# Toward a Method for the Evaluation of Multipurpose Land Information Systems

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**Abstract:** *Automated land information systems are being proposed and developed throughout North America and the world. Because many, if not most, of these systems are being developed with public funds, it is essential that methodologies be developed that can be used to evaluate the effectiveness of these expenditures. As a beginning of the development of such an evaluation methodology, a model based upon an article by Jordan and Sutherland (1979) entitled "Assessing the Results of Public Expenditures: Program Evaluation in the Canadian Federal Government" is presented. The described measures for evaluation include: operational efficiency, operational effectiveness, program effectiveness, and contributions to well-being. Suggestions are made with respect to the application of the model to three "on-line" issues: real property valuation; land tenure delineation and recordation; and land capability assessment.*

In several recent studies, the National Research Council (1980, 1982) has described the need, as well as procedures and standards, for the design and implementation of multipurpose cadastres at the local level of government. Ironically, the United States is among the least developed nations when it comes to a coherent policy for large-scale mapping and detailed land records maintenance and utilization, while at the same time, it leads the world in development of the technologies that might reasonably be employed to address the problem. Barr (1984) summarized this contradiction:

*"Keeping the property map current as a legal record of all land parcels is nothing new*

*for countries that maintain cadastres, and it has been done for more than a century in some parts of Europe. However, for the institution of property mapping in the United States, it is a major development. It provides the basis for a fully integrated system of local government mapping, which eventually can tie together base maps, property maps, and various overlays of other characteristics of the land."*

A cadastre may be defined as a record of interest in land, encompassing both the nature and extent of these interests. Multipurpose land information systems (MLIS), including the cadastral component, are intended to coordinate and integrate all routinely maintained records concerning the land such that they can be identified and accessed with respect to the unique portion of the earth to which they refer. Such systems are beginning to appear throughout North America and indications are that the rate of their adoption is increasing. This is a function of (1) the increasing responsibilities placed upon local government for land management, and (2) the application of new technologies to meet these responsibilities. The creation of a functional MLIS, although promising effective benefit/cost ratios in the long term, represents a potentially significant investment. Because these systems are often public, methods of evaluation need to be developed.

**Assumptions**

To begin addressing the problem of developing a mechanism to evaluate a multipurpose land information system, it is desirable to make some assumptions. First, it must be assumed that we are concerned with the evaluation of the system in the context of a continuous process rather than simply evaluating the products of the system. Second, we are concerned with extremely complex systems. If, for example, one considers the real possibility of telephone access, it is apparent that both accuracy and service must be components of the evaluation. Third, although such a system would exhibit many of the fundamental characteristics of any public program, it is inherently different. Consider the public expenditure or investment in such areas as highways, parks, sewers, and schools. Although these programs require information, in and of themselves, their fundamental purpose is a clearly defined service. Information systems, in this case also public programs, have the significantly less tangible purpose of providing information to a wide variety of users, both public and private.

The basic framework that is used to begin to define a methodology for the evaluation of multipurpose land information systems was obtained from an article by Jordan and Sutherland (1979). In this article the authors propose seven underlying assumptions for the evaluation of programs at the federal level in Canada. These assumptions (Table 1), even though

**Horwood Critique Article**

In 1985, URISA established the Horwood Critique Prize in memory of Dr. Edward Horwood of the University of Washington and the founder of URISA in 1966. The objective of the prize is to challenge information systems professionals to more critically interpret developments in the field. The prize is given annually to the author(s) of a paper published in the previous annual *URISA Proceedings* representing the best critical analysis of an urban, federal, regional or local system design, implementation or application; technology policy or issue; or contextual environment.

Papers are judged on their candor, critical insights, and conclusions and methods employed in the critique. All papers appearing in the annual Proceedings are judged in the competition. To share these outstanding papers with a wider audience, upcoming issues of the *URISA Journal* will highlight a past Horwood Award winner. In keeping with the critical intent of these papers, we will include comments and responses along with the Horwood paper itself.

The first in the Horwood series is "Toward a Method for the Evaluation of Multipurpose Land Information Systems." The jurors described the paper as "a well-developed and significant path-finding effort toward defining perspectives and criteria for evaluating evolving multipurpose land-information systems."

TABLE 1.
Underlying Assumptions for Program Evaluation
(From Jordan and Sutherland 1979)

| | |
|---|---|
| A. | The program must be well-defined. It must possess clearly defined objectives and goals. |
| B. | These goals must subsequently be translated into measurable indicators of progress toward the program objective. |
| C. | There must be a rational linking of program components to these indicators of progress. |
| D. | There must exist an agreed-upon performance standard describing how much the program should accomplish. |
| E. | The indicators selected must trace program accomplishments in a context which makes sense to those outside the program. |
| F. | Methods must exist that can be used to assess the impact of the program on society separately from the effects of other programs. |
| G. | The evaluation must reach appropriate decision points in the bureaucratic and political networks, and then be acted upon. |

originally described for the evaluation of programs at the federal level, are suggested as a basic framework for the evaluation of land information systems at the local level of government.

In the case of designing and implementing an evaluation of existing land information systems, each of these underlying assumptions presents its own difficulties. In particular, the authors cite assumption E, having to do with the selection of indicators of progress that communicate to others not associated with the program; and F, having to do with methods of evaluating the system separately from other related programs, as the most difficult to address adequately. These difficulties have their origins in the prior acceptance that land information can be evaluated as a system, and that the effectiveness of the system must be evaluated in terms of its positive effects upon other programs.

TABLE 2.
Evaluation of a Multipurpose Land Information System
(A Means-End Hierarchy)

| INPUTS | OPERATIONAL OUTPUTS | PROGRAM OUTPUTS | PROGRAM EFFECTS | SOCIETAL BENEFITS/ COSTS |
|---|---|---|---|---|
| Data<br>Labor<br>Capital<br>Material | Interactive<br>Cartographic<br>Capability<br>Products | Information<br>Availability<br>Public and<br>Private<br>Understanding | Enhanced<br>Decision<br>Making<br>Timely<br>Problem<br>Recognition | Integrity<br>Justice<br>Wealth<br>Fulfillment |
| Means —A.→ End | Means —B.→ End | Means —C.→ End | Means —D.→ End | Means |
| A.<br>Operational<br>Efficiency | B.<br>Operational<br>Effectiveness | C.<br>Program<br>Effectiveness | D.<br>Contributions<br>to Well-Being | |

## Toward a Method of Evaluation

Taking into account the above assumptions, it is appropriate to begin to design a model that might be utilized for the evaluation of existing land information systems. The proposed model is intended to facilitate discussion and contribute to further development of appropriate evaluation methodologies.

Table 2 presents the concepts of the model. Each column is viewed as a component of the system and is considered as the means for achieving the end listed in the subsequent column. The interval between the columns is conceived as a node in the system to which appropriate evaluation criteria might be applied to determine effectiveness of the overall functioning system. A discussion of each of these is presented below.

## Operational Efficiency

The first level of evaluation, and probably the most straightforward, is the operational efficiency of the system in obtaining data and storing it in such a way that it can be accessed by a user in selected elements as it relates to a unique portion of the earth.

The inputs to the system would appear to be relatively easy to quantify. For example: cost per control point established, pro-rated maintenance costs, cost per area unit of base maps, cost per parcel boundary and description linked with a unique identifier. These tasks appear to be straightforward, although to date, sufficient benchmark figures are not available for comparison. There are, however, recent examples that would seem to indicate the direction such research should take. The National Research Council (1982) has projected costs for hypothetical average urban and rural counties to accomplish such tasks as establishing coordinated geodetic control and base maps. Crossfield (1984) recently published the results of his work in which he presents a cost model for alternative methods of geodetic control densification. It is important that these and other hypothetical studies be tested in site-specific situations. Further, and perhaps more important, it is essential that additional investigations, such as Larsen (1978), be conducted to identify and document the costs of operating existing systems. It appears that much better information is available on costs of upgrading these systems than is available for operating the existing systems.

### Operational Effectiveness

The second level of evaluation assumes the end of the first level as a means; that is, the ability to access selected data as it relates to a unique portion of the earth. This level of evaluation is intended to measure how well information needs are satisfied, and what adverse effects are created. The intent is to address concepts of adequacy of services relative to need and would include concepts of quality as well. Although quantification of products in themselves may be straightforward with techniques such as error ellipses and currency, their evaluation in terms of need is essential. Such issues as adequate coverage in terms of levels of data as well as scale, specificity, response time, and availability, would have to be addressed. In addition, and perhaps fundamental, is the issue of equity of service provided. Does the system require equal payment for equal service or is it based upon ability to pay? Are operating costs centralized or distributed, and if distributed, on what basis (i.e., per capita, per unit area, etc.)?

### Program Effectiveness

The third level of evaluation, in turn, assumes the end of the second level as a means. For example, it is possible that the system can provide the capability to obtain all desirable information pertaining to a unique portion of the earth in real time but, for some reason, the information is not used in the decision process whether public or private. In this case, the operational efficiency and effectiveness might be evaluated as excellent but the program effectiveness fails. Thus, the program effectiveness must be evaluated in terms of the effectiveness with which the necessary information is employed in the decision process. Questions which may be posed include: Does the system encourage quicker, more explicit articulation of decisions that need to be made? Does the system help to identify and clarify real conflicts, which might be seen as differing intentions regarding land use? Does it remove or reduce conflicts over issues such as data availability between parties engaged in the decision making?

In as much as the system is intended to support the decision process, it is necessary to attempt to evaluate the system and not the individual decisions. A sincere effort must be made to avoid the judgment that, since the decision was correct from a particular perspective, therefore, the system was right. This is and will continue to be difficult.

### Contribution to Well-Being

The fourth and last level of evaluation is concerned with the contributions of the system to the well-being of society as a whole. As should be the case in any public program, the ultimate evaluation must be in terms of potential benefits to citizens. In this regard, efforts must be directed toward the effects the land information system has upon such broad goals as individual integrity, social justice, distribution of wealth, and fulfillment of human aspirations. Examples of issues which might be addressed at this level of evaluation are

varied and tend toward the long term.

Certain demands upon a land information system, such as health studies, could require mechanisms which would permit the association of a social security number to specific coordinates. In fact, some nations already have such systems. It is open to question as to whether this should be done. If it is to be done, what controls must be in place to prevent the information from being used for purposes not intended? Is the information within the system equally available to all citizens when needed, and with equal ease of access? Does the availability enhance knowledgeable participation by the public in the decision process, or does the system, in fact, create an information elite? Does the system enhance the principles of a democratic society? In the long term, are the decisions made with respect to the use of the land, in the aggregate, contributing to a positive future?

**Implications: "On-Line" Issues**

In order to consider the proposed evaluation model, it is desirable to examine it as it might be applied to day-to-day land-related issues. These issues involve individual ownership parcels and their associated bundle of rights and responsibilities as they interact with public rights and responsibilities. Included are **Land Valuation, Land Tenure,** and **Land Capability.**

*Land Valuation*

According to McLaughlin (1984): "The importance of adequate cadastral information for equitable property assessment has been of major concern since the beginnings of the modern fiscal cadastre concept in seventeenth century Europe."

*Operational efficiency* with respect to land valuation is concerned with the discovery and description of taxable property. Where is the parcel located? What are its positive and negative physical characteristics? What are its improvements, its taxable status and current assessments? In addition to linking such information, it is also necessary to measure the effective market within which the parcel is situated. How efficiently does the system provide for the monitoring of markets for the sales prices, construction costs, mortgage rates, etc., of comparable properties?

*Operational effectiveness* may be considered as the linking of taxable property records to owners, and to the restrictions placed on that property. What is the taxable status of the owners of each portion of the bundle of rights? Which rights have been reserved through regulations imposed on the property? Has the system succeeded in associating the parcel with the appropriate market?

*Program effectiveness* may be measured in terms of real property appraisals (cost, market, income, multi-appraisals) in comparison to the tax roles. Has the system aided in achieving the required updating, correction, and complete determination of the required assessments?

*Societal benefits* may appear in the improvement of tax equity, the derived benefits through tax-supported programs such as education and a cost-effective tax system.

*Land Tenure*

As noted by Clapp and Niemann (1977), the missing component of automated land information systems has continued to be reliable, detailed, parcel-specific information on ownership of the bundle of rights.

Improved definition and description of parcels and the associated rights are a measure of the *operational efficiency* of the system in terms of land tenure. To the extent such improvement is engendered, there will be a corresponding reduction in the number of off-title claims, as questions of possession, easements, severed rights, and the public interest are resolved.

*Operational effectiveness* is measured by the establishment of a land record base from which to draw reconcilable sets of information.

*Program effectiveness* is measured through the volume of activity concerning adjudications, entitlements, transfers of rights, settlements for liability, approbations, and regulations. Has the system been able to provide the essential information in a timely fashion to a variety of users?

*Societal benefits* from improvements regarding land tenure are largely in the area of equity of information access and security of interests gained.

*Land Capability Assessment*

Dangermond (1984) observed that many resource planning agencies have yet to realize that the automated databases they create are a renewable resource, useful beyond the "one-shot" project: "Although substantial lip service is paid to the future use of these "project" data, this is rarely done in actual practice." Nevertheless, he remains optimistic: "It is the overwhelming possibilities and opportunities for geographic information to have value to our institutions that seem to be leading toward increased creation of such databases."

*Operational efficiency* can therefore be measured as the enhanced determination of land character in terms of soils, slopes, cover, proximity to other features, etc.

The further ability to interrelate these characteristics in terms of other and future legislatively mandated resource boundaries is also sought. *Operational effectiveness* is seen as the linkages made between these characteristics and the environmental regulations imposed for such issues as floodplains, wetlands, prime agricultural lands, erodible land and the spatial association of these issues with specific parcels.

*Program effectiveness* would be evidenced by enhanced development and effective application of policies regarding development, environmental regulation, zoning, and taxation.

*Societal benefits* would be evidenced by the appropriate use of the land resource over time.

## Conclusions

The proposed model for program evaluation is presented as a framework, which the authors hope will facilitate more explicit discussion among colleagues of diverse disciplinary interests. No single discipline or profession as currently structured can address all aspects of a complete evaluation. A remote sensing specialist who is primarily concerned with designing instrumentation will likely spend more time toward the left portion of the model, asking questions related to operational efficiency: How well is the system producing products from the inputs? A land surveyor fundamentally concerned with location of property boundaries may spend more time asking questions of operational effectiveness: How have output products led to clarification of the boundaries of rights? A planner concerned with protection of land as a natural resource may spend more time asking questions related to program effectiveness: Has the system led to timely recognition of decisions to be made? A sociologist concerned with automation in government may spend more time near the right side of the model, asking questions regarding contributions to societal well-being: Has the system secured public interests without adversely impacting individual rights?

It is also suggested that different levels of government may dwell more frequently on questions in one portion of the model. Federal agencies may tend to spend energies in the left portion with mapping initiatives and coordinating committees. County agencies, on the other hand, must be far more sensitive to perceived societal costs and benefits. State agencies incorporate elements of both higher and lower levels of government, hence their central and vital role in coordination.

## Epilogue

When this paper was originally published in the 1985 *URISA Proceedings*, the authors hoped that it would ". . . facilitate more explicit discussions among colleagues of diverse disciplinary interests." To date it has failed to do so. The authors hope its re-publication will help to accomplish the paper's objective.

Since 1985, there have been significant investments in some aspects of the development of Multipurpose Land Information Systems, specifically in the application of information technologies to the manipulation and analysis of geographically referenced data. However, little progress has been made towards the evaluation of these investments in a multipurpose context. The apparent tendency is that each office, agency, utility, or department at all levels of responsibility, is

acquiring and implementing its own capability designed to meet its own needs. No single one of these has the responsibility, much less the authority, to evaluate the entire system from a multipurpose perspective.

If this trend continues, there is a near certainty that incompatible components will proliferate and duplication of data collection will continue, all at citizen expense.

In hindsight, perhaps a more fundamental question than "How does one evaluate a multipurpose land information system?" is "Who or what authority is responsible for the efficient expenditure of public funds for the collection and utilization of information concerning the land?"

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