SCOPE 27 - Climate Impact Assessment

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13 Social Analysis

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13.1 INTRODUCTION

From the evolution of custom and culture in different climatic zones and the seasonal rhythms of all societies, we have strong evidence that climate has social impact. However, the *systematic* assessment of the impact on society of climate variability and change, which is the subject of this chapter, remains a lightly developed area. By social impact assessment (SIA) we refer to a body of research that examines more strictly the behavioral or `social' aspects of impacts on communities and individuals, arising from related demographic and economic factors. We draw from recent efforts to analyze the social impacts of technologies and environmental changes, with primary interest in the methods for and experiences in social impact assessment for such climatic phenomena as frost, hail, or sustained changes in snowpack, rainfall and temperature.

As orientation to the nature of the concerns under consideration, the chapter first offers two illustrations of social impact assessment, one of climate change in a developed country context and one of climate variability in a developing country context. Subsequent sections discuss the origins and methods of social impact assessment, present more examples of climate-related projects employing SIA, and identify research concerns and opportunities.

13.2 CASE STUDIES

13.2.1 Metromex

One major effort to assess the impacts of persistent climate change is METROMEX (for Metropolitan Meteorological Experiment)—the study of the St Louis urban weather anomaly. In brief, METROMEX was an unplanned natural experiment. Urban-induced, unintended changes in the local climate of up to 30 years in duration were established (Changnon, 1981c). For summer weather patterns, these included a 10 percent increase in local cloudiness, a 30 percent increase in rainfall (primarily from late afternoon and early evening thunderstorms), and increased severe storm activity (up to 100 percent). The changes occurred over the city and eastward within a 4000 km^2 area.

By 1950, concomitant changes were detectable in streamflow, flooding and crop yields. Measured impacts included more runoff (11 percent), more local flooding (up to 100 percent), and more stream and groundwater pollution (up to 200 percent). A net local-area average increase in grain crop yields of 3–4 percent was found, although there was a 100 percent increase in crop-hail losses. While the net effect of the anomaly on agriculture appears to have been beneficial, local, state and federal agencies have borne increased costs of water management and flood control. Figure 13.1 presents a chart summarizing first-, second-, and third-order impacts of the urban weather anomaly; not all of the impacts shown have been empirically established. As the chart suggests, the weather changes resulted in both economic winners and losers.

The social impacts of the St Louis urban weather anomaly were specifically studied after the anomaly's characteristics had been clearly identified by atmospheric scientists (Farhar *et al.*, 1979). A comparative case study design was used to select a random urban/rural sample within the impact area (experimental) and a similar sample was used nearby but outside the impact area (control). Structured interviews were conducted with these samples regarding perceptions of and adjustments to the weather anomaly.

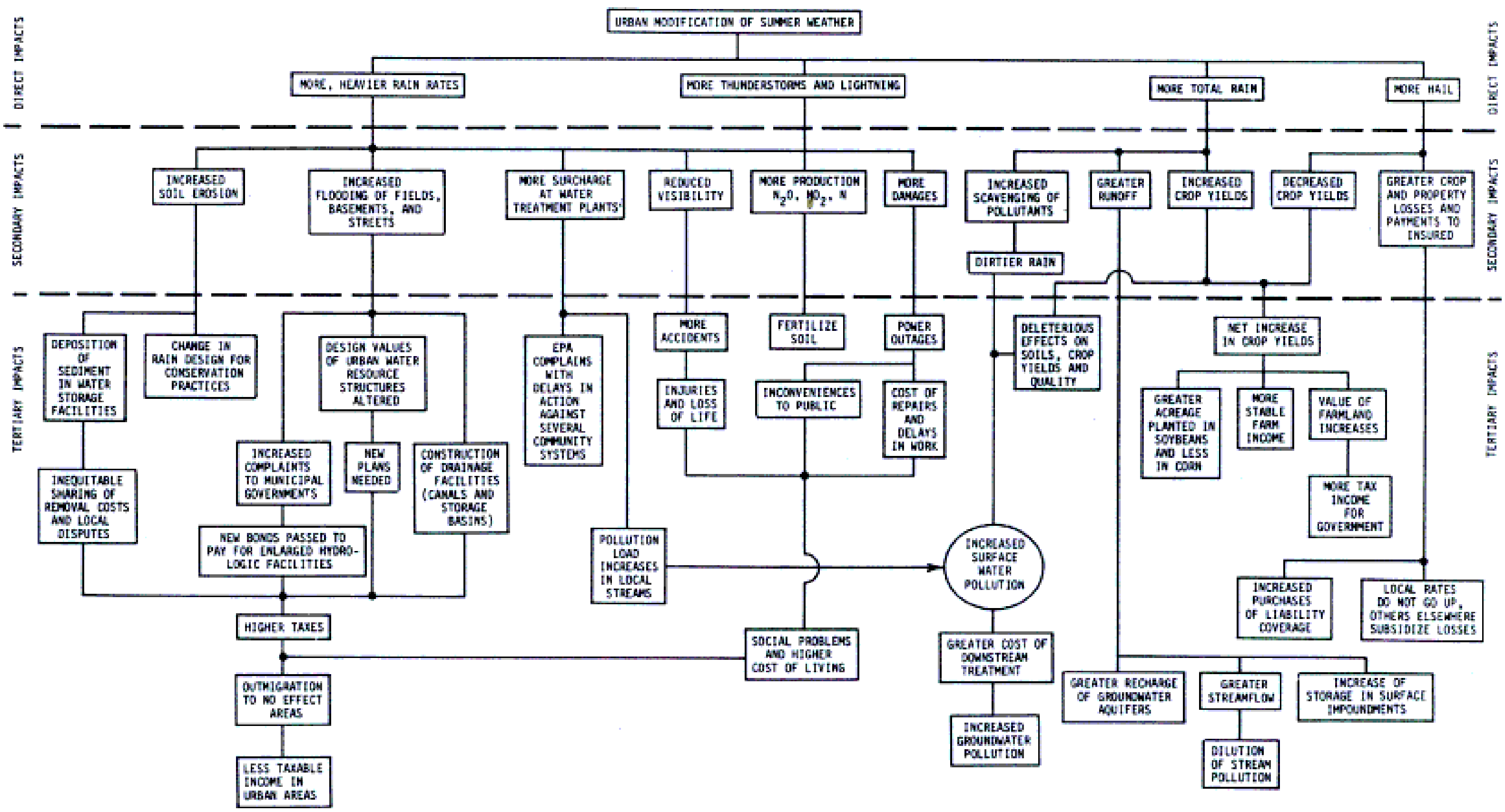

Figure 13.1 Interrelated impacts of certain urban-induced precipitation anomalies at St Louis, Missouri. Reproduced by permission of the American Meteorological Society from Changnon, *Meteorological Monographs*, Vol. 18, No. 40 (1981b), 156

Detailed data were collected on a variety of relevant variables, including perception of weather and climate, favorability toward local climate, perceived weather changes, adjustments to weather changes noticed, knowledge of urban-induced weather changes, sources of information on weather and weather changes, preferred amounts of rainfall, reaction to hypothetically increased/decreased rainfall, perception of relationship between weather and health, impacts on health, comfort and safety (such as loss of sleep, profusion of insects, household water quality, sewer backups, mood and comfort, health problems), lightning strikes, extent of air conditioning use, commuting behavior, perception of impacts on traffic flow, experience of traffic accidents and road trouble, observance of street flooding, experienced impacts on everyday occupational and recreational activity, perceived impacts on lawns and gardens, weather-related property damage and inconvenience, basement flooding, experienced power outages, and adjustments to these problems. In addition, farm respondents were asked about perceived weather-related damages to crops from droughts, flooding and hail, and their corresponding adjustments. Perceptions of crop yields were explored, as were perceptions of how weather and precipitation specifically affect crop yields. Little difference in response to all of these variables was found between the experimental and control areas.

Findings from METROMEX show that in a 30-year period, a climate change as great as a 30 percent increase in summer precipitation can go virtually unnoticed by the population experiencing it. Even those who might be expected to be most directly affected by rain increases—farmers—attributed higher crop yields (which they *had* noticed) to better agricultural technology (primarily the use of fertilizers and better seed varieties). The data on adjustments suggest that slight changes in occupational and recreational behavior patterns have occurred in response to the local climate change, but people remain unaware that they are making these changes in response to anything unusual. These adjustments are themselves impacts of climate change.

Three other social impact analyses were performed in connection with METROMEX. The first of these explored the relationship between rainfall and the occurrence of traffic accidents, using METROMEX precipitation data from a dense raingage network and traffic accident data from the Illinois Department of Transportation (Sherretz and Farhar, 1978). A linear relationship was found between increased rainfall and frequency of traffic accidents; however, severity of accidents (as measured by the ratio of the number of injuries per accident) was not found to increase. The second analysis examined the relationship between rainfall and selected criminal activity; no relationship was detected, possibly due to crime data problems (Farhar *et al.*, 1979). The third analysis explored responses to urban weather anomaly on the part of organizations that reasonably could be expected to be concerned (Farhar *et al.* ,1979). These included air traffic control, sanitation districts, water quality control, regional government, air pollution control, floodlighting, utility companies, engineering design firms, urban planning agencies, private industry, and the National Weather Service Forecast Center. The interests and responsibilities of these organizations were potentially directly affected by the urban climate anomaly. For example, sewage treatment facilities are not designed to handle 100 percent of historical precipitation, but are designed to handle a tolerably low number of surcharges per season. At the time of the study, thunderstorms and consequent system overloads caused untreated sewage to be passed directly from a sewage treatment facility into the Mississippi River three to six times each summer. One of the municipal water intakes on the Mississippi is downstream from this facility. The impact on water quality is not known, but one respondent said this was a low priority as the Mississippi is a multi-use river, and usage is not considered degraded by the problem.

Most organizations were relatively uninterested and felt that the magnitude of change measured was in the `noise' of weather variability. Organizational response and adjustment to the anomaly were minimal to nonexistent. Organizations unanimously indicated that all systems are designed and operated at less than 100 percent of potential capacity. Designs assume periodic power outages, floods and surcharges, for example. Storm drainage systems are designed for a 5- or 10-year event, but not for a 100-year event. Increased precipitation meant that systems based on historical data were exceeding design more frequently. But at 30 percent increase, organizations responsible for existing systems were not very much interested in information about the anomaly. Organizations designing new systems were somewhat more interested. However, Changnon (1981c) reports that urban anomaly data were used in a federal court decision regarding water use in the Chicago area.

The METROMEX social impact assessments were done in piecemeal fashion, as limited resources would permit. Nevertheless, by accomplishing focused empirical investigations on elements of the problem (such as water quality, crop yields, occurrence of surcharges, perceived impacts, and traffic safety), the foundations for a comprehensive assessment of social system impacts of climate change were gradually laid. As Changnon (1981b) points out, the impact analysis remains incomplete, both because more research is needed and because the story is still unfolding.

13.2.2 Post-frost Adjustment in Brazil

Margolis (1980) has reviewed the post-frost strategies of coffee cultivators in southern Brazil. Frosts have received little attention from environmental impact researchers, probably because they present no direct threat to human life and, as such, are said to have low catastrophe potential (White and Haas, 1975). Then, too, as Margolis (1980) points out, the full impact of frost damage in agricultural communities may not be felt for many months, that is, until the normal time of harvest of the affected crops.

In early August 1975, as Margolis reports, a mass of cold Antarctic air swept up from the south and blanketed Brazil's major coffee region with the most severe frost within living memory. Temperature fell below 0°C in parts of Mato Grosso and Minais Gerais—areas which had never frozen before—but the greatest devastation was wrought in Parana state, the most southerly in Brazil's coffee zone. Close to 100 percent of the 915 million coffee trees in Paraná were affected. As the temperatures inched below freezing, the leaves on the trees blackened and fell to the ground, eliminating the two subsequent harvests. In the most severe cases, the cells of the tree trunks were ruptured by the expansion of the ice, killing the trees when the trunk split. As a result of this event, Paraná in 1980 had an estimated 600 million coffee trees, or nearly one-third fewer than before the frost.

The most immediate effect of the frost was large-scale unemployment. In the coffee zone as a whole, it is estimated that of the one million workers involved in the cultivation and processing of coffee, 600,000 were left jobless as a consequence of the frost. The response to widespread joblessness frequently was emigration, with people often moving to the large urban centers of the coast or newly opened frontier areas.

The aftermath of the unusual weather was by no means uniform in the coffee-growing communities where the impact of the frost was greatest, in the northern portion of the state of Paraná. By 1978, three years after the event, much of northern Paraná had been transformed, and three distinct responses to the frost were evident. In one area, thousands of small farms had been replaced by large mechanized estates devoted to soybean and wheat agriculture. In a second region, hundreds of medium-sized holdings had given way to extensive cattle ranches. In a third area, where cattle ranching had made important inroads before the 1975 frost, the conversion to pasture was halted after the frost and coffee trees started to be replanted.

Margolis concludes that the 1975 frost was a catalyst for rather rapid social and economic change in Paraná's coffee zone. But the specific responses to the extreme weather condition in each of the zone's three subregions were shaped largely by conditions existing prior to it. Land divisions, soil quality, water resources, labor legislation, and credit availability all influenced the frost's impact and the subsequent evaluation of the various areas. In conclusion, Margolis emphasizes the need for analyses of predisaster conditions for full understanding of post-disaster responses.

13.3 BACKGROUND AND METHODS

13.3.1 History

Although study of the social impact of environment and technology has a long history, explicit social impact assessment (SIA) methodology is a recent development, stimulated largely by legislation like the US National Environmental Policy Act (NEPA) of 1969 (Enk and Hart, 1978). A US Ad Hoc Interagency Working Group on SIA was formed in July, 1974 (Connor, 1977). In the United States, SIA has been used to assess the social impacts of such projects as proposed oil shale development, nuclear power plants, coal projects, pipelines, dams and offshore drilling. In developing countries, impacts on local populations have been assessed for rural roads, electrification, water supply, irrigation, family planning, and health care projects and programs (Albertson, 1983; Cano, 1983; Mohanty, 1983). The recently formed International Association for Impact Assessment and the Social Impact Assessment Center (along with its publication *Social Impact Assessment)* serve as clearinghouses in the United States for information from all countries on impact assessments in fields as diverse as health and climate. New designs and handbooks on SIA are being developed (Rossini and Porter, 1983; Flynn and Flynn, 1982; Branch *et al.*, 1982). Recent reviews and manuals include Chalmers and Anderson (1977), Bowles (1981), Finsterbusch and Wolf (1981), and Leistritz and Murdock (1981). The most highly developed area of study is probably in social impacts of energy resource development, where Denver Research Institute (1979), Murdock and Leistritz (1979) and Conn (1983) are indicative of the state of the art.

13.3.2 Public Participation

As a methodological approach, SIA can be viewed as a component of both environmental impact statements (EISs) and technology assessments (TAs). These approaches are a class of policy analysis that came into being to address public demands to assess the `hidden costs' commonly associated with proposed projects and programs (Peterson and Gemmell, 1977). The approach has more recently been used to assess the consequences of proposed regulations. SIA is often anticipatory research that aims to predict and evaluate the impacts of policies, projects, or programs on society (Wolf, 1981).

When an SIA is undertaken on behalf of a government, it typically incorporates a broad mandate for public involvement, including affected publics, organizations, and communities. Indeed, techniques for public participation and reviews of findings are generally included as integral parts of SIA, EIS and TA projects. The many parties-at-interest, or 'stakeholders', that can be affected by the change or project in question are involved not merely as objects of study.

13.3.3 Patterns of Assessment

The incidence and distribution of social costs and benefits is a key matter for assessment. In fact, the central question for SIA is frequently social equity: who wins and who loses in a given situation. What to do about it once the assessment is completed is a matter for public policy.

SIA draws freely on all social science disciplines. Since every impact situation has unique features, methods must be adjusted to suit each assessment problem. No one `best way' of conducting assessment is accepted. However, Wolf (1981, 18-19) presents a `main pattern' that assessment projects tend to follow. The assessment steps comprising the pattern are:

- scoping the problem,
- identifying the problem,
- formulating alternatives,
- profiling the system,
- projecting effects,
- assessing impacts,
- evaluating outcomes,
- mitigating adverse impacts,
- verifying results,

- specifying who wins and who loses, and
- designing institutional arrangements and management.

With regard to style of work, it is generally desirable for assessment projects to be

- interdisciplinary and interactive
- synthetic, aggregative, integrative
- inclusive (involve users of the assessment information in the process), and
- policy relevant.

13.3.4 Types of Data

Assessment projects usually rely on already-existing data. Four basic types of social data that can be used in assessment are:

1. *statistical social data* (for example, censuses of population/housing, traffic counts, vehicle registrations, mortality, farm size, employment, hospital beds, police cars);
2. *written social data* (for example, letters to editors, novels,* prepared testimony, historical documents, reports, newspaper articles);
3. *observational social data* (for example, systematic observation of relevant events, unobtrusive measures, land modifications, measured responses to experimental situations); and
4. *respondent contact social data* (for example, polls and surveys, interviewing, ballots, citizen/expert comment on impacts, registration applications and other forms (Miller, 1970; Gale 1977b).

* For example, *The Grapes of Wrath* may be viewed as a potent statement on the social impacts of the 1930s Dust Bowl in the United States.

These types of social data result from accepted techniques used routinely in behavioral science research.

How data are analyzed and synthesized to complete the basic function of SIA research will always be subject to revision and improvement. Connor (1977) lists 14 different data collection and analytical techniques that have been used in various combinations in SIAs:

demographic analysis	evaluative research
community studies	institutional analysis
causal modeling	value analysis
social indicators	multivariate analysis
ethnomethodology	social network analysis
archival research	social forecasting
survey research	matrix methodologies

13.3.4.1 Impact Categories

Drawing on studies of the forest sector, Gale (1977a) presents a comprehensive list of social impact categories that can be used to guide assessment projects (see Table 13.1). The value of such an heuristic device is that it provides a framework for the systematic assessment of impacts on society's sectors and processes, helping to ensure that major interests are not overlooked. It also serves to organize frameworks for the multiplicity of data that are inherent in any assessment project.

13.3.4.2 Data poor Countries

Given SIA's reliance on existing data, what can be done in data-poor countries, such as the developing countries? Some preliminary attempts have been made to deal with this problem in the context of impact assessment efforts (Castro *et al.*, 1981). *A* number of evaluation studies conducted or sponsored by the US Agency for International Development have sought to include social characteristics such as extent of village social cohesion, degree of village isolation, demographic characteristics, leadership, and access to major urban areas. A `social soundness analysis' produced by the US Agency for International Development (1978) recommends a form of qualitative stakeholder analysis, specifying who wins and who loses as a result of proposed developmental projects. Using the household as a unit of analysis, Castro *et al.* (1981) developed indicators of economic stratification for rural villages in developing countries (see Table 13.2). Mohanty (1983) examined the sociopolitical conflict arising from the Hirakud Dam Project in the state of Orissa, India. The environmental and sociopolitical impacts of the Sahel drought have been explored (Glantz,1976,1977). Albertson (1983) claims that the world hydropower potential is vast and urges worldwide study of hydropower's effects on agriculture, fisheries, forestry, mining, health, employment, income distribution, political factors, standard of living, ecology and environment, and self-reliance of local people.

Table 13.1 Forest-use social impact categories, variables and components

Social impact categories	Social impact variables	Social impact components
SOCIAL	Community culture change	
INSTITUTIONS	(subculture, trait, or theme)	
	Leisure and `cultural'	Carrying capacity
	opportunities	Available land and facilities
	Recreational opportunities	
WAYS OF LIFE		Recreational demand
	Special group access	`Optimal recreationist'
	(elderly, handicapped,	
	poor, transit-dependent)	
	Security (anxiety, unpre-	
	dictability, and the 'unknown')	
	Open space	
		Minority group impacts
		Civil rights
SPECIAL CONCERNS	Minority and civil rights	
	Historical and archeological sites	
	Physical cohesion (barriers)	
	Demographic cohesion	
COHESION AND CONFLICT	(class characteristics)	
	Attitude and value cohesion	
	Proposed action activities	
	cohesion and conflict	
	Community activities	
		Actual use compatibility
		Suitability (environmental
	Land allocation and use	carrying capacity)
		Esthetic effects
LAND TENURE AND		(viewer access)
LAND USE		Conditional use and

	Land use regulation	building permits Comprehensive planning and zoning
	Population size (growth, stability, decline)	Population size perspectives Population size change
	Population density Displacement of people	Physical displacement Use displacement
POPULATION DYNAMICS	Population distribution Population of people	Geographical mobility Social mobility
	Population structure (age and sex)	
COMMUNITY CONTEXT	Community identity `Sense of place'	
SYMBOLIC MEANING	Places Practices `Things'	
BASIC VALUES	Value orientations Value dimensions Value rankings	

Source: Gale, 1977a, 2.

13.3.5 Types of Methods

The use of scenarios, or `social forecasting', can be a useful method where empirical data are relatively scarce or the phenomenon to be studied, such as climate change impacts, will occur in the distant future. Social forecasting involves the analysis of probable social consequences of current trends and events. The social future cannot be forecast without ambiguity; present knowledge and methods are not sufficiently powerful to permit accurate predictions of social behavior over long periods of time. Nevertheless, as Vlachos (1977) argues, use of scenarios is one class of methods that relies on informed disciplined imagination; this approach is worthwhile in outlining the alternative futures that society might face. Scenarios are future histories describing how the world might look. (For a view on scenario uses as a more formal modeling device, see Lave and Epple, Chapter 20, this volume.)

The scenario is but one method that can be used in social impact assessment. Vlachos (1977) has defined four additional classes of methods. These are:

1. consensus—opinions by themselves; agreement among experts (delphi); conjecture; brainstorming; heuristic programming; moot courts.
2. historical extrapolative—historical determinism based on how the past was; historical surveys; social trends analysis; monitoring; correlation and regression; probabilistic analysis; growth metaphors; historical analogies.
3. problem structuring—

    a. modeling: identify a set of elements, concepts, etc., explore their relationships within a situation and generate a graphical representation of structural relations. Models are partial representations that organize elements in time and space.
    b. cross-impact matrix: relates elements to each other based on expert judgment.
    c. other: simulation, iterative system projection, systems analysis, input–output analysis.

4. decision methods— determine a goal, then `backcast' to analyze what should be done now to get there; includes forecasting and casting around, using morphological analysis, contextual mapping, objective trees, relevance trees, judgment theory.

Each of these classes of methods is appropriate for different parts of the SIA. For example, scenarios and extrapolative methods are useful in establishing the context of the problem, consensus is useful in defining the range of alternatives and potential impacts, and decision methods are useful in policy option analysis. Any assessment project could employ one or more of these kinds of methods in combination.

Data-poor countries can also begin to accumulate `bits and pieces' of social data bases, using resources which are limited but available for a variety of projects. Eventually, as happened in the METROMEX project, a more comprehensive picture which is based on accumulating empirical evidence will emerge. Employing available frameworks will guide the effective selection of variables on which to collect data.

13.4 EXAMPLES

Prior to 1960, little research on weather is reported in the social science literature (see Riebsame, Chapter 3, this volume). In the last two decades social science research in the climate area has focused on natural hazards (White and Haas, 1975; Drabek,1983) and human modification of weather and climate.

Table 13.2 Indicators of rural household economic status

Surveys of economic stratification. Household is unit of analysis.
Land ownership
Quality of land
Intensity of cultivation and types of crops
Land outside sample area
Tenants and landless
Ownership of capital equipment and consumer durables
Income
Agricultural income
Sale of crops
Rent
Hired labor
Marketing and processing
Non-agricultural income
Ownership of livestock
Ownership of non-productive property
Housing
Furnishings and consumer goods
Access to fuel
Ceremonial expenditures
Diet, nutrition and health
Education
Household size and composition

Source of indicators: Castro *et al.*, 1981.

13.4.1 Snowpack Augmentation

Some early work in assessing the impact of weather on human activity was spurred by cloud seeding projects proposed to increase snowfall in Colorado and California. Two studies are worthy of mention here:

1. the technology assessment conducted by Stanford Research Institute for the US National Science Foundation (NSF) on proposed widespread orographic showpack augmentation in the San Juan Mountains of Colorado (Weisbecker,1974) and
2. the partial social assessment conducted by Human Ecology Research Services for the Bureau of Reclamation and NSF on proposed orographic snowpack augmentation in the Sierra Nevada, California (Farhar and Mewes,1974; Farhar and Rinkle,1976).

The Weisbecker study was an interdisciplinary technology assessment involving the following steps:

- defining a weather modification system,
- identifying effects on water quantity and quality
- assessing impacts of water supply on economic systems,
- assessing impacts of increased snow on environmental and ecological systems,
- assessing impacts of increased snow on social systems, and
- addressing public policy.

To assess the *social* impacts of more snow, Logothetti (1974) identified potentially involved sectors of society, or stakeholder groups (see Table 13.3). Many stakeholders were interviewed, using scenarios to collect data on their *perceptions* of impacts, but sampling was unsystematic. Demographic analysis describing mountain populations and growth were performed. Tables 13.4 and 13.5 list some advantages and disadvantages of snowpack augmentation to supporters and opponents.

The Sierra study consisted of a partial assessment of citizen and organizational perception of snowpack augmentation and its potential effects; it was conducted through systematic surveys in and around the proposed project area during 1974 and 1975. Citizen testimony at public hearings in the project area provided another data source.

A random sample of area citizens thought snowpack augmentation was a less desirable way to augment water supply than building more reservoirs and practicing water conservation. They were concerned about the risk and controllability of the proposed project and about potential adverse impacts.

The organizational perception study was based on a systematic sampling of stakeholders. A sampling matrix was used to identify the relevant groups located in, or with interests in, the study area (see Figure 13.2). The sampling frame compares sociopolitical levels of concern (federal, regional, state, county, city) to functional interests (such as agriculture, energy and transportation) with relevance to snow. Specific individuals and organizational representatives were identified for each cell of the matrix (representing domains of responsibility) and a structured instrument was used to interview each of them personally. Sampling frames such as this can be useful in identifying specific parties-at-interest.

The study found that stakeholders tend to adopt positions toward snowpack augmentation consistent with their assessment of how increased snow will affect their interests. If they feel their interests are unaffected, their position is neutral or indifferent. Heterogeneity of weather needs characterizes the area, so it is not surprising that some respondents perceived benefit from increased snowfall (for example, ski areas and utility companies) and some perceived harm (for example, county government because of highway snow removal costs).

A few generalizations can be drawn from the snowpack studies. Increases in snowpack in the order of 10–20 percent per winter season have not yet been found to have serious adverse impacts on society or the environment. Changes of that magnitude, being within normal climate variability, might go unnoticed by the populations experiencing them for relatively long periods of time (if they are not from publicized weather modification programs). The heterogeneity of weather needs on the part of major sectors of society was made clear: some will benefit and some will lose as a result of any weather event or pattern. Systematic data on who the winners and losers are and how they are affected is sparse indeed, however. Additionally, interregional problems arise in that a weather pattern that possibly harms one geographic area (more mountain snowfall) may benefit another (downstream water users).

Table 13.3 Stakeholders, as represented by 29 groups, concerned with snowpack augmentation in the Colorado Rockies

Bureau of Reclamation	Irrigators
Cattlemen and ranchers	Loggers
Cloudseeding contractors	Mountain communities and community leaders
Colorado Mining Association (individuals, mining companies, mining communities)	Panel on Public Information in Weather Modification
	People afraid of interfering with nature
Congressmen	People with weather-related problems
Downwind residents	Protectors of the public interest
Ecologists	Public Health Service
Elected representatives of mountain communities	Senators
Electric power companies	Ski area owners and operators, skiers
Farmers	State and local governments

Federal government	Target area residents
Federal weather-modification regulatory agency	Tourist industry, tourists
Grand Mesa Water Users Association	Water users (especially in Arizona and California)
Industries	WOSA scientists, forecasters

After Logothetti (1974).

Table 13.4 Possible advantages to stakeholders

More water for irrigation
More water for electric power
More water for municipal uses
More water for industrial uses
More snow for ski area corporations
More water for livestock and grass
More snow for skiing and snowmobile use
More water for Los Angeles residents
More water for irrigation and agriculture in southwest Colorado

After Logothetti (1974).

Table 13.5 Possible disadvantages to stakeholders

More avalanches, causing revenue losses to mining companies and communities
More avalanches, causing losses of life and limb
More unintended snow on residents in downwind areas
More snow feeding avalanches that are threats to property
More snow increasing snow removal costs
More snow preventing employees from getting to work
More snow reducing geological exploration by mining companies
Heavier snow load on roofs
More water and spring flooding
More snow affecting logging operations
More snow shortening the summer tourist season
More floods keeping tourists away

After Logothetti (1974).

	Forest	Highway	Political	Land/water use administration	Environmental organizations	Economic interests*	Media	Other**
Federal								
State / Regional								
County								
Community								

* For example: lumbering, recreation, agriculture, utilities, mining.

** For example: community 'opinion leaders'

Figure 13.2 Sampling matrix to identify weather stakeholders in a study area (for snow). (After Farhar and Rinkle, 1976)

13.4.2 Severe Winters

Work on the impacts of natural severe winters on society has been conducted in Illinois (Changnon, 1979; Changnon *et al.*, 1980). Urban and rural residents completed questionnaires on the impacts of the severe winter weather of 1977–78 on their households. Specific impacts and their frequency of occurrence were identified, ranging from heating costs to absences from school and work, morbidity and medical costs, and family arguments arising from being snowbound. The average added cost per household attributed to the severe winter was $93; extrapolating to the state from these findings, the authors estimated economic costs to state residents, as well as the inconvenience, anxiety, extra work and injuries. Decreased tax revenues, loss of work and other costs to government and industry were not calculated. The specificity and detail of the data represent an advance over the earlier snow impact studies, yielding information more useful in building systematic assessments of how climate and its variation can affect society.

13.4.3 Hail Suppression

Following the assessments of snowpack augmentation, a major national technology assessment for hail suppression was conducted in the United States—TASH, for Technology Assessment of the Suppression of Hail (Changnon *et al.*, 1977, 1978; Farhar *et al.*, 1977). The TASH project team were experts, each from a different discipline,* with prior experience in weather modification. Rather than gathering the experts under one roof, team members remained at their organizational homes across the country, while the project was managed at the University of Illinois. Project integration and coordination were achieved through frequent team meetings interspersed with conference calls. The project was iterative; team members prepared working papers in their own areas of expertise. These were reviewed by other team members until a common vocabulary and understanding developed that superseded disciplinary lines. As work progressed, each element of the team found itself dependent on the input of others. For example, economists had to produce crop-yield data by crop-producing region before social impacts could be fully assessed, but sociologists projected the probable adoption (social acceptability) of the hail suppression technology across the nation before economists could assess macroeconomic impacts.

* Represented were atmospheric sciences, agricultural economics, law, sociology, political science, environmental science, assessment methods, and—unlike earlier efforts—representatives from businesses, such as crop-hail insurance and cloud seeding.

Assessment study users (stakeholders) representing national and local perspectives carefully reviewed the final draft of the project report at workshops held for the purpose. The TASH project, which employed scenarios, computer modeling, consensus, existing survey data, historical case study analysis, and a limited amount of new data, was fully interdisciplinary, iterative in process, and synthetic in product.

One of the key findings from TASH was that, while hail damage represents a serious problem to those experiencing it, on a national scale its impact is relatively minor. Much more significant social, economic, legal and political impacts arise from changes in precipitation—both increases and decreases. Figure 13.3 shows the interrelationship of impacts of less hail and more rain in one of the conceptual models employed.

13.4.4 Global Cooling, Global Warming

The examples described so far in this study illustrate methods and concerns which have arisen primarily in the assessment of local and regional climate variation. The question of the social impact of a global climate change has also been addressed on at least two occasions, once for the Climate Impact Assessment Program (CIAP) of the US Department of Transportation, which focused on the possible consequences of a global cooling (see Glantz and Robinson, Chapter 22, this volume), and more recently by the US Department of Energy's Carbon Dioxide Program, which has focused on global warming. For CIAP, social impacts were analyzed by Sassone (1975), who sought to estimate the costs for municipal governments and the like, and by Haas (1975), who explored the effects on family and community activity. Table 13.6 outlines changes which might be associated with cooler and wetter or cooler and drier conditions. The studies for the carbon dioxide case (see Chen *et al.*, 1983) stress the need for a variety of perspectives: cultural, psychological, historical, political and legal. They outline research needs and largely refrain from the assessment of possible outcomes.

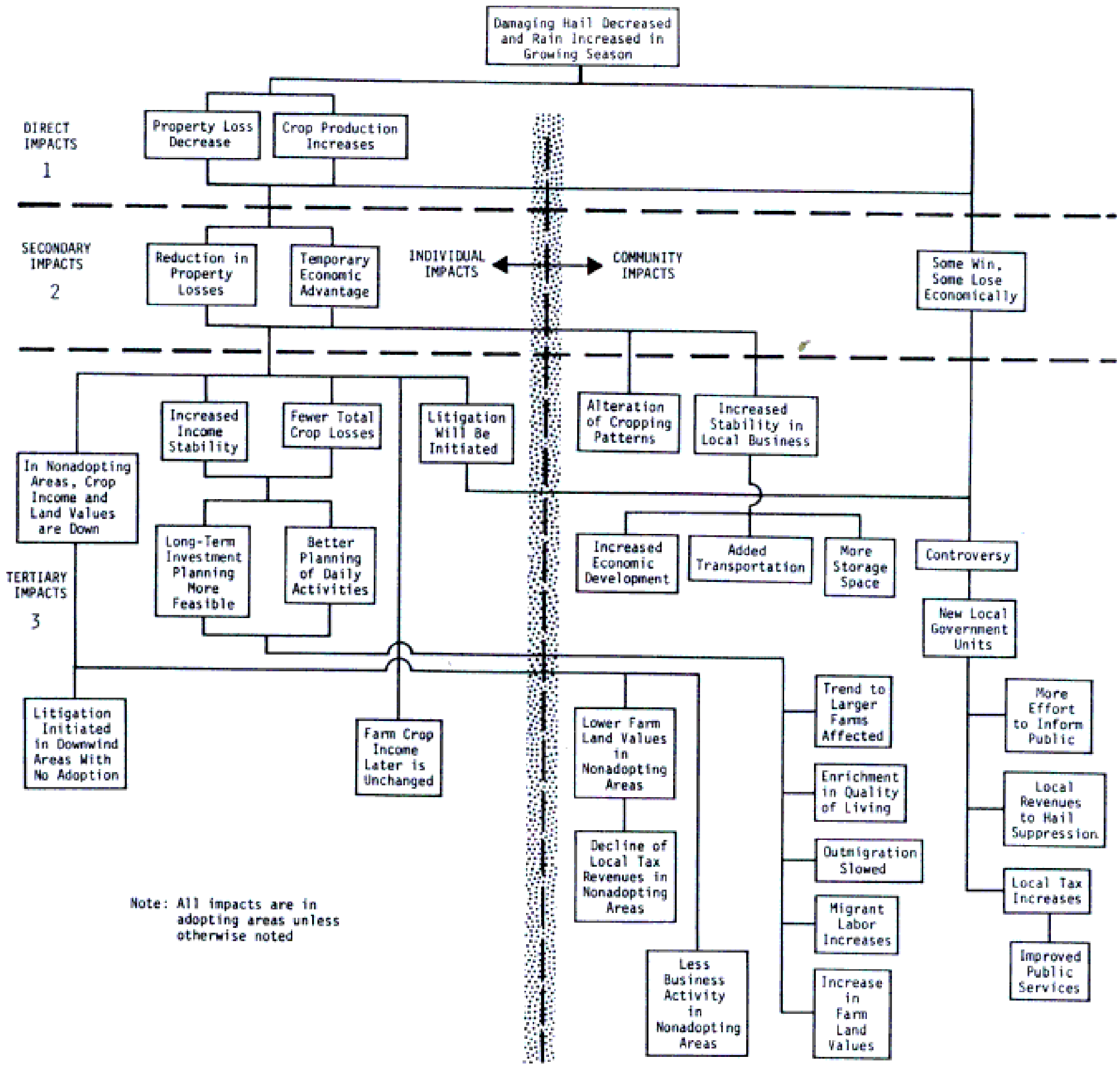

Figure 13.3 The interrelationship of impacts resulting from hail suppression capability. Source: Changnon *et al.*, 1977, 356)

Table 13.6 Outline of anticipated changes in family and community activity due to two types of climatic change

Activity	Average weather conditions are: Colder and wetter	Colder and drier
(Local)		
Within the nuclear family	Increased adult–child interaction Increased sibling interaction	Less significant change in same variables
Neighboring	Reduction in frequency	Minor change only
Journey to work	Increased tardiness and absenteeism More time spent on road	No significant change

Shopping	Slight increase in time per unit purchased	No significant change
Education	More school closings Increase in unsupervised children at home Reduction in outdoor exercise for children	Minor change only
Leisure and recreation	Sharp reduction in outdoor activity (winter) Significant reduction in outdoor activity (summer) Increase in indoor, passive leisure	Slight reduction in outdoor activity (winter) Slight increase in out-door activity (spring, summer and fall)
Health care	For both home and hospital, increase in time spent caring for sick and injured	No significant change
Political activity	Reduced citizen participation Additional reliance on TV during political campaign	Minor change only
Other business activity	Greater day-to-day variance in volume of retail sales More frequent delays in delivery of products and services	Minor change only
Religious activity	Reduction in participation in organized activity	No significant change
(Distant) Familial	More interrupted and cancelled trips	No significant change
Leisure and recreation	Increase in interrupted and cancelled trips (winter) Decline in trips to certain areas (all seasons)	Minor change only
Commuting to work	Decline in number of commuters using autos	No significant change

Source: Haas, 1975, 4–105.

13.5 RESEARCH CONCERNS AND OPPORTUNITIES

Some specific concerns arise in attempting to apply SIA methods to the study of climate.

13.5.1 Type of Problem

SIA is not appropriate in studying how social processes affect climatic processes; for example, how social behavior gives rise to the CO_2 accumulation in the atmosphere, public and decision-maker awareness of the CO_2 problem and its climatic consequences, willingness to change behavior and under what conditions, and institutional arrangements and normative structures that would avert CO_2 accumulation. However, SIA could be applied to study the social impacts of fossil fuel use, such as `boomtown studies', which document the phenomena of rapid-growth communities.

SIA can appropriately be used to study adaptations to actual and projected climate change. Adaptations can be efforts to benefit from expected or actual changes or efforts to mitigate anticipated or actual adverse impacts. Adaptations to benefit from such climate change effects as precipitation increases could involve, for example, constructing irrigation systems or changing cropping patterns. Adaptations to mitigate adverse impacts from such climate change as precipitation decreases could involve construction of water storage facilities, planned slow migration, and food trade arrangements among nations.

13.5.2 Study Sequence

Behavioral science is concerned with the *indirect* effects of climate change. Indirect effects are best studied after something is learned—or projected—about the first- and second-order impacts of climate change. Regional changes in precipitation (and other weather variables), their direction and magnitude, and their subsequent effects on, for example, water supply, crop yields and energy use must be investigated or defined by actual data or in scenario form before social impacts can be assessed. SIAs cannot be conducted in isolation from other disciplines.

13.5.3 The Rate of Climate Change and the Rate of Social Change

An important question in assessing social impacts is whether social adjustments and adaptations to climate change will be slow and incremental, or will climate change be ignored until its effects (if adverse) reach catastrophic proportions? At what point and under what conditions does a quantitative change in climate become a qualitative event that affects the quality of life, increasing or decreasing social well-being? When does it become socially disruptive?

As climate (experienced, measured and anticipated) is the aggregation of discrete weather events statistically distributed over time, so social impacts are discrete events, multiplied across populations and aggregated over time. Since large climate changes are likely to be experienced as an unusual sample of historical weather and climate, behavioral scientists should be studying current situations involving repetitive droughts, flooding, precipitation increases, frost, and higher and lower temperatures and their impacts on society. How are populations adjusting to such phenomena? How great a change seems tolerable for existing infrastructures without undue strain? Studies of societal response to some kinds of catastrophic disasters (such as volcanic eruption, earthquakes, tornadoes and hailstorms) may be helpful in assessing the relevant social impacts of climate change. However, their onset is sudden and intensely disruptive, while climate change is more likely to involve a gradual accumulation of opportunities and hazards.

13.5.4 Perception

Whether citizens, stakeholder groups, and organizations perceive slow climate changes and how significant they feel these are is an important research question. While there is little doubt that everyone in an affected area is aware of an event like an earthquake, it is unclear whether most people sense slow, incremental climate changes and adjust to them appropriately. `What people define as real is real in its consequences' has become a sociological truism that applies as well to climate change as to other phenomena. In the case of climate change, however, what people *ignore* can be just as real in its consequences. The difference between ordered, minimally disruptive and maximally beneficial adaptation to climate change and more chaotic, disruptive response to adverse impacts (or missed opportunities for beneficial ones) may lie in the perceptual arena (see Whyte, Chapter 16, this volume).

The *credibility* of climate forecasts is probably crucial in this regard. Adaptive response will depend on expectations for future climatic conditions. If historical methods of determining likely future weather/climate conditions are to be replaced by long-range scientific predictions, those predictions will have to be believed before important decisions based on them will be implemented. Such belief will be critical in determining responses. It is important to keep in mind that adaptive behaviors in turn produce *impacts*—beneficial or adverse—upon various sectors.

13.5.5 Equity Issues

Studies on society and weather/climate interactions have shown that some win and others lose. Analysis should be performed to identify stakeholders and assess the likely impacts on them. Distribution of impacts by age, gender and social class should be included in these analyses. Such analyses should be extended from the `arena of effect' to include interregional trade-offs in costs/benefits from the changes expected. Studies of current weather-change situations can address this distribution-of-effects problem. Policy analysis can be used to design potential institutional mechanisms that could be employed to meet values of social equity—that is, to distribute beneficial and adverse effects more equitably throughout society and between societies. It remains a political issue to decide which mechanisms, if any, are ultimately employed.

13.5.6 Infrastructure

Existing agricultural and water resource systems are designed and operated within known levels of probability or frequency of adverse or beneficial weather conditions. Farmers and insurance companies, for example, expect certain levels of crop risk from weather events; urban water supply and drainage systems are designed to handle certain flow levels that are known to be exceeded some of the time. Climate change is likely to change the probability of occurrence of events to which the infrastructure's systems are designed. As change occurs, affected systems may become increasingly inadequate to handle increases in frequency and/or intensity of, say, precipitation events, or to make use of them.

Organizational adaptive strategies to such situations should be studied. Determining domains of responsibility, interest in protecting existing systems, denial that change is occurring, concerns about organizational maintenance—these are potential organizational responses to changing environments and are areas for study in current relevant weather situations. Determining the allocation of political responsibility for climate change impacts is a central problem. By studying how these responsibilities are being handled in current weather situations, insights useful for future situations could result.

13.5.7 Research Agenda

An array of methodological and topical research recommendations has been made concerning how to approach the problem of assessing the impacts of climate variation on society. These include:

- study indirect effects (such as multipliers, social disruption) (Warrick and Riebsame, 1981).
- focus on process (identifying the pathways and linkages within social systems through which effects of climate change are transmitted, how they are transmitted, decision processes) (US Department of Energy, 1980; Warrick and Riebsame,1981).
- focus on adaptation (how peasants handle drought; how societies have responded to a variety of natural disaster situations through such mechanisms as insurance, contour plowing, etc.) (Wisner, 1977; Berry and Kates,1980; Meyer-Abich,1980; US Department of Energy, 1980).
- study `natural- disaster' stress situations (US Department of Energy, 1980).
- perform interdisciplinary integration (Ad Hoc Panel on Climate Impacts, 1980; Glantz *et al.*, 1982 and Chapter 22, this volume; Kates, Chapter 1, this volume).
- distinguish between research and assessment (Glantz *et al.*, 1982 and Chapter 22, this volume).
- include stakeholder analysis (objective and perceptual analysis of impacts and adjustment of parties-at-interest) (Glantz *et al.*, 1982).

To these can be added the research recommendations arising from this review:

- study the existing situation of known weather/climate change in various climate regimes. These would involve drought, precipitation increases, flooding events, and high and low temperature events.
- monitor trends over time (longitudinal studies).
- study perceptions of weather/climate variation on the part of citizens, stakeholders and organizations. Awareness of changes and adaptations to them are important issues for these studies.
- study the allocation of political responsibilities and decision processes in affected and potentially affected areas.
- study interregional trade-offs involving impacts.
- examine the credibility of weather and climate forecasting.
- in data-poor countries, build incrementally the data on relevant SIA variables as funding is available.

13.6 CONCLUSION

Social impact assessment can fruitfully be employed in countries throughout the world to initiate and extend an understanding of what impacts localized and global changes will have on societies. In countries with existing data bases, longitudinal studies of current situations involving repetitive droughts, flooding, precipitation increases, frost, and higher and lower temperatures will extend their utility. In data-poor countries, collecting data on a piecemeal basis in connection with various projects will begin to build the data bases needed to approach with more certainty the question of climate impacts. The immediate use of SIA methods mentioned in this chapter that do not relly heavily on empirical data will also be beneficial. To the extent that the goal is to study social change, much can be gleaned from reviews of related literatures on natural hazards and natural resources development and management.

Consideration of the potential part social analysis might play in assessing the impacts of global climate change is best limited to multiyear persistent episodes and longer periods of gradual climate changes. What will these changes mean to the world's societies? Interannual and persistent, multiyear episodes can be studied by focusing on current situations of drought, urban weather anomolies, flooding, and so on, using the approaches mentioned above. Longer, century-scale `little ages' can best be addressed using scenarios and decision methods. These methods permit imaginative synthesis of climate change problems, consideration of various outcomes emergent from current trends, and identification of action alternatives.

At all relevant time-scales, social impact analysis has a demonstrated capability to make an important contribution to studies of the interaction of climate and society. Just as applied climatologists strive to disentangle the complexities of the atmospheric system into the components important to human affairs, so social impact assessors systematically reduce the complexities of social interaction to entities amenable to survey and study. As with all such reduction, some essence of the whole is lost, but a considerable improvement in analytic power is gained.

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