteria noted above. The systems evaluated include:

(1) Alberta Oil Sands, Fort McMurray, Alberta, Canada (Fort McMurray Planning Team, 1980*a*,*b*)
(2) Cathedral Bluffs Shale Oil Project, Rio Blanco County, Colorado (Pace Quality Development Associates, Inc., 1980*a*,*b*)
(3) Chief Joseph Dam, Douglas County, Washington (Harnisch *et al.*, 1980)
(4) Coal Creek Power Plant, McLean County, North Dakota (Toman *et al.*, 1976; Wieland and Leistritz, 1978; Denver Research Institute, 1979)
(5) Hartsville Nuclear Power Plants, Hartsville, Tennessee (Tennessee Valley Authority, 1978, 1980)
(6) Huntly Social and Economic Impact Monitoring Project, Huntly Borough, New Zealand (Fookes, 1977, 1980; Vautier, 1977)
(7) Mercer County Energy Projects, North Dakota (Zainhofsky and Pearson, 1981)

TABLE 1. Comparison of operational socioeconomic monitoring systems

Item	Alberta oil sands	Cathedral Bluffs shale oil project	Systems Chief Joseph dam	Coal creek power plant	Hartsville nuclear power plant
Dates operational:	1977 to present	1978 to present	1974 to present	1975–1979	1976 to present
Auspices for monitoring:	Initiated by local government	Initiated by developer	Initiated by developer	Initiated by developer	Nuclear regulatory commission (condition for construction licensing)
Entity responsible for data collection and analysis	Local planning personnel	Developer (by contract with consulting firm)	Developer (U.S. Army Corps of Engineers)	Developer in cooperation with North Dakota State University, ND-REAP and University of Wyoming	Developer (Tennessee Valley Authority)
Indicators monitored:					
1. Work force information					
(a) Present work force	NA	×	×	×	×
(b) Projected work force	NA	×	×	×	×
(c) Worker characteristics	NA	×	×	×	×
—migrant status		×	×	×	×
—place of residence		×	×	×	×
—type of housing		×	×	×	×
—marital status and number/age of dependents		×	×	×	×
—housing preference		×	×	×	×
—housing costs		×			×
—public service satisfaction		×			
(d) Mechanism for work force data collection	NA	Entry survey	Periodic surveys	One-time survey	Semi-annual survey
2. Community impact information					
(a) Housing	×	×	×	×	×
(b) Public safety		×	×	×	
(c) Health care					

(d) Education (schools)		×	×	×	×
(e) Employment, labor force, unemployment	×	×		×	×
(f) Retail sales		×	×	×	
(g) Bank deposits/loans		×	×		
(h) Personal income		×			
(i) Population	×	×	×	×	
(j) Assessed valuation				×	
(k) Other services			×		×
(l) Public finance			×	×	×
(m) Traffic			×		×
(n) Service satisfaction					
(o) Mitigation expenditures				×	×
Number of jurisdictions monitored	1 city	2 counties: 2 cities	2 cities	1 county: 2 cities	5 counties: 7 cities
Frequency of data collection	Annual	Semi-annual (some annual)	1 major study for peak impact period	Annual	Semi-annual
Forecasting reassessment capability:					
Included in system	No	No	Yes	Yes	No
Variables	NA	NA	Work force Population School enrollment	Work force Secondary employment Population School enrollment Housing requirements Service requirements Net fiscal balance	NA
Reporting: Report frequency	Annual census report Quarterly housing reports	Quarterly work force reports Semi-annual community facilities reports	Four reports were issued during period 1974–1978	Four reports and numerous unpublished projection updates during the period	Semi-annual

TABLE 1. Comparison of operational socioeconomic monitoring systems—*continued*

Item	Huntly power project	Mercer county energy projects	Systems Missouri Basin power project	Susquehanna power plant	Washington nuclear project
Dates operational:	1975 to present	1978 to present	1976 to present	1975 to present	1977 to present
Auspices for monitoring:	Initiated by national government	North Dakota Public Service Commission	Wyoming Industrial Siting Council	Initiated by developer	Washington Energy Facility Site Evaluation Council
Entity responsible for data collection and analysis	University of Waikato Social Science School	Developer (ITAT), local planning body (EDB), and state research agency (REAP)	Developer	Developer	Developer (contracts with regional planning bodies)
Indicators monitored:					
1. Work force information					
(a) Present work force	×	×	×	×	×
(b) Projected work force		×	×		×
(c) Worker characteristics		×	×	×	×
—migrant status	×	×	×	×	×
—place of residence	×	×	×	×	×
—type of housing	×		×	×	×
—marital status and number/age of dependents	×	×	×	×	×
—housing preference					
—housing costs	×			×	
—public service satisfaction					
(d) Mechanism for work force data collection	Annual survey/periodic survey	Entry survey	Entry survey	One-time survey (1975–1978)	Entry survey
2. Community impact information					
(a) Housing	×	Not specified	×	×	×
(b) Public safety	×		×	×	×
(c) Health care	×		×	×	×
(d) Education (schools)	×		×	×	×
(e) Employment, labor force, unemployment	×		×		
(f) Retail sales	×				×
(g) Bank deposits/loans					×
(h) Personal income	×				×
(i) Population	×			×	×
(j) Assessed valuation	×		×	×	×
(k) Other services	×		×		×
(l) Public finance	×		×	×	
(m) Traffic	×		×	×	
(n) Service satisfaction	×				
(o) Mitigation expenditures				3 counties	5 counties

(e) Employment, labor force, unemployment	×		×	×	×
(f) Retail sales	×				
(g) Bank deposits/loans					×
(h) Personal income	×				×
(i) Population	×				×
(j) Assessed valuation	×			×	×
(k) Other services	×		×		×
(l) Public finance	×		×	×	×
(m) Traffic	×		×		×
(n) Service satisfaction	×		×	×	×
(o) Mitigation expenditures			×	×	
Number of jurisdictions monitored	1 borough 7 subdistricts	1 county: 6 cities	1 county: 5 cities	3 counties: 3 cities	5 counties
Frequency of data collection	Annual	Not specified	Monthly and quarterly	Annual	Annual (some quarterly)
Forecasting reassessment capability:					
Included in system	No	Yes	Yes	No	No
Variables	NA	Work force Secondary employment Population School enrollment Housing requirements Service requirements Net fiscal balance	Work force School enrollment	NA	NA
Reporting:					
Report frequency	Annual	Monthly work force reports Revised projections as required by change in construction schedule	Monthly (work force, population, housing and school enrollment) Quarterly (work force) and community indicators)	Two reports (1976 and 1978)	Quarterly

NA—Not Applicable.

(8) Missouri Basin Power Project, Platte County, Wyoming (Missouri Basin Power Project, 1977, 1980)
(9) Susquehanna Power Plant, Luzerne County, Pennsylvania (Pennsylvania Power and Light Company, 1976, 1978)
(10) Washington Nuclear Project, Grays Harbor County, Washington (Washington Public Power Supply System, 1980).

Although several other monitoring systems have been implemented recently (TOSCO Foundation, 1981; Baril, 1981; Schmueser and Associates, 1981) and several other systems have been proposed for use in connection with large-scale projects (Peelle *et al.*, 1979; Braid and Kyles, 1977), the systems evaluated here include most of those for which significant operational experience has been gained.

A comparison of these systems is presented in Table 1, which reveals both similarities and significant contrasts among these systems. All but four of the systems were initiated between 1975 and 1977, and all but one are still in operation. Four of the monitoring programs were initiated voluntarily by project developers (i.e. Cathedral Bluffs, Chief Joseph, Coal Creek, and Susquehanna), while four were required by regulatory authorities as a condition for project licensing/permitting. In all but two instances, the developer was responsible for data collection and analysis, but local planning bodies or state agencies sometimes participated in these activities through contracts or co-operative agreements with the developer (e.g. Mercer County Projects, Washington Nuclear Project).

Information concerning work force characteristics is included in all but one of the systems (i.e. Alberta Oil Sands). Worker characteristics monitored are quite similar among systems, with information on present and projected work force levels, migrant status (local/non-local), place of residence, and demographic characteristics being included in virtually all systems. Mechanisms for worker data collection differ between systems, with both entry surveys and periodic surveys being used extensively.

Some community impact indicators are included in all the systems reviewed. Variables measuring effects on schools, housing, public safety, and health care are included most frequently. Data collection is usually conducted annually with some key services being monitored semi-annually and occasionally more frequently. All systems make use of data from annual reports of national, state, and local agencies with additional data collection undertaken principally in cases where existing reports are deemed inadequate either in frequency or detail of information provided. The number of jurisdictions monitored differs substantially between systems, the primary criterion apparently being to include those units which may experience significant impacts.

Five of the systems incorporate forecasting/reassessment capabilities, with work force requirements, population, and school enrollments being the variables most often projected. Frequency of reporting varies substantially. Two systems provide monthly reports on work force level and worker characteristics, while other systems report these data, often together with selected community impact indicators, quarterly or semi-annually. In general, systems that are mandated by regulatory authorities tend to feature fixed reporting schedules, while those initiated by developers often have more flexible reporting formats.

5. System Evaluation

The monitoring systems compared in the preceding section can best be characterized as pioneering efforts initiated during a period when the guidelines for socioeconomic

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impact assessment were just beginning to evolve and impact mitigation activities were being undertaken at only a few project sites. The intent of this section is to draw upon the experience gained in developing and operating such systems in order to summarize our impressions of the current state-of-the-art in socioeconomic monitoring for large-scale projects, and to point out areas where additional conceptual and/or institutional development appears to be required. The evaluation is based not only on a review of the reports emanating from the various systems, but also on interviews with key personnel responsible for operating several of these systems (Cross, 1981; DeVeney, 1981; McGinnis, 1981; Pearson, 1981; Rafferty, 1981). In each interview, system personnel were asked to comment both on the usefulness and limitations of the procedures employed in their system, and to recommend changes or refinements in monitoring techniques based on their experience.

An initial observation is that work force information, community data, and reassessment capabilities are all essential components of an effective monitoring system. In addition, it is clear that special problems in system design emerge when several projects are being developed concurrently in the same local area.

5.1. WORK FORCE INFORMATION

While it is generally agreed that work force information is fundamental to a successful impact monitoring effort, substantial differences of opinion exist concerning the best method for obtaining information on worker characteristics, particularly for construction work forces. The two major alternatives appear to be (1) an entry survey, in which each worker completes a brief questionnaire at the time of hiring, or (2) a periodic survey, in which questionnaires are distributed regularly to all workers (e.g. semi-annually). Advantages of the entry survey are that high rates of worker compliance can be attained and shifts in worker characteristics can be detected quickly, assuming the survey responses are tabulated and reported frequently (McGinnis, 1981; Pearson, 1981). The principal disadvantage of this approach is that some worker characteristics, such as housing type, location, and presence/absence of family members in the impact area, are likely to change during the course of a worker's tenure with the project, and would not generally be detected by an entry survey. In addition, unless the system provides a mechanism to identify workers who terminate their employment with the project and remove their records from the data base, worker turnover can cause the data base to become unrealistic (McGinnis, 1981).

The periodic work force survey has two major advantages over an entry survey. These are: (1) the periodic survey has the potential to provide more accurate data on some worker characteristics (as noted above), and (2) it is a more appropriate vehicle for evaluating project workers' utilization of, and satisfaction with, local services (newly hired workers may have little basis for responding to such questions). The disadvantages of the periodic survey relate primarily to problems in implementation. Particularly during project construction, the cost (in terms of workers' time lost from their jobs) of complying with a periodic survey may appear prohibitive. Construction managers and subcontractors may therefore be reluctant to co-operate in such an effort. Union officials may also be reluctant to support survey efforts. Co-operation and support from company and union officials are very important to achieve satisfactory response rates, and the attitudes of such officials must be considered carefully in designing work force monitoring procedures (McGinnis, 1981; Cross, 1981; Pearson, 1981).

Whether an entry survey or a periodic survey is employed, two factors are extremely important in designing the survey instrument. First, because the questionnaire must

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usually be self-administered, it must be relatively short and easily understood by the workers to achieve a high response rate. Second, careful attention must be given to definitions, particularly in such areas as place of residence (permanent vs. work week), place of previous residence, and family status (presence/absence of family in the impact area).

5.2. COMMUNITY IMPACT INFORMATION

In the area of community information, the major differences between systems and critical decisions in system design relate primarily to the scope (number of indicators and jurisdictions included) and frequency of monitoring. As noted earlier, the most appropriate community indicators to monitor can be expected to differ between project sites according to both the nature of anticipated project effects (e.g. worker relocation vs. commuting) and the perceptions of local officials and their constituents concerning those effects. Existing systems differ substantially in the number of community indicators monitored, but examination of Table 1 suggests that several variables are regarded as being important in most impact situations, with additional indicators apparently being incorporated in response to specific local concerns.

A general impression obtained in reviewing the monitoring reports, and supported by most interviews with monitoring personnel, is that many systems have placed too much emphasis on data collection and not enough on analysis of the information obtained. The usefulness of most systems would have been increased if greater attention had been given to evaluating the implications of the community data both in terms of impact attribution (i.e. to what extent were the changes observed the result of the project's development) and in terms of implied needs for impact mitigation measures.

Selection of communities to be monitored is a critical system design decision, because the number of communities included will affect directly the cost of operating the system. It appears that the principal criterion for including a community in the monitoring effort should be the magnitude of impacts the community is expected to experience. Unfortunately, while the systems studied differ substantially in the number of communities they include, available reports do not generally explain the rationale for determining which communities to include. Even if a definite criterion were established (e.g. include all communities anticipated to experience project-related population growth of $x\%$ or more), recent studies indicate that predicting work force settlement-commuting patterns, and hence forecasting the distribution of project-related growth, have been areas in which past anticipatory impact assessments have been relatively weak (Gilmore *et al.*, 1981). Thus, the best approach in designing a monitoring system may be a flexible one providing for an initial selection of communities based on the anticipatory assessment, but also scheduling a re-evaluation of this decision as monitoring data become available. Communities could be added to or deleted from the monitoring effort based on analysis of the monitored data.

5.3. IMPACT REASSESSMENT CAPABILITY

The projection updating or impact reassessment capability is clearly an important component of a monitoring system. The monitoring system personnel interviewed supported the importance of the updating feature, even those associated with systems lacking this capability. A recurring comment was that, when some of these systems were developed, the state-of-the-art in impact modeling was still quite primitive and few well-documented, validated models were readily available (McGinnis, 1981; Cross, 1981). Some monitoring personnel also indicated that, in their particular situation, a

formal, computerized model did not appear necessary because impact reassessments were required very infrequently (e.g. twice in five years) (DeVeney, 1981). Overall, a review of the reports from operating systems suggests that more attention should be given to the reassessment capability. Several systems lack this feature and, even when periodic updates are provided, the methodology for developing revised projections generally is poorly documented.

5.4. MULTIPLE PROJECT CONSIDERATIONS

When several development projects concurrently affect the same area, the problems associated with impact assessment, mitigation, and monitoring are compounded. Developers' mitigation actions and communities' growth management plans can be realistic only if they are developed from information concerning all proposed projects in the area. If a monitoring system is to provide useful guidance for impact management decisions, it must, in turn, incorporate information from all major projects. In Mercer County, North Dakota, an Inter-industry Technical Assistance Team was created to meet the need for a comprehensive monitoring system (Zainhofsky and Pearson, 1981) and the Southwest Wyoming Industrial Association has played a similar role in that state (Gilmore *et al.*, 1981). Similar efforts to develop area-wide monitoring systems are currently underway in north-western Colorado and in north-eastern Wyoming.

To summarize, several lessons can be learned from the monitoring systems that have been implemented to date. Paramount among them is the need to recognize the pivotal position of the monitoring system in the process of socioeconomic impact assessment and mitigation. If a monitoring system is to provide useful guidance in the impact management process, the needs of key decision-makers must be considered carefully during the system design phase, and, ideally, the developer and community officials who will be the principal clientele of the system should be actively involved in the design process. In addition, a systematic assignment of priorities to the information to be included in the monitoring system is vital to the ultimate success of the effort. Past monitoring programs have often been hampered by attempts to collect too many data, a large portion of which was not essential to decision-making. The need for each indicator proposed for inclusion should be justified in terms of the specific purpose it will serve.

6. Conclusions and Implications

Given the increasing recognition of the need for comprehensive socioeconomic impact management programs in connection with large-scale projects, the implementation of socioeconomic impact monitoring systems appears likely to increase. The results of the review and evaluation of such systems reported here suggest several considerations relative to such systems.

First, in any socioeconomic impact management program, particularly those where the project has large work force requirements and a long construction period, there is a great need for the types of information that such systems can provide. The systems implemented to date demonstrate the potential of monitoring programs for providing the information needed for decision-making in a timely manner.

Second, because such systems have been implemented only recently, much work remains in evaluating the relative advantages of alternative data collection and analysis procedures. Achieving closer integration of the anticipatory assessment, monitoring, and mitigation phases of the impact management process clearly requires concerted attention.

Finally, if properly designed, such systems can meet a wide range of possible decision-makers' data needs. Further, the experience of entities that have implemented such

systems can be useful in the system design process. For example, using data such as those presented in Table 1, it is possible for an environmental decision-maker or analyst to identify systems most nearly meeting his/her needs. Contact may then be established with the agency sponsoring development of each of the systems selected in order to obtain additional information, including monitoring reports and suggestions for adapting or refining the system. In sum, the results of this analysis suggest that, if system design can be done with care, socioeconomic monitoring systems will provide a valuable tool for use in the impact management process.

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