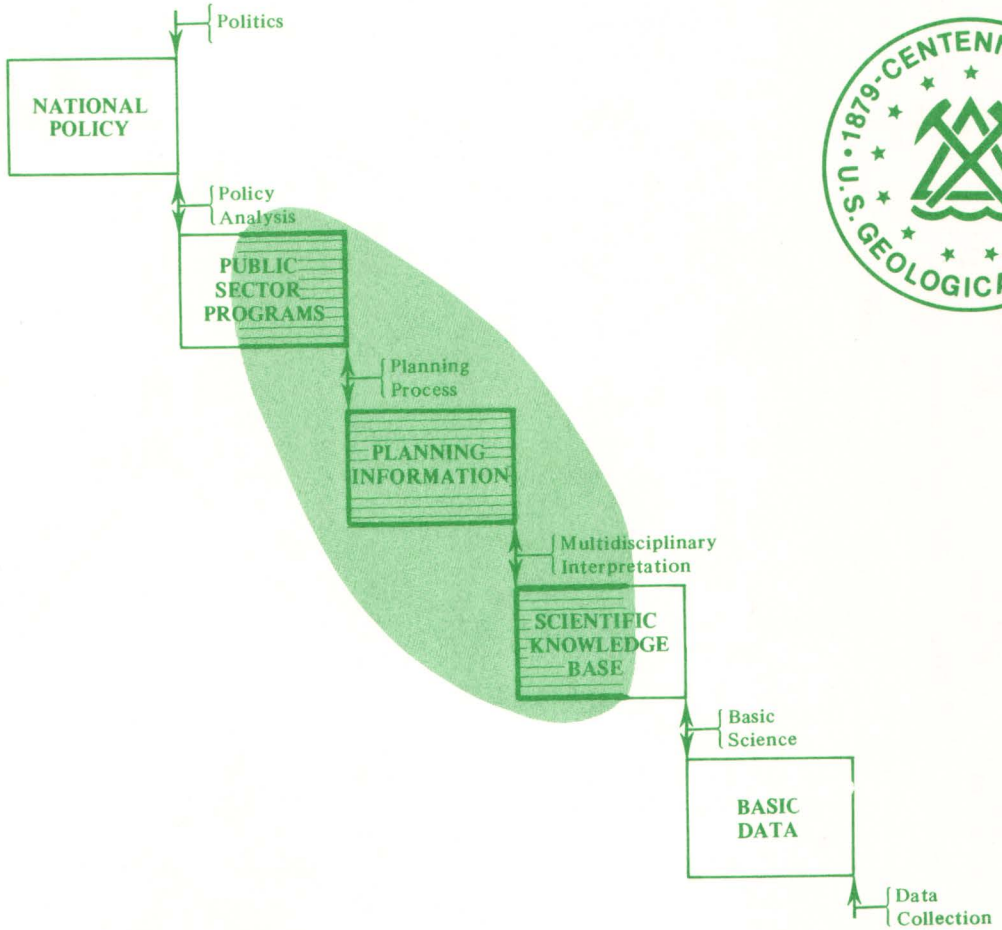
TRANSFERRING EARTH SCIENCE INFORMATION TO DECISIONMAKERS

Problems and Opportunities as Experienced by the U.S. Geological Survey



GEOLOGICAL SURVEY CIRCULAR 813

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By Thomas F. Bates

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FOREWORD

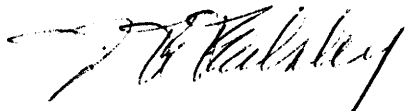
In 1972, the Survey's ninth Director, V. E. McKelvey, expressed his concern that the U.S. Geological Survey was not communicating earth science information to the land resource planners and decisionmakers of the Nation as effectively and widely as possible. Director McKelvey perceived a need for the Survey to enlarge its traditional style and format of communication, and established in 1974 a testing ground within the Survey, the Land Information and Analysis (LIA) Office, where experimental programs could be carried out to develop new methods of information transfer.

Several themes emerge from the experience of the diverse LIA programs that should be of particular interest to scientists and engineers concerned with effectively conveying earth science information to planners and decisionmakers. Among these are:

- The earth scientist must be able to view a problem from the decisionmaker's perspective to facilitate development of useful earth science information.

- Consultation and follow-up contact is necessary until the use by planners and decisionmakers of a particular kind of earth science information becomes a regular accepted practice.

The report that follows highlights these and other points, and is offered with the hope that the earth science community will build upon our experiences.



J. R. Balsley
Chief, LIA Office

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TRANSFERRING EARTH SCIENCE INFORMATION TO DECISIONMAKERS

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INTRODUCTION

Owing to increasing energy, environmental, and land use pressures, earth scientists must augment their efforts to make earth science information (ESI) more readily available and useful to the citizens of the United States. Two major trends account for these pressures: (1) Increasing numbers of decisions are being made in the counties and municipalities throughout the country relating directly to effective use of the Nation's land surface and subsurface. (2) Federal, State, and local regulations, as well as assistance programs for more effective and commonly multiple use of the land and its resources, either encourage or require local land use planners and decisionmakers to take earth science information into account. They can do so only if ESI is transferred effectively to them and the citizens they serve.

The magnitude of the challenge to the earth science community will justify the attention of a large proportion of its members, whether employed as consultants, or by government, universities and colleges, or private industry. Indeed, the task is so great that it will require an appreciable increase in the size of this community over the years--first, to correct current deficiencies and, second, to provide continuing growth to meet increasing demands.

The interest in applying earth science information more effectively to land use planning problems is not new: the Soil Conservation Society of America held its first meeting on land use in May 1948. Again, positions for engineering geologists were established in both the city and county of Los Angeles in 1959. Each year increased attention and time is given to the subject by earth science information producers and land use planners alike.

What is new is that the needs are assuming nationwide proportions and no longer relate only to people that have suffered, or that live in anticipation of, earth-related catastrophes, such as earthquakes, landslides, and floods. Population continues to increase, and "set-aside" legislation for parks, highways, wild and scenic areas, etc., inexorably reduces the average private-land acreage per U.S. citizen. As a result, new problems confront thousands of communities throughout the Nation. These include: Water supply and water quality, solid and liquid waste disposal, loss of prime agricultural land, pollution of air and water, recovery (or preservation for future recovery) of construction materials and other mineral and fuel resources in urbanizing areas, more use of the subsurface for transportation and utility corridors as well as parking garages and working quarters, and multiple land and water uses where conflicting purposes and societal pressures dictate shared responsibilities of various interest groups.

Past and current activities in the information transfer area, such as those reported herein, show that an appreciation at local government levels of the potential applications of earth science information depends on a large number of variables which differ from place to place. Each town and county, council of governments, and river basin commission will need assistance from soil scientists, geologists, hydrologists, engineers, biologists and/or other earth scientists to meet its own land use problems. However, in each instance one ingredient is essential to success, namely, the establishment and maintenance of close, mutually beneficial working relationships among the cooperating groups--the scientists, the land use planners and decisionmakers, and the citizens they serve.

In an editorial (Woolfe, 1978) on the lack of meaningful interaction between earth scientists and planners, Donald A. Woolfe, former Planning Director of the San Mateo County Planning Department in California, offered this advice to geologists: "it is imperative for you to develop a trusting, working relationship with someone who has the ability to sell your information to public officials. Join with other environmental professionals! Take a planner to lunch!" In this and other ways he was pointing out that the use of earth science information for planning and decisionmaking will not achieve its full potential until earth scientists and planners understand each other's needs, problems, pressures, and aspirations and can communicate these to each other in a common language.

The number of geologists working as, or in close association with, planning officials, and the number of planners who have been geologists, is small. Although energy and environmental pressures are encouraging some universities to include a smattering of earth science courses in their planning curriculums, and although some State geological surveys have long been attempting to educate the citizenry in the importance of environmental geology, the earth science community as a whole has yet to realize that it has primary responsibility for ensuring adequate and proper use of earth science information by the public and its representatives.

The earth scientist-citizen user community partnership must prevail throughout all phases of land use planning and decisionmaking. Key role

players within the various "power structures" of the area involved must first be identified; joint assessments of perceived and real needs and of the nature and format of the products to best help satisfy those needs must then be made; and preparation and transfer of the information in ways that will ensure its most effective application by the lay user to the problem should follow. Throughout the overlapping stages of need assessment, product preparation and packaging, and information transfer and use, there must be continual formal interaction and informal dialog between the producer and user communities if the needs of the latter are to be most effectively served.

This paper reports on the experiences of U.S. Geological Survey (USGS) scientists in interfacing with members of the land use planning and decisionmaking community on a wide variety of projects of the type administered by the Land Information and Analysis (LIA) Office of the USGS. It addresses the following questions:

- Who are the new users of earth science information, and what characteristics and interests place them in a position to relate more closely to the earth science community?
- What are the needs of these users for earth science information?
- What specific forces generate pressure for increased application of earth science information to land use planning problems?
- What are some of the difficulties faced by the earth science producer and the user communities in working together on these needs and problems?
- What are some of the more successful methods, as demonstrated on USGS projects, of transferring earth science information to nontechnical users?

Examples provided herein are drawn from a large number of LIA projects. They comprise a small but reasonably representative sample of the activities of five USGS programs, (1) which are interdisciplinary with respect to the four existing USGS divisions (Conservation, Geologic, Topographic, and Water Resources) and (2) which administer projects that relate to and involve the user community mentioned above.

ACKNOWLEDGMENTS

The material for this paper was obtained in part from analysis of a number of program evaluation reports (referenced herein) but to a greater extent from interviews with a large number of people personally involved in earth science information exchange. The heads of the five LIA programs and numerous LIA project leaders and staff members who interface between the earth scientists and the land use planners and decisionmakers have been particularly helpful. The author is particularly grateful to Carol Hurr and Jennifer Shawe for careful, critical editing of the manuscript.

USGS ACTIVITY IN THE LAND USE PLANNING AREA

The U.S. Geological Survey has lead agency responsibility for the welfare of the American people so far as it depends on the discovery, understanding, and effective use of data and information about the Earth and its physical resources. In the 100 years since it was founded in 1879, the USGS has met the earth science information needs of a wide variety of users, including:

- Hikers, fishermen, prospectors, landowners, surveyors, the military, and a host of others relying on its topographic maps.
- Natural science and engineering professionals depending on geologic maps, water data, and resource assessments to advance their own interests or those of their organizations.
- State Survey and academic personnel sharing the challenges of scientific discovery to advance the state of knowledge of the Earth and the universe about it.

The great majority of these users have had sufficient motivation and self-interest to seek out earth science information, as provided by the USGS and other producers, and to learn how to use it for their own particular purposes.

In the fifties and sixties, a new set of potential users began looking more closely at the products of the USGS. With the passage of the Clean Water Act of 1965, city managers, county commissioners, and members of sanitation district boards and river basin commissioners found they had to be more concerned with both water supplies and effluents in their own and neighboring jurisdictions. Maps and water data from the USGS, the Corps of Engineers, the Bureau of Reclamation, and other sources suddenly became important to these new "customers" who discovered the need for earth science information.

In this same period, mounting postwar population growth and development pressures were increasing the attractiveness of land surrounding the Nation's population centers. It soon became evident--painfully so, in some cases--that land removed from agricultural and forest usage was not always geologically suitable for residential and commercial development. Landslides, shoreline erosion, fault zones, shrink-swell clays, subsidence phenomena, and eutrophication became terms all too familiar to developers and homeowners. With mounting talk of land use planning, in the county courthouse as well as on Capitol Hill, agencies at all levels of government evaluated their own activities in anticipation of possible Federal land use legislation. Such legislation was, in fact, seriously considered by the Congress in the early seventies and debated as a national need or, alternatively, as a threat to local jurisdictional authority. Awareness spread to an ever larger group of responsible citizens that earth science information, heretofore considered important only in areas of geologic hazards, was also important for communities with less "catastrophic" but more pervasive and long-reaching land use problems. The realization grew

that the inventory, characterization, and classification of the land and the subsurface is elemental and essential to its effective use. Citizens, planners, and decisionmakers in the cities, counties, States and regions, unwilling or unable (politically) to consider jurisdictionwide land use planning, reinstituted conservation district approaches and began to talk in terms of fragile, critical, and special interest areas.

In 1974 the OPEC oil price increases added to the growing list of reasons for making the American public more earth science conscious and for encouraging planners and decisionmakers in energy-producing regions to take harder looks at the land and its resources.

The 1970's became a period of rapid transition to a new era for the producers of earth science information. The interacting impacts of energy, environment, and land use have led to the creation of a huge new set of potential users, who are, for the most part, not knowledgeable about the existence or usefulness of the products or even of the need to investigate that usefulness. One of the top priorities for the earth scientists is to educate the American citizen and his representatives in local, State, and Federal Government to the importance and applicability of earth science information to land resource planning and decisionmaking.

In 1975, in recognition of this need and challenge, the Director of the U.S. Geological Survey set up the Land Information and Analysis (LIA) Office and charged it with providing national leadership in this area. LIA has worked toward the accomplishment of this mission by pursuing four major goals:

1. To create in the citizens and their representatives a greater awareness and understanding of the usefulness--indeed, the critical importance--of earth science information in meeting many of their needs.

2. To work with the divisions of the USGS in the preparation of technical earth science information in the formats and language most suitable for its effective use by intelligent laymen.

3. To assist the public and its representatives in making use of the information by providing and sponsoring educational, advisory, and review services.

4. To illustrate to the earth science community as a whole, by project examples and demonstrations, the difficulties, rewards, and challenges that earth scientists will face in furnishing such assistance.

Five programs have been administered by LIA, all working toward the attainment of these goals. Each seeks to answer the question: How can earth scientists best help the American citizen use earth science information more effectively?

ENVIRONMENTAL IMPACT ANALYSIS (EIA) PROGRAM

The Environmental Impact Analysis (EIA) Program constitutes an integrated USGS response to the requirements of the National Environmental Policy Act (NEPA). Each environmental impact statement (EIS) for which the EIA Program is responsible is a compendium of all available pertinent information (earth science, natural resource, socioeconomic, etc.), relative to an area of concern, set forth in a manner that clearly illustrates the most probable consequences of various actions upon the natural and human environment of that area. Each statement is prepared for a keenly interested, highly motivated segment of the user community concerned with the region involved. Formal public participation in the EIS process is provided for in NEPA and is further directed by guidelines to each EIS study team in the EIA Program.

EARTH RESOURCES OBSERVATION SYSTEMS (EROS) PROGRAM

The Earth Resources Observation Systems (EROS) Program administered by the USGS on behalf of the Department of the Interior, develops techniques to obtain and analyze remotely sensed data and promotes the use of these techniques in fulfilling the resource and environmental inventory and management responsibilities of the Department. This objective is accomplished in cooperation with the National Aeronautics and Space Administration (NASA), the National Oceanic and Atmospheric Administration (NOAA), and other Federal agencies.

A large part of the EROS Program effort is carried out at the EROS Data Center (EDC) in Sioux Falls, South Dakota. EDC maintains an extensive archive of satellite imagery and aerial and space photographs of the Earth, processes and distributes photographic and digital products, and provides extensive user training and technical assistance in the use of remotely sensed data. There is a high demand for all these services, particularly applications training, by representatives of foreign, Federal, State, regional, and local government agencies.

GEOGRAPHY PROGRAM

The Geography Program of LIA provides nationwide capability to assess the status and changing nature of land cover and land use. Through cooperative agreements with State agencies, regional and river basin commissions, and local government units, Geography personnel furnish data showing what is happening to the land, the rate at which it is happening, and the implications for society. Current users include a Department of the Interior task force studying the Barrier Islands of the Atlantic and gulf coasts, the U.S. Fish and Wildlife Service, the Heritage Conservation and Recreation Service (formerly the Bureau of Outdoor Recreation), the Bureau of Land Management, the Environmental Protection Agency, the Soil Conservation Service, the Appalachian Regional Commission, the Ozarks Regional Commission, the Delaware River Basin Commission, the Pacific Regional Commission, San Mateo County in California, and many State and local agencies. The Geography Program, like EROS, faces supply and demand

problems: rapidly increasing user demand throughout the Nation far exceeds the capabilities of the scientists and staff to advance and transfer the rapidly changing technology. Projects administered by both EROS and Geography address a wide spectrum of users, the majority of which are affiliated with agencies of Federal and State governments, and regional commissions. On the whole, these people, though not necessarily specialists with respect to the products and type of training LIA programs offer, are working in natural resource areas and are attempting to improve their own capabilities and the projects of the agencies they represent. Their interest is measured, in part, by their willingness to meet some of the program costs, using mechanisms ranging from cost-sharing arrangements in Geography's USGS-State cooperative land use and land cover mapping program, to payments of fees for courses and workshops at the EROS Data Center. Growing demand demonstrates that the technical training and specific products offered by these two LIA programs are increasingly essential to land resource planning and decisionmaking. (For example, see Natural Resource and Environment Task Force, Intergovernmental Science, Engineering, and Technology Advisory Panel (ISETAP), June 1978.)

RESOURCE AND LAND INVESTIGATIONS (RALI) PROGRAM

The Resource and Land Investigations (RALI) Program was established in 1972 by the Secretary of the Interior to provide the organizational framework to more effectively mobilize the Department's technological capacity and scientific competence for objective analysis of the alternatives in land use. With appropriate collaboration by other agencies of Government, RALI provides the knowledge base for efficient and safe land and resource development. In addition, the program evaluates the tradeoffs between resource development and environmental protection concerns. The program's clientele is primarily Federal, State, and local land use planners but includes others that require earth science, biological, and socioeconomic data, methods, and technologies not available from any single Departmental bureau.

The RALI Program demonstrates exceptional capability to explore, assess, and communicate the role of earth and natural science to the growing community of land resource planners and decisionmakers. RALI factbooks compile, analyze, and synthesize the information this community needs in critical land use planning areas. Workshops transfer this information in a manner tailored to fit the needs of the planners and the citizens they serve. The user population addressed is large and diverse, uncertain of its needs, and largely uninformed as to what part earth science should play relative to socioeconomic, legal, political, and other aspects of land resource evaluation and decisionmaking.

EARTH SCIENCES APPLICATIONS (ESA) PROGRAM

The Earth Sciences Applications (ESA) Program directs and coordinates multidisciplinary USGS projects aimed at providing earth science information for land resource decisionmaking. The program's objectives are threefold: (1) to interpret, demonstrate, and encourage the use of earth science

information for land resource decisionmaking through specially designed projects and report products and through interaction with, and technical assistance to, users; (2) to stimulate, coordinate, and integrate multidisciplinary land resource studies in the USGS; and (3) to serve as the focal point within the USGS for multidisciplinary studies in support of the work of other Federal, State, and local agencies.

To accomplish its objectives, the ESA Program has undertaken projects in selected urban-centered areas of the United States. These studies are conducted by personnel of the Geologic, Water Resources, and Topographic Divisions of the USGS and are supported by funds from the ESA Program. Results are diverse. Robinson and Spieker (1978) gave examples of the importance and utility of earth science products for land use planning and decisionmaking in these urban centers. Detailed assessments of the use of earth science products by city, county, and regional planning agencies in the San Francisco Bay region have been made by Kockelman (1975, 1976, 1979). The ESA Program has also completed tunneling-feasibility studies for the central business districts of Minneapolis-St. Paul, Minnesota, and Los Angeles, California. Also, as the focal point for multidisciplinary land-resource studies, ESA has been instrumental in developing guidelines and procedures to enable the USGS to carry out geologic-hazard warning responsibilities, as required by the Disaster Relief Act of 1974.

Figure 1 shows the locations of some of the information transfer projects, studies, and workshops administered by these five LIA programs in fiscal years 1970-78. For the period 1974-78, a conservative count of all map and book reports prepared under the aegis of these programs totals 575. The following partial list of topics from the LIA bibliography demonstrates the variety and scope of program efforts and concerns.

Coal development
Computerized information
Construction conditions
Earthquakes
Energy resources
Engineering geology
Environmental impact statements
Environmental information systems
Erosion
Faults
Flood prone areas
Hazards
Hydrology
Land use planning
Landslides
Liquefaction
Mineral resources
Oil spill trajectory
Outer Continental Shelf
Overburden
Runoff
Slope
Urban planning
Vegetation
Waste disposal
Water quality
Water supply

USERS AND THEIR NEEDS

The community addressed by LIA projects, studies, and workshops comprises a wide spectrum of users, ranging from members of Federal, State, and local government agencies to the citizens they serve; diversity is the rule rather than the exception. Furthermore, the character and compo-

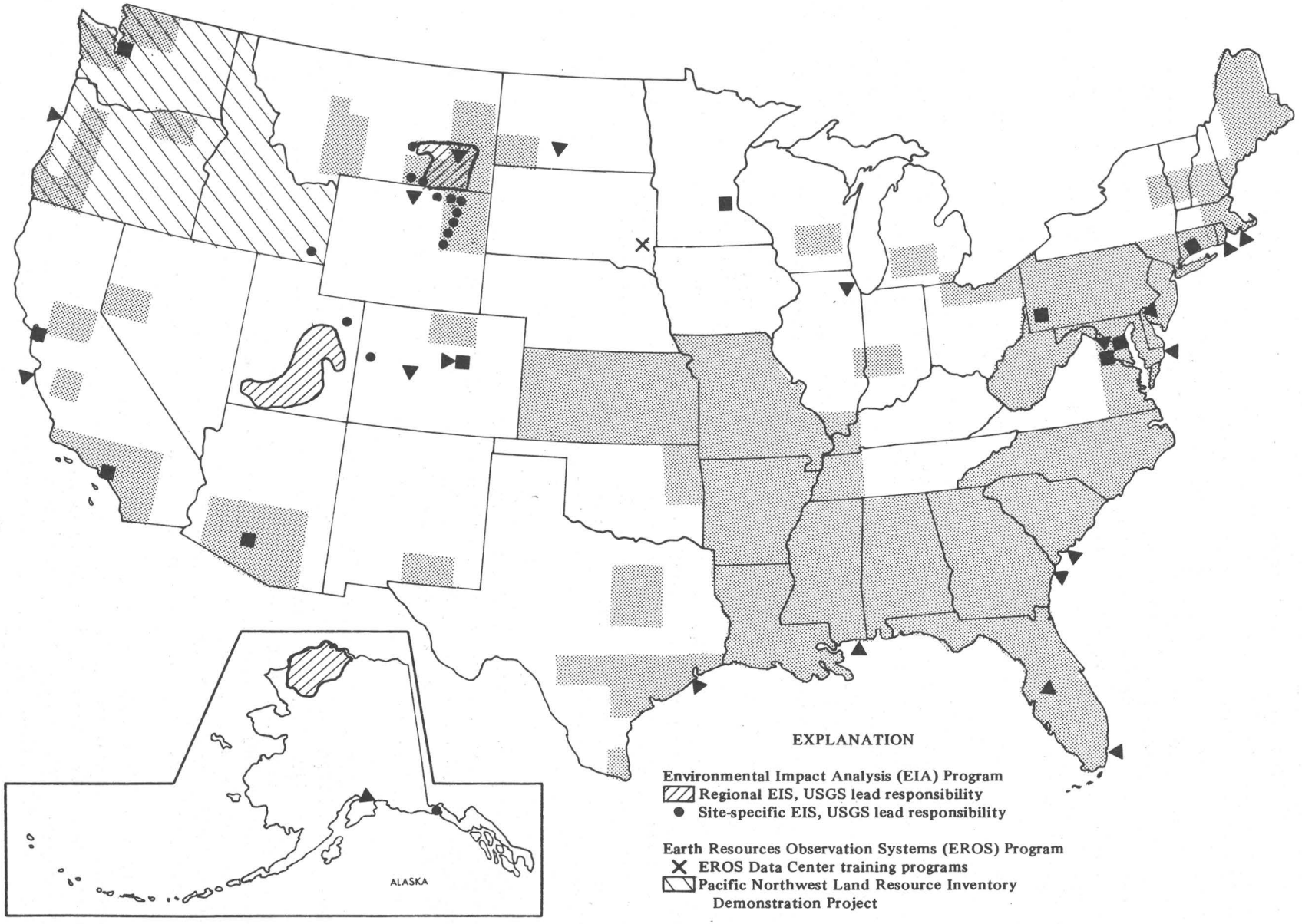

FIGURE 1.—Location of representative LIA information transfer projects, 1970-78.

sition of this user community is continuously changing. Particularly in the land use planning area, where important decisions are made at the local jurisdictional levels, changes in citizen participation and interest, in elected officials, and not infrequently in planning staff members not only increase liaison problems but constantly expose the earth science information to interpretation by new personnel who have not had the benefit of previous experience with the project. This changing "mix" requires that earth science information be furnished in language and format easily comprehended by the intelligent layman. This concept appears simple enough; its application has proved to be more difficult. Although no one area in the information transfer field has received as much attention as this, this issue deserves more.

Commonly, the earth scientists producing and disseminating information have little to do with, or say about, how and by whom the information is used. Conversely, some key users, who may have a great deal to do with the overall success of an ESI effort, are predetermined and well known to the information producers. The USGS-LIA project examples discussed in the next section extend to both extremes; indeed, the extremes may be represented within a single project. A final environmental impact statement (FES), prepared by the Environmental Impact Analysis Program, is used by decisionmakers in the Nation's Capital as the basis for judgments required by NEPA. Strictly speaking, these decisionmakers [e.g., the Secretary of the Interior, and the Council on Environmental Quality (CEQ)] are the users of the information provided in the statement. But there is also a diverse group, including citizens, private and nonprofit organizations, and governmental agencies, that reacts to and uses the draft environmental statement (DES), which is subject to critical comment. This group is "unselected," at least by ESI producers, although its participation is sought both formally through public hearings and informally through a variety of contacts made in the preparation for and production of the report.

When information products are in considerable demand, the producer has the greatest opportunity to determine their market. For example, remotely sensed data available through the training courses at the EROS Data Center are of such significance to so many potential users that limits must be placed on the number to be accommodated.

The problem of effectively identifying and involving key representatives from large and diverse user communities has proved to be different for each of the LIA program efforts. Experience has shown that earth scientists are unlikely to have specific knowledge of the politics, administrative goals and procedures, and the numerous hidden forces that affect the operations and interests of many of the user communities; for this reason, alliance with an intermediary type of organization, respected by both producer and user communities, is often advisable.

In the first of the Urban Area Studies (San Francisco Bay Region Environment and Resources Planning Study, 1971), the high population density of the Bay area made identification of key representatives in the huge user community particularly difficult. The Association of Bay Area Governments, acting as intermediary, helped to alleviate the problem.

For the Connecticut Valley Urban Area Project, the Connecticut Geological Survey worked with the USGS to assure linkage with citizens, planners, and decisionmakers at the local government levels.

Certain problems are potential to any use of intermediaries; numerous factors affect and determine an organization's capability to serve in this capacity. On a number of the Urban Area Study projects, the attempted use of regional groups as coordinating and communicating "mechanisms" to link producer and user communities was found to be ineffective. Failure can be attributed to such things as lack of strength (political, financial, authoritative, or otherwise), lack of apparent "rewards" from the project (in the sense of its improving the image of the coordinating entity, at least in the eyes of its own members), or lack of sufficient preliminary planning to assure adequate understanding and commitment on the part of the intermediary.

Unfortunately, there is some feeling in the community of earth scientists that the use of intermediaries, or transfer agents, relieves the information producers of responsibility for interfacing directly with the users, or even for putting their information into lay language. It is also felt that requiring or encouraging potential planners to include earth science courses in their training absolves information producers of these same responsibilities. LIA experience has indicated that although both the use of transfer agents and the education of planners in the earth sciences (as well as of earth scientists in the art, science, and politics of planning) are increasingly important components of the information transfer system, nothing replaces intensive producer-user interaction, and preparation and presentation of products in the simplest form possible.

There are three types of needs that must be served by the earth scientists in relating to the new user community:

1. The need to make potential users aware of the availability, importance, and utility of earth science information.

2. The need for the products themselves--the maps, reports, remotely sensed photographs and data, etc.

3. The need to assist the user in the effective application of the information to his problems by providing appropriate educational, advisory, and review services.

The same considerations that determine the ability of earth scientists to identify and involve appropriate user communities and their leaders also have an important bearing on correctly assessing user needs for earth science information. In some areas, needs are equally obvious to producers and users alike, and the manner in which the needs can best be met may be very clearly defined. The RALI workshops, EROS Data Center training application courses, and environmental impact statements are in this category. These LIA projects are initiated because of product demand, generated in the first two examples by the activities of the scientists involved and in the last by NEPA legislation.

More commonly, user needs are not so well defined, and, because of lack of mutual understanding of each other's problems, both ESI producers and users may have perceptions of need that require considerable modification as the result of continuing dialog and mutual education. The Urban Area Studies projects, among others, were set up as demonstrations intended to determine, at least in part, (1) the ability of the earth scientists to respond to apparent needs of the user communities, and (2) the response of these communities to earth science information production and transfer efforts. Although some of the projects have accomplished more than others, all have successfully shown that earth science information is needed for good land use planning and that those members of land use planning and decisionmaking communities who have been made aware of the availability and utility of this information recognize this need and commonly advocate additional work in this area.

The amount of effort that can justifiably be devoted by the information producers to each of the three types of need varies in proportion to other factors over which the earth science producer community may have moderate, little, or no control. One such factor involves those "driving forces," or pressures, on the members of the user community which require or encourage them to devote time, effort, and other resources to the application of earth science information. Examples of various types of driving forces are given in table 1.

Members of the user community are most receptive to the use of earth science information when they are influenced by driving forces, such as peer pressure or legislative mandate. Thus, the success of any earth science information transfer project, including the effectiveness of producer-user interaction, is directly related to the amount of user commitment to the project as determined by such pressures. So it was that effective participation and commitment from State agencies in Oregon, Washington, and Idaho, in the Pacific Northwest Land Resource Inventory Demonstration Project, was secured as a result of the direct involvement, interest, and support of the three State Governors in their roles as members of the Pacific Northwest Regional Commission. Elements of both "peer" and "system" driving-force pressures were in effect. In a RALI project involving workshops on Onshore Facility Siting, the requirements imposed by the Coastal Zone Management Act (CZMA) and the National Environmental Policy Act on State and local planners, the participation of the Governors' offices in selecting the attendees, and the absence of fees, encouraged sincere and purposeful commitment by the user to the achievement of workshop objectives. In the Urban Area Studies Program, maximum producer-user interaction and consequent benefits to the users have accrued in those areas where the earth science information provides direct and useful input to help meet user needs generated by those driving forces resulting from State or Federal legislation. For example, passage of the Alquist-Priolo Seismic Safety Act in California has greatly increased the demand for fault maps and earthquake study reports produced as part of the San Francisco Bay Region study. Similarly, sand and gravel maps produced in the Front Range Urban Corridor studies in Colorado and drainage area maps on the Connecticut Valley Urban Area Project are among the many products generated in anticipation of or in response to land use planning needs resulting from Federal or State legislation.

TABLE 1.--"Driving forces" that encourage use of new products, tools, and techniques

Force	Significance	Problems
Survival pressure--	Probably most effective of all is survival of office (project, staff, responsibility, etc.). Requires adoption of new techniques, products, etc.	Bureaucratic systems may allow archaic operations to survive long after they should be modernized or eliminated.
Peer or competition pressure.	Fairly effective. If it is the thing to do, market economics will provide the stimulus.	Again, in bureaucratic systems (local, State and Federal Government), an operation can survive without too much concern for this element.
System pressure----	Often very effective. The need to impress people "up the line" in the system, or in other units of the system, is often important. Also, if the system requires or encourages the use of the products, the pressure is obvious. May be in anticipation of laws, rules, and regulations, or after the fact.	Pressure must usually come from a high level if it is to be effective. Lack of money to implement laws may be major stumbling block.
"Reward" pressure--	Fairly to very effective if benefits are obvious: free products and services, Federal or State monies tied to performance re various laws (HUD 701, EPA 208, Mine Reclamation, Coastal Zone Management, etc.)	Unfortunately, many of these vehicles are deficient in spelling out specific requirements for effective use of earth science information.

In this connection, there is an increasing amount of Federal legislation which includes sections that implicitly encourage or explicitly require the application of earth science information. Spicer, Braud, and Bordelon (1977) pointed out:

> "Today, well over 850 Federal programs make available grants, loans, guarantees, technical assistance, land, and equipment or authorize direct Federal action. Many relate in some

manner to land development and use. Over 130 of these programs have a direct impact on land use.

"...four are relatively broad in perspective. They are Section 208 of the FWPCA [Federal Water Pollution Control Act]; Section 404 of the FWPCA; Sections 305, 306, and 308 of the CZMA; and Section 701 of the Housing and Urban Development Act."

To this list the Surface Mining Reclamation Act of 1977 can be added as another example of legislation of particular significance to ESI producers and the land use planning and decisionmaking community.

Table 2 indicates the extent to which individual States, influenced in part by both Federal pressures and financial inducements, had begun to encourage more explicit land use planning and decisionmaking at State and local government levels.

Since 1976, when these data were published, legislation at the Federal, State, and local level has not only increased but shows a growing tendency to regulate land use, as well as simply provide guidelines. The laws represent decisionmakers' interpretations of the concerns of their constituents for continued growth in an environment conducive to improved quality of life. They constitute the principal driving force that is rapidly increasing the need for earth science information for land use planners and decisionmakers.

LIA EXPERIENCE AT THE PRODUCER-USER INTERFACE

The five LIA programs relate to the users and their needs in a variety of ways. Table 3 indicates some of these variations from program to program with regard to a number of user-related parameters. Parameter 3, "Current product demand," provides an example. In the Environmental Impact Analysis Program, for example, demand for the the environmental impact statement is generated by the law that requires it. The ultimate users of an EIS are the administrative officials who must decide which of several courses of action is to be taken for the region, facility, or site under consideration. The public, including all groups and institutions, plays a dual role: first, as user of the information, and, second, as a participant in the preparation of the final EIS by virtue of reacting (in writing or at public hearings) to the draft EIS. Both the administrative officials and the public are interested in and concerned with the product. A high proportion of these users have a reasonably sound background knowledge of at least some of the subject matter and issues covered by the report and are highly motivated to seek out and understand all available information pertinent to their concerns.

Demand for EROS and Geography products is equally strong and rapidly increasing, but for different reasons. Remotely sensed information proves more and more useful in activities that range from scientific research, through natural and human resource inventory, to detection and assessment of land use and land cover changes over time. The need for photographic

TABLE 2.--State land use programs

[From Council of State Governments, 1976b]

State	Type of State Program			Coastal Zone Management[4]	Wetlands Management[5]	Power Plant Siting[6]	Surface Mining[7]	Designation of Critical Areas[8]	Differential Assessment Laws[9]	Floodplain Management[10]	Statewide Shorelands Act[11]
	Comprehensive Permit System[1]	Coordinated Incremental[2]	Mandatory Local Planning[3]								
Alabama				X		X	A			X	
Alaska		X		X		X			B		
Arizona		X				X			A	X	
Arkansas						X	A, B		A	X	
California		X		X		X	X		C	X	
Colorado						X	X	X	A	X	
Connecticut		X		X	X	X			B	X	
Delaware		X		X	X				A		X
Florida	X	X	X	X	X	X	A	X	A, C		
Georgia		X		X	X		A, B				
Hawaii	X	X		X		X	X	X	B	X	
Idaho			X				X		A		
Illinois				X		X	A, B		B	X	
Indiana		X		X			A, B		A	X	
Iowa							A, B		A	X	
Kansas							A, B				
Kentucky						X	A, B		B		
Louisiana				X	X						
Maine	X	X	X (LTD)	X	X	X	A	X	B	X	
Maryland		X		X	X	X	A, B	X	B	X	
Massachusetts				X	X	X			B		
Michigan				X			X		C	X	X
Minnesota		X		X	X	X	X	X	B	X	X
Mississippi				X	X					X	
Missouri					X	X	X		A	X	
Montana		X	X			X	A, B	X	B	X	X
Nebraska			X			X			B	X	
Nevada		X	X			X		X	B		
New Hampshire				X	X	X			B, C		
New Jersey				X	X	X			B	X	
New Mexico		X				X	A		A		

See footnote at end of table. (Table continued on next page)

TABLE 2.--State land use programs--Continued

State	Type of State Program			Coastal Zone Management [4]	Wetlands Management [5]	Power Plant Siting [6]	Surface Mining [7]	Designation of Critical Areas [8]	Differential Assessment Laws [9]	Floodplain Management [10]	Statewide Shorelands Act [11]
	Comprehensive Permit System [1]	Coordinated Incremental [2]	Mandatory Local Planning [3]								
New York	X	X		X	X	X	X	X	B	X	
North Carolina		X		X	X		X		B	X	
North Dakota						X	A		A		
Ohio				X		X	A		B		
Oklahoma							X		A	X	
Oregon		X	X	X		X	A	X	B		
Pennsylvania				X	X	X	A	X	B		
Rhode Island		X		X	X	X			B		
South Carolina				X		X	A		B		
South Dakota							A	X	A		
Tennessee						X	A, B				
Texas				X	X		X		B		
Utah		X					A		B		
Vermont	X	X			X	X	X		C	X	
Virginia			X	X	X		A, B		B		
Washington		X		X	X	X	A		B	X	X
West Virginia							A, B			X	
Wisconsin		X		X	X	X	X	X		X	
Wyoming		X	X			X	A		A		

[1] State has authority to require permits for certain types of development.

[2] State-established mechanism to coordinate state land use-related problems.

[3] State requires local governments to establish a mechanism for land use planning (e.g., zoning, comprehensive plan, planning commission).

[4] State is participating in the federally funded coastal zone management program authorized by the Coastal Zone Management Act of 1972.

[5] State has authority to plan or review local plans or the ability to control land use in the wetlands.

[6] State has authority to determine the siting of power plants and related facilities.

[7] State has statutory authority to regulate surface mines. (A) State has adopted rules and regulations. (B) State has issued technical guidelines.

[8] State has established rules, or is in the process of establishing rules, regulations, and guidelines for the identification and designation of areas of critical state concern (e.g., environmentally fragile areas, areas of historical significance.

[9] State has adopted tax measure which is designed to give property tax relief to owners of agricultural or open space lands. (A) Preferential Assessment Program—Assessment of eligible land is based upon a selected formula, which is usually use-value. (B) Deferred Taxation—Assessments of eligible land is based upon a selected formula, which is usually use-value and provides for a sanction, usually the payment of back taxes, if the land is converted to a non-eligible use. (C) Restrictive Agreements—Eligible land is assessed at its use-value, a requirement that the owner sign a contract, and a sanction, usually the payment of back taxes if the owner violates the terms of the agreement.

[10] State has legislation authorizing the regulation of floodplains.

[11] State has legislation authorizing the regulation of shorelands of significant bodies of water.

* SOURCE: Prepared by the Council of State Governments, based on information collected by the Council of State Governments, *Land Use Planning Reports 1974* and 1975, and the U.S. Department of the Interior, Office of Land Use and Water Planning; and the Resource Land Investigations Program. Data compiled October 1975.

imagery, digital data, and applications training is admitted by an ever larger number of users, to the point where program supply falls far short of user demand, even though users are willing to share the costs.

The product demand for the RALI and ESA studies is less clear cut. ESA concentrates on ESI application, particularly to urban area problems. RALI is more problem-oriented (how do we manage this coastal zone?; how do we mitigate these impacts of coal production?, etc.) and, through the use of factbooks and workshops, assists the users in developing approaches to problem solution by applying all types of pertinent information, including the earth sciences. The user communities involved are large and diverse, and their knowledge about the applicability of ESI to problem solution ranges from good to poor. Consequently, product demand must often be created by a variety of educational efforts designed to make the user aware that earth science information will indeed help in the solution of some of his problems. Here, driving forces come into play. Because the entire Nation is in some way subject to land-resource-related impacts (sanitary landfills, water quality and quantity, mineral and fuel extraction and land reclamation, multiple land use, etc.), the potential user community for RALI- and ESA-type assistance is huge. However, product demand will grow only as this population is made aware of the value of the available information.

Difficulties encountered at the producer-user interface within these five LIA program areas, and the approaches that have proved successful in removing them, are numerous and varied. The following section describes the general nature of the problems and cites a few examples of approaches taken and lessons learned in the LIA experience.

URBAN AREA STUDY PROJECTS OF THE ESA PROGRAM

Of the programs administered by LIA, ESA's Urban Area Study projects have had the greatest problem with producer-user interface, largely because of the size and diversity of the communities they are trying to serve. ESA has recognized this problem and attempted to meet it by investigating various approaches to its solution. Indeed, according to the program design statement for the San Francisco Bay Region Environment and Resources Planning Study (1971), the primary goal of the work was "to develop earth science concepts, products, and procedures which can significantly improve regional planning and development."

The major producer-user interface problems encountered in all the Urban Area Study projects center around:

- Identification of key representatives in the user community, who not only have the greatest interest in and the most to gain from interaction with the producers, but who also have influence among their peers.

- Determination of the needs to be met, as perceived by the user, and of the information available or that can be produced to assist in meeting them.

TABLE 3.--Land Information and

LIA program	Type and diversity of earth science information (ESI)	Products	Current product demand	Types of needs to be met
EIA-------	Broad range of ESI for specific regions.	Environmental impact statements, environmental analyses, and reviews of similar products by other Federal agencies.	Strong.	Information for high-level decisions as to alternate actions.
EROS------	Broad range of ESI, worldwide coverage.	Remotely sensed imagery and digital data, and training in its use.	Demand for training exceeds capacity by factor of five.	Information and training for a broad range of land resource management actions.
Geography--	Land use and land cover information, nationwide.	Maps, digital data, and training.	Increasingly strong.	Information and training for a broad range of land resource management actions.
RALI-------	Broad range of earth science and other information related to planning techniques and methods.	Information transfer, using a variety of methods including factbooks, reports, workshops, and pilot studies.	Strong, when users are made aware of product availability.	Wide range, increasing steadily with need for land resource planning.
ESA--------	Very broad range of ESI for specific regions.	Maps, reports, and pilot projects, supplemented by educational assistance.	Variable, depending on nature of product; increasingly strong, in general.	Very wide range, increasing rapidly with legislation requiring use of ESI.

- o Establishment and maintenance of effective producer-user communication throughout the project.
- o Provision for followup educational, advisory, and review services to assure that the user community can make optimal use of the products and information provided.

These problems may be compounded by users who have little or no knowledge of the earth sciences, by scientists who tend to be overly optimistic as to the applicability of their products, by ineffectual intermediaries, and/or by budgets and plans unequal to the task at hand. In the Urban Area Study projects, all these factors existed in varying degree.

Analysis Program characteristics

Types of users addressed	Relative size of user community	Diversity of of user community	Knowledge of potential user about the applicability of ESI to his needs	Availability of user funds	Problems of meeting user needs
Administration decisionmakers and concerned public.	Small.	Wide but with regional focus.	Good to excellent.	Necessary funds are provided.	Primarily those of report format constraints and rapid response to changing policy.
Government agencies at various levels. Preponderantly Federal, State, and international.	Large and growing rapidly.	Wide and becoming more so.	Good to excellent.	Fairly good.	Difficulty in servicing increasing number of users.
Government agencies at various levels. Preponderantly State and regional.	Large and growing rapidly.	Relatively narrow but growing wider.	Good to excellent.	Fairly good.	More emphasis needed on user training, particularly in digital applications.
Professional planners and decisionmakers.	Currently small, potentially large to very large depending upon topics covered.	Extremely wide.	Good.	Good.	Limited manpower resources.
Citizens and their governmental representatives.	Small, but potentially very large at all levels throughout the Nation and in foreign (especially developing) countries.	Extremely wide.	Poor to fair.	Poor until interest is created.	Largely communication and awareness problems.

When the San Francisco Bay Region Environment and Resources Planning Study was planned in 1969, USGS and Department of Housing and Urban Renewal (HUD) representatives were aware that, so far as land use studies of this magnitude were concerned, they were breaking new ground. Some problems were anticipated, many others were not. The need for working with an intermediary aware of the "politics" of the region was recognized early in the study, and the Association of Bay Area Governments was invited to participate. This liaison proved useful even though the association did not have as much of an influence over its member governments as the scientists had expected and hoped. Due to initial lack of communication, and misperceptions on the part of user groups as to their own needs and how the USGS products might help meet them, early products were almost exclusively those which the scientists deemed valuable. As it turned out,

many of them were. But the project had been underway for several years before multidisciplinary user-producer task forces, assigned to specific subject-matter areas, discovered exactly which products would best meet user needs. This discovery was made only after key role players were identified, communication channels were made effective, users achieved a better understanding of their needs for ESI and of the scientists' abilities to satisfy them, and scientists learned which products, set forth in which formats, scales, etc., were most useful.

Nor did the project personnel of the San Francisco Bay Region Study (SFBRS) appreciate from the outset the full extent to which information transfer would be a problem. Plans had been made for product dissemination to a large number of potential users, for press releases, for distribution of publication lists, for prompt publication of results, and for the use of various types of panels, advisory groups, and task forces to bridge the "gaps" between producers and users. But assistance in how to use information must accompany its dissemination. This realization was driven home only after the project was midway toward completion, because it was at this point that the users were required to test the applicability of the products pertinent to land use decisions and public hearings but had yet to build up their own competence in interpreting and explaining the significance of ESI. Fortunately, some degree of resource flexibility enabled project administrators to respond to these needs. Scientists working on the project were supported in their efforts to explain their work to members of the user community; indeed, for some project members the priority attached to publication of results was modified to permit them to spend more time in advisory roles. A professional planner previously appointed to the project staff also spent much of his time working with the user community. Universities in the area were encouraged to use the products in appropriate courses.

Evaluations of the project (Arthur D. Little, Inc., 1975; Kockelman, 1975, 1976, 1979) bear out the importance of these educational and advisory efforts. Kockelman's inventories (1975, 1976) of the use of SFBRS products in 91 cities and 8 counties in the Bay area showed that:

- All eight counties, and three-fourths of the cities, had planning staffs who were familiar with SFBRS products or had made use of them.

- Planning applications most often indicated were geologic hazards studies, seismic safety and public safety plan elements, general reference, and the preparation and review of environmental impact reports and statements.

- About 90 percent of some 87 SFBRS products were used at least once by cities and counties alike; 1 product was used at least 67 times for various city planning activities; and 9 products were used over 30 times each for various county planning activities.

- At least 45 USGS products, apart from those generated by SFRBS, were also used for various city planning activities, and 85 others for county planning activities.

The Colorado Front Range Urban Corridor Project, in contrast to its West coast counterpart, had essentially no flexibility with regard to resources available to foster activity in the information transfer area. However, as a result of the conscientious work of the project administrator and the individual project members in producing useful products, the project has had a strong, beneficial influence. It has helped to set the stage for important State legislation in the areas of mineral fuels and construction materials, to encourage the employment of geologists and use of geological consultants at local government levels, and to provide a host of reports and maps that effectively demonstrate the usefulness of earth science products in a rapidly urbanizing area. Despite such positive results, a recent user survey made for the USGS (Downing, 1978) revealed that of the 318 potential users interviewed (local government planners, consulting engineers and geologists, architects, and university professors, two-thirds of whom were on the project mailing list) 49 did not know of the Urban Corridor Project, over half had not used the maps, and only 10 percent had made extensive use of them. It is evident that, if maximum benefits are to be derived from projects involving large expenditures for the preparation of earth science products for land use planning, funds must be allocated to assure that planners and decisionmakers know about ESI and are able to use it.

Similar conclusions were reached in an evaluation of the USGS Greater Pittsburgh Regional Studies Program. The study, commissioned by the Appalachian Regional Commission (Wissel and others, 1976), details comparable difficulties in achieving effective information transfer to a high percentage of the potential users. The authors based their conclusions on "extensive personal interviews with elected officials from 109 of the 417 municipalities (including the 6 county governments) in the area, and with 44 land use planners who deal with land use questions via either county and municipal planning departments or private consulting firms." Their findings were described with respect to "those critical links" in the communication process between (1) suppliers and translators; (2) translators and users; and (3) suppliers and users. Regarding category (1), the investigators pointed out that "most planners [translators] who are eventually charged with responsibilities on land use questions do not receive much emphasis on technical training in the geological sciences in their planning curricula." However, "three-fourths of the planners interviewed make requests of the USGS with some frequency, most of them finding the information they obtain to be very useful." In category (2), "great variation was discovered among elected officials [users] concerning perceptions of the seriousness of physical problems in making land use decisions, the technicality of information needed in making such decisions, and the value of information on land use." As for the category (3) link, "from the vantage of most elected officials, [it] is almost non-existent * * *."

Other LIA projects differed from the Urban Area Studies in a number of ways that bear directly on the nature and extent of problems en-

countered at the producer-user interface. These projects, though different each from the other, involved producers with similar perceptions of needs to be met, of products that might meet them, and of the means of information transfer. Specific "ultimate-users" of the information in question were more readily identified for these projects, and monetary and other resource commitments from the users were more easily obtained; thus, truly cooperative efforts between the earth science and user communities were more easily achieved. The following examples will serve to illustrate that cooperation, and to point out how producer-user interface problems here differed from those of the Urban Area Study projects.

RALI PROJECT FOR "ONSHORE PLANNING FOR OFFSHORE OIL AND GAS DEVELOPMENT"

The Onshore Planning for Offshore Oil and Gas Development Project was initiated in 1975 to assist coastal States, and representatives of their governmental units at all levels, to prepare for possible onshore impacts of offshore energy developments. This effort involved, first, the gathering of pertinent data, then, its analysis and assemblage in a form suitable for the intended audience, and, finally, the transfer of information, together with instruction in its use, to that audience. To further its goal, specifically to meet problems anticipated at the producer-user interface, RALI contracted with two "intermediary" organizations. The New England River Basin Commission (NERBC) was to gather the information and put it in a form suitable for effective transfer to planners and decisionmakers; the American Society of Planning Officials (ASPO) was to plan and run the information transfer workshops. The real possibility of recovering oil and gas off the coast of the New England States, and the potential for onshore support facilities, made the problem a practical one for NERBC. The Commission approached its task of identifying and involving key representatives by instituting a regional steering committee of Federal and State officials; by forming a project advisory group, consisting of people active in the fishing industry, environmental groups, port management, banking and commerce, labor, the regional energy industries, and heavy construction; and by establishing working arrangements with the Production Subcommittee of the American Petroleum Institute's Exploration Committee. ASPO worked with RALI project leaders, NERBC, and the Environmental Protection Agency to plan and prepare for 15 three-day workshops to be held over a 2-year period. A user survey was conducted to identify both the audience for whom the workshops should be designed, and the significant issues as perceived by the respondents. The governors' offices in the coastal States in question helped designate workshop participants, at all levels of government within the region, who could profit most from the information. A multidisciplinary faculty was chosen, supported at each workshop by area specialists who "spoke the language" of the participants and who had already dealt with major facility siting and development problems. Workshop responsibilities were assigned by this faculty on the basis of information acquired from preregistration forms. Postworkshop evaluations, by both participants and faculty, were used as the basis for modification of ensuing sessions.

The most significant differences between this RALI project and the Urban Area Study projects are the size and diversity of the user communities

involved, the duration of the projects, the number and variability of the products provided, and the degree of control established and maintained by the information producers in working with the user community. The SFBRS, largest of the Urban Area Study projects, covered 9 Bay area counties, comprising 91 cities and a total population (in 1970) of over 5 million. The responsibilities of the decisionmakers in the area ranged from the granting of permits for homes or subdivisions to the managing of water quality in San Francisco Bay. Over 100 maps and reports were produced in the 6 years of project operation: some of these were used extensively throughout the region; others received limited local attention. The RALI effort was to transfer information to an audience consisting on the average of 75 planners and decisionmakers. In a total of 15 workshops, approximately 1,000 persons from Federal, State, and local government, industry, and special interest groups attended. Each workshop was tailored to different regional issues. Clearly the two projects are comparable only in that problems of communication and cooperation between producers and users are similar. Even so, identification of key role players, definition of the needs to be met, preparation of products usable by the intelligent layman, and effective transfer of the information are equally critical to the success of both types of operation.

USGS-STATE LAND USE AND LAND COVER MAPPING PROJECT

The Land Use and Land Cover Mapping Project, administered by the Geography Program, was authorized by the Congress in 1975 to provide, within 7 or 8 years, land use and land cover maps and associated data for the entire United States. Experience in this program at the producer-user interface differs from that of both the RALI and Urban Area Study programs.

The user community addressed consists of the representatives of those State agencies assigned responsibility to work with USGS scientists in completing graphic coverage of their State and, in some places, to enter the data into computers through the use of digitization processes. Responsibility for the transfer of the information to people at the regional and local government level within the State rests with the State agencies involved.

Much of the planning for this program derived from previous experience of both Geography and EROS, in association with NASA, in evaluating potential applications of remotely sensed data obtained from Landsat (formerly ERTS) satellites and high altitude aircraft. In 1970 a large project had been undertaken by the three groups to study the application of such data to a variety of land use planning problems in a part of the Atlantic coastal region, called the Central Atlantic Region Ecological Test Site (CARETS). In the same year, studies were begun on urban change detection to provide a basis for evaluating land use changes in eight urban areas. A land use classification system for use with remotely sensed data (Anderson, Hardy, and Roach, 1972; Anderson and others, 1976) was set up and put to use in these and subsequent projects such as those initiated in the Ozark region in 1972, and in Pittsburgh and Atlanta in 1974. In addition, user seminars on this system were held in 1973 in Boston, Memphis, Denver, and San Francisco.

Prior to formalization of a new cooperative agreement with each State entering the program, Geography personnel and State agency user representatives hold briefing sessions and informal discussions to work out details. However, the need for continuous information and technology transfer was not anticipated at the beginning of the program, and the lack of sufficient resources for adequate briefings, seminars, and workshops during all phases of activity remains a problem. A major reason is the rapidly growing interest in and consequent use of new techniques for digitization and computer analysis of information initially provided on maps. The problem has compounded proportionally as greater numbers of users have access to land use and land cover maps and data but possess minimal knowledge as to its quality, significance, and applicability to their needs.

A further complexity, which also argues for more formalized user-producer communication, is the rapidly changing technology in the field of land use and land cover mapping. A 7- to 8-year period will be required to achieve uniform national coverage; meanwhile, today's techniques are rapidly changing and improving. Production problems of various sorts result because States now coming into the program can avail themselves of methods and formats that were not available to those States where mapping had already been completed.

Nevertheless, producer-user interface problems for this Geography project are not as numerous as those for the RALI and the Urban Area studies. The key users here are known and, though not necessarily expert in remote sensing and mapping techniques, have considerable technical knowledge of scientific methodologies applicable to the measurement of natural systems. They are also aware of the state of the art relative to their activities. Furthermore, each States' vested financial interest in the program reinforce their desire to get as much out of it as possible. Thus, the major problem remains that of accumulating sufficient resources to provide adequate educational training in the use of this particular technology.

PACIFIC NORTHWEST LAND RESOURCE INVENTORY DEMONSTRATION (PNLRID) PROJECT

The Pacific Northwest Land Resource Inventory Demonstration Project was instituted for the purpose of determining the technical and economic feasibility of using Landsat data as an aid in the solution of regional land resource problems in the States of Idaho, Oregon, and Washington. In working toward this objective, the three Federal sponsors--the EROS and Geography Programs of the USGS and the National Aeronautics and Space Administration (NASA) -- focused on the attainment of three subsidiary goals:

1. Training of State personnel in the use of remotely sensed data.

2. User estimation of the applicability of those data to solving his problems.

3. User evaluation of a statewide or regionwide, user-oriented remote sensing system.

The Pacific Northwest Regional Commission (PNRC), representing the three user States, played a key role in the initiation and implementation of this project. As with Geography's National Land Use and Land Cover Mapping Program, considerable planning was done prior to project inception. The respective roles of the Federal agencies and a Commission task force were defined; probable needs of potential State agency users for products and training were assessed; and a management plan was prepared. This plan put the task force--working under the direct aegis of the Commission members, i.e., the Governors of the three States--in a strong coordinating position to serve both as a buffer to assure that the Federal agencies did not get involved in problems and decisions in the purview of State and local governments (and vice versa) and as a bridge to effect useful transfer of information between producer and user groups.

By way of initiating this project, each commissioner contacted his State and local government agencies, inviting them to hear project plans and to consider becoming involved in the effort. Approximately a dozen agencies responded and joined the project in the first several months; during the next 3 years, agency membership grew to over 45. While there was no formal effort on the part of the Pacific Northwest Regional Commission or its project task force to select user agencies, the Commission nonetheless established itself as an effective driving force for this project by its monetary commitment and the personal involvement of the commissioners. Furthermore, similar responsibilities were assumed by participating user agencies from the outset. Coupled with the understanding that initiation, justification, and partial support of specific demonstration projects, to be considered for eventual implementation, would also come from these agencies was the assurance that the program would be "user-driven."

Program development was staged, first, to acquaint users with the nature of earth science products and their general applicabiity vis-a-vis land use problems; then, to interest the agencies in proposing specific remote sensing projects of potential significance to their programs, and, finally, for proposals considered worthy of continued study and support, to conduct technology training to enable various agency representatives to undertake and accomplish the research objectives. Throughout the 3-year project, Federal agency personnel at the EROS Data Center and NASA's Ames Research Center worked with some 125 representatives of the State and local government user agencies to familiarize them with the possibilities of using remote sensing in land resource management areas, such as forestry, natural resources, agriculture, water resources, fish and wildlife, and urban change.

PNLRID problems and interactions at the producer-user interface both resembled and differed from those of other LIA projects. For example, the goals and implementation mechanisms of the Pacific Northwest Study were supported by cooperative funding and the management strengths of the Regional Commission, an organization strongly linked to the political hierarchy of the three-State area. Such large-scale commitment was impossible for the Urban Area Study program. It afforded PNLRID a latitude

amounting to (1) agency backup support for the "trainees," without the need for new or additional authorization to assign employees to work in directions not formerly included among agency activities; and (2) a regional atmosphere and approach that encouraged participants to consider and relate specific agency problems to important interstate and intrastate activities. In addition, the control exercised by the Commission task force resulted in procedures for information transfer geared to the capabilities and interests of the users. These included: (1) care in selecting trainees; (2) use of a logical sequence of demonstrations and training steps, supplemented by personal guidance where necessary; (3) provision of ample opportunity for direct, continuous interaction between students and faculty; and (4) allowance, in project planning and implementation, for formal feedback and evaluation reports.

On the other side of the coin, the PNLRID Project resembles the Urban Area Studies and Land Use and Land Cover programs in that one of the major problems not anticipated by project sponsors was the unexpectedly great amount of individual attention required to achieve information transfer because of the extreme variability in background experience of the trainees, and the wide diversity of research problems posed by the various agencies.

IDAHO PHOSPHATE ENVIRONMENTAL IMPACT STATEMENT

Of all the LIA projects, the environmental impact statements (EIS) administered by the EIA Program are probably the most highly structured with respect to producer-user community relationships. The primary purpose of an EIS is to assist decisionmakers at the national level in considering the probable impacts of a proposed development on the environment. These decisionmakers are also responsible for making available to the public "advice and information useful in restoring, maintaining, and enhancing the quality of the environment" (the National Environmental Policy Act of 1969, Sec. 102(f)). In addition, numerous Executive Orders, Office of Management and Budget circulars, Federal laws, and guidelines issued by the administering agencies specifically spell out the desirable or required participation of State and local agencies and the public in environmental impact matters.

During preparation of the Idaho Phosphate EIS, contact between producer and user ranged from conversations in the task force office to formal public hearings. The task force leader kept interested parties abreast of EIS progress through press releases, talks and meetings with local, regional, and statewide organizations, and radio and TV appearances. Following its completion in April 1976 (1 1/2 years after project initiation), four sets of hearings were held to allow public response to the draft EIS. In addition, 90 sets of written comments were received. All of this input was considered in preparing the final EIS.

Idaho Phosphate resembles every other LIA effort in that the scientific information in an environmental impact statement must be set forth in form and language intelligible to the layman. Unlike the other LIA projects, however, the producers of an EIS have little need to identify

key representatives in the user community or to make potential users aware of the possible import of the EIS. Because EIS's typically consider issues of regional significance, most of the users are well informed, at least with respect to their own particular areas of concern.

In summary, these LIA projects exemplify the difficulties of effectively transferring information from producers to users. Experience has proved that no single approach to this interface suffices for every situation. Briefings, workshops, seminars, advisory committees, task forces, telephone calls, press releases, one-to-one user-producer conversations: all have their place. For whatever project, no matter what communication technique or combination of techniques is to be used, interaction between producer and user must be planned in advance and budgeted for as a continuous, essential part of the program that sometimes prevails long after formal termination of the project.

Spangle and others (1976, p. 26) expressed the matter in a slightly different way, pointing out that: "Both the earth scientist and planner need to be aware that providing accurate and well interpreted ESI for use in the planning process is only a first step. To assure that ESI will influence actual decisions requires public understanding of the issues. * * *. The essential point, however, is the need to foster an institutional, legal, and political climate favorable to full and effective interplay between planners and earth scientists on the one hand and professionals and public decisionmakers on the other." H. Milton Patton, Associate Director for Environmental Resources of the Council of State Governments (1976a, p. vii), put it more succinctly: "The largest problem, however, may be a lack of simple communication among users and producers."

CONCLUSIONS

The programs of the Land Information and Analysis Office of the U.S. Geological Survey have just begun to meet the challenge of providing earth science information to the Nation's planners and decisionmakers. Projects throughout the country have exposed many problems and provided some solutions. More importantly, they have illustrated the difficulties of communication between the producers and the users of earth science information. These projects indicate that the entire earth science community must overcome two major obstacles in attempting to move from isolated demonstrations to nationwide application of earth science information.

First, areas throughout the Nation which have an urgent need for earth science information must be identified, and those needs must be continuously reassessed. Second, effective working relationships between the earth scientists and the ever-changing constituency of users in those areas of need must be established and pursued.

To successfully negotiate the first obstacle--identifying the areas in the Nation where earth science information is urgently needed--LIA experience has shown that attention should be directed toward:

- Areas where the intensified use or abuse of the land requires immediate corrective actions (e.g., areas subject to the deleterious effects of waste disposal sites).

- Areas characterized by rapid change and the accompanying conflicts of interest (e.g., urbanizing regions).

- Areas where the characteristics of the land, the subsurface, the water, and the environment restrict land use (e.g., mountain slopes, flood plains, earthquake zones, shrink-swell clays, etc.).

- Areas of particular geographic, political, environmental, or resource significance (e.g., river basins, wilderness areas, coal regions, coastal zones, alluvial valley floors, prime agricultural lands, etc.).

- Areas which can be effectively evaluated by new and improved technology (e.g., methods of change detection and monitoring by remote sensing).

Judicious use of criteria to define such critical areas throughout the Nation would reveal hundreds of high priority "hot spots" urgently in need of the application of earth science information to wise land resource decisionmaking. The citizens, planners, and decisionmakers in local, regional, and State areas who must bear the responsibility for cooling these "hot spots" should be the primary beneficiaries of massive efforts by American earth scientists to provide vital information and assistance in its use.

To successfully overcome the second obstacle--the establishment and maintenance of a strong working relationship between producers and users--LIA has found that two major efforts are requisite:

- Establishing and maintaining a clear understanding of the current "real world" value of the scientific information.

- Planning and budgeting for explicit activities (task forces, workshops, public relation programs, technique demonstrations, etc.) which will result in strong producer-user relationships before, during, and after a project. Wherever possible, such planning should include the effective use of influential intermediaries to assist in establishing and maintaining the critical communication links between the earth science producers and the users.

In conclusion, LIA experience suggests that, if earth science information is to be applied nationwide to the solution of land resource problems, the entire earth science community must mobilize to achieve what LIA has attempted to do with its projects:

- Create nationwide awareness of earth science information needs and uses.

- o Provide specialized, technical information in a form and language understandable to the intelligent citizen.

- o Engage in the educational, advisory, and review services necessary to assist the public and its representatives in making effective use of that information.

In striving toward these objectives, many approaches are needed; some will succeed better than others. However, all will require establishing intimate working relations by every possible means of communication and interaction between the two "communities" involved--the earth scientists and the land resource planners and decisionmakers throughout the Nation. To expand Donald Woolfe's position, don't just "take a planner to lunch," share an office with him!

REFERENCES CITED

Anderson, J. R., Hardy, E. E., Roach, J. T., 1972, A land-use classification system for use with remote sensor data: U.S. Geological Survey Circular 671, 16 p.

Anderson, J. R., Hardy, E. E., Roach, J. T., Witmer, R. E., 1976, A land use and land cover classification system for use with remote sensor data: U.S. Geological Survey Professional Paper 964, 28 p.

Arthur D. Little, Inc., 1975, An evaluation of the San Francisco Bay Region Environment and Resources Planning Study, Report to the U.S. Department of Housing and Urban Development, Office of Policy Development and Research: 114 p.

Council of State Governments, 1976a, Natural resource data needs recommendations: Lexington, Ky., Council of State Governments, RM-574, 25 p.

_____1976b, State growth management: Prepared under the direction of the Office of Community Planning and Development, U.S. Department of Housing and Urban Development, May 1976.

Downing, T. E., 1978, Use of the Front Range Urban Corridor studies, Final project report to the U.S. Geological Survey, DOI 14-08-001-G-461: Boulder, Colo., University of Colorado, Institute of Behavorial Science, 89 p., 7 appendixes.

Kockelman, W. J., 1975, Use of USGS earth science products by city planning agencies in the San Francisco Bay region, California: U.S. Geological Survey Open-File Report 75-276, 110 p.

_____1976, Use of USGS earth-science products by county planning agencies in the San Francisco Bay region, California: U.S. Geological Survey Open-File Report 76-547, 186 p.

_____1979, Use of U.S. Geological Survey earth-related products by selected regional agencies in the San Francisco Bay region, California: U.S. Geological Survey Open-File Report 79-221, 173 p.

Natural Resource and Environment Task Force, Intergovernmental Science, Engineering and Technology Advisory Panel (ISETAP), 1978, State and local government perspectives on a Landsat information system: Washington, D.C., Office of Science and Technology Policy, Executive Office of the President, 56 p., 5 appendixes.

Robinson, G. D., and Spieker, A. M., eds., 1978, "Nature to be commanded...," Earth science maps applied to land and water management: U.S. Geological Survey Professional Paper 950, 95 p.

San Francisco Bay Region Environment and Resources Planning Study, 1971, Program design: U.S. Department of the Interior, Geological Survey, and U.S. Department of Housing and Urban Development, Research and Technology, 123 p.

Spangle, William, and Associates, Leighton, F. Beach, and Associates, and Baxter, McDonald, and Company, 1976, Earth-science information in land-use planning--Guidelines for earth scientists and planners: U.S. Geological Survey Circular 721, 28 p.

Spicer, B. E., Braud, D. G., Bordelon, J. M., 1977, States' interest in land use: Soil Conservation Society of America, Special Publication No. 22, p. 405-411.

Wissel, P., O'Connor, R., Cigler, B., 1976, The use of geological information in the Greater Pittsburgh area: Pennsylvania State University, Center for the Study of Environmental Policy, Appalachian Regional Commission Report ARC 74-19-2564, 264 p.

Woolfe, D. A., 1978, A planner's view: Geotimes, vol. 23, no. 3, p. 19.

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