N91-15627

A PROPOSAL TO EXTEND OUR UNDERSTANDING OF THE GLOBAL ECONOMY

by

Robbin R. Hough
Oakland University
Rochester, Michigan 48063

Manfred Ehlers
University of Maine
Orono, ME 04469

ABSTRACT

To date, global models have been just that. They have identified problems common to the peoples of the globe, without setting forth a basis for the specific actions carried out by specific peoples that could step toward a resolution of the identified problems. There is another way.

Satellites acquire information on a global and repetitive basis. They are thus ideal tools for use when global scale and analysis over time is required. Data from satellites comes in digital format which means that it is ideally suited for incorporation in digital databases and that it can be evaluated using automated techniques.

The paper proposes the development of a global multi-source data set which integrates digital information regarding some 15000 major industrial sites worldwide with remotely sensed images of the sites. The resulting data set would provide the basis for a wide variety of studies of the global economy.

The preliminary results obtained to date give promise of a new class of global policy model which is far more detailed and helpful to local policy makers than its predecessors. It is the central thesis of this proposal that major industrial sites can be identified and their utilization can be tracked with the aid of satellite images.

The Problem

The focus of this paper is the role of policy, resources and the environment in economic and social development. The world view which it attempts to sketch for the reader will be alien to many who perceive economics as a policy science increasingly concerned with abstract "macro" entities. To be of use to humankind, policies for humans must be on a human scale. Moreover, it is of central importance that peoples be moved to perceive the objectives of the policies as important to them. To date, global models have been just that. They have identified problems common to the peoples of the globe, without setting forth a basis for the specific actions carried out by specific peoples that could step toward a resolution of the identified problems. There is

another way. Humans must have stories, images, habits and rules of thumb to live in complex environments and they just don't have them as they relate to our world as a whole. Simply browsing an atlas or even a world globe is an exercise in looking at more information than an individual can handle at once. The importance of manufacturing activity in the total market economy makes it imperative that manufacturing images and understandings be developed along with those which have to do with agricultural lands, forest lands, air quality, water quality, etc. The purpose of this proposal is to seek support for a project which will contribute to manufacturing images and understandings.

Satellites acquire information on a global and repetitive basis. They are thus ideal tools for use when global scale and analysis over time is required. Data from satellites comes in digital format which means that it is ideally suited for incorporation in digital databases and that it can be evaluated using automated techniques.

Background

In order to approach the problems discussed above, a number of preliminary efforts have been undertaken. The first effort was a study of the relationship between economic activity in the 494 Rand-McNally basic trading areas and the sites of major manufacturing facilities. The 494 basic trading areas have 1361 sites of major economic activity. The 378 trading areas with manufacturing sites have a total employment in manufacturing of 20529027. The 116 trading areas without manufacturing sites have a total manufacturing employment of 1385727. The observation that 80 percent of the trading areas have 95 percent of the manufacturing employment indicates that an appropriate definition of "major" was utilized in the identification of the manufacturing sites. A simple linear regression of sites against manufacturing employment suggests that there are 12804.5 employees per site. The results are statistically significant at the one percent level. The scale of the coefficient (1/4 of the total regional mfg. employment) again points to an appropriate definition of "major". Moreover, it was possible by further work to account for nearly 85% of manufacturing employment on an industry by industry basis.

The second effort undertaken was to construct a global database of regions which include as their centers, 738 cities chosen for their scale, their size in relation to their neighbors or their role as largest city in a nation bounded by geographic barriers or other regions. Based on the size given for the cities used as regional centers:

Average size of the largest city	959173
Number of cities per country	3.67052

A profile of manufacturing employment for the regions centering on each city was computed based on the U.S. estimates. That is, each of approximately 13000 plant sites was assumed to provide the same level of employment provided by its counterpart in the United States. Assuming that a local labor-force is trained to work in manufacturing (L) and that fuel (F) and machines (K) are imported a production function would appear as:

$$Output = f(L,F,K)$$

When estimates are aggregated by country the following result is obtained for 50 countries on which World Bank data is available:

$$National\ income = .45 * L^{.54} * F^{.24} * K^{.18}$$

$$R^2 = .912$$
$$F = 158.915$$

In essence, over 90 percent of the variation in national income appears to be accounted for by the site based employment estimates, fuel imports and machine imports. The close fit and plausible magnitude of the coefficients are taken as preliminary evidence that the U.S. based estimates will serve as reasonable substitutes for the actual levels of manufacturing employment in the regions.

A third effort sought to understand the scale of cities around the globe on the basis of the economic activity which they sustain. On a global basis, commercial farms, trading facilities and the manufacturing facilities discussed above can be shown to determine the scale of the cities supported by a given region.

A fourth effort has been directed at the development of a multi-level hierarchical flat-file manipulation language which allows relational operations on digital geographic information systems as well as the storage of links to image collections. Language M is the result of that effort. It has been in commercial use for nearly two years.

In a fifth project, DIRIGO - an image processing system, for remote sensing data has been developed. The DIRIGO system adheres strictly to the Macintosh interface guidelines and hence enables users to become quickly familiar with the system. The system supports four file formats (1) image data, (2) ASCII text files of control point coordinates or training area statistics, (3) classified images and (4) training areas for classification. An intelligent interface insures that only files with the appropriate format can be opened for the selected application tasks. At present DIRIGO supports (1) point operations such as linear and Gaussian contrast stretch and histogram equalization; (2) spatial filtering; (3) geometric correction such as image-to-map rectification and image-to-image registration using first-degree polynomials and standard re-sampling techniques; and (4)

classification techniques such as parallelpiped, minimum distance, and maximum likelihood. Execution times for a 512 by 512 image with three bands range from seconds to approximately five minutes for a maximum likelihood classification with six classes.

The results reported above give promise of a new class of global policy model which is far more detailed and helpful to local policy makers than its predecessors. It is the central thesis of this proposal that major industrial sites can be identified and their utilization can be tracked with the aid of satellite images. The concept that a major industrial facility gives rise to employment and income which cannot be ignored is both simple to grasp and open to verification. Policy makers are already highly sensitive to plant openings and closings on the scale of the plants studied here. Indeed these "local" matters are matters of focus for legislatures, the press, trade unions, chambers of commerce and others. By global interdependence is meant that those actors must become aware of the kinds of changes occurring elsewhere on the globe that will influence the plants with which they are concerned. The paper industry in Green Bay should be vitally interested in changes in Finland.

Project Objective

The objective of the project being proposed is to produce a remotely sensed image for each of the 13,000 major industrial sites worldwide. A latitude and longitude as well as an industrial classification can be identified for each site. Given this information and a scene which centers on the information it should be possible to identify the major site and a variety of the key facilities which are physically associated with it by interpretation. It would be expected that the working image so identified would be but a small fraction of the total image from which it would be extracted. That is, the industrial plant image would usually occupy less than one tenth of one percent of the total image. Thus each plant image would be expected to require only about 36k of storage. The complete global collection of images covering all sites of economic interest would be reduced to an easily manageable 1/2 gigabyte. A full working system for global analysis and modelling including detailed digital demographics for each of the regions and a variety of digital maps could be handled in less than 600 megabytes.

Products of the Project

With the images identified by site a variety of analyses are enabled. In principle, interpretation could be supplemented by automated analysis. A few of the many possibilities are:

1. A study of the requirements of the industry specific sites based on the analysis of the

images of the site. Buildings, parking lots, water sources, retention basins, storage space, special facilities, etc would be open to examination.

2. A comparison of image features to known characteristics of the plants from other sources. Such analysis would, for example, make it possible to distinguish integrated manufacturing facilities from assembly plants, consider power requirements and siting, the relationship to common public facilities, residential spaces, transport networks and the like.

3. A third form of analysis would proceed with the tracking of these sites over time and the relating of the characteristics of the tracked images to the known economic and operating characteristics of the plants.

4. The most straightforward product of the proposed effort is a digitized industrial atlas of the world. The resulting product would have an exceedingly wide range of potential uses. It is possible to compare potential industry sites based on the characteristic parameters of other existing industrial sites. If criteria can be established combining image and non-image information of the global database, it will be possible to rate potential sites based on this information. Earlier work in this area by the project principals includes the development linear associative retrieval systems for use in comparative evaluations.

5. It would be possible to include other (future and current) satellite images with other spectral information (e.g., thermal, mid-infrared, microwave etc.) and tie this together with SPOT's high spatial resolution. This would allow multispectral, multitemporal, and multispatial site assessments.

References

Ehlers, Manfred. 1990, *Their Own Mac-Based Remote Sensing System,* Advanced Imaging, May, 1990, pp. 65-67.

Folland, Sherman T. and Hough, Robbin R. *Some Evidence of a Relationship Between Nuclear Power Plants and the Value of Agricultural Land,* Land Economics, forthcoming February 1991.

Hough, Robbin R. and Hough, Tor H., *Database Tools for the Manipulation of Hierarchic Relations,* Advances in Support systems Research, Baden-Baden, 1990.

Hough, Robbin R., *Natural Language and Geographic Information Systems*, Proceedings of a NCGIA Workshop on Geographic Information Systems, University of Maine, 1990.

_____. *Specialization and the Ecology of Microcomputers*, Advances in Systems Research and Cybernetics, ed. George E. Lasker, University of Windsor and Oakland University, 1989.

_____. *Evolutionary Process in Hierarchical Systems*, Perspectives on Adaptation, Environment and Population, ed. John C. Calhoun, New York: Frederick Praeger, 1986.