WORKING PAPER

No. 10

ALBANIA SERIES

September 1997

Aerial Photography and Parcel Mapping for Immovable Property Registration in Albania

Maksimiljan Gjika and Edmond Leka

Land Tenure Center

AN INSTITUTE FOR
RESEARCH AND EDUCATION
ON SOCIAL STRUCTURE,
RURAL INSTITUTIONS,
RESOURCE USE,
AND DEVELOPMENT

UNIVERSITY OF WISCONSIN —
MADISON

AERIAL PHOTOGRAPHY AND PARCEL MAPPING FOR IMMOVABLE PROPERTY REGISTRATION IN ALBANIA

by

Maksimiljan Gjika and Edmond Leka

WORKING PAPER, NO. 10

ALBANIA SERIES

Land Tenure Center

University of Wisconsin–Madison

September 1997

This paper is an output of the Land Market Action Plan in Albania, implemented by the Project Management Unit of the Immovable Property Registration System and the Coordinative Working Group (Tirana, Albania), with support from the Government of Albania; from the Land Tenure Center, University of Wisconsin–Madison (financed by the U.S. Agency for International Development, contract no. EUR-0049-A-00-4031-00); from the European Union's PHARE; and from the Terra Institute (financed by the World Bank's Agricultural Sector Adjustment Credit project with the Albania Ministry of Agriculture and Food).

Prepared for

PROJECT MANAGEMENT UNIT, IMMOVABLE PROPERTY REGISTRATION SYSTEM, TIRANA, ALBANIA

by

LAND TENURE CENTER, UNIVERSITY OF WISCONSIN–MADISON, USA

in

JUNE 1995

All views, interpretations, recommendations, and conclusions expressed in this paper are those of the authors and not necessarily those of the supporting or cooperating institutions.

CONTENTS

AERIAL PHOTOGRAPHY AND PARCEL MAPPING IMMOVABLE PROPERTY REGISTRATION IN ALBANIA*

by

Ing. Maksimiljan Gjika
Project Management Unit
Immovable Property Registration System

and

Ing. Edmond Leka
Military Topographic Institute

1. INTRODUCTION

Planimetric map production makes up one of the basic graphic documentation elements of the Immovable Property Registration System (IPRS) in Albania and is one of the main objectives of the Land Market Action Plan (LMAP).

Photogrammetric work occupies an important place among the well-known methods of mapping. At this time, methods for various types of map production based on aerial information are being developed.

During the last two decades, the transition from analogical to analytical photogrammetry has been done. Analytical photogrammetry is completed theoretically, on an advanced technological base and with hands-on experience in all phases. At present, photogrammetry and remote sensing is changing from analog to digital, from aerial to space-based imaging/mapping, from local to global concepts, and from manually managed to computerized information systems such as the geographic information system (GIS).

But not always and everywhere do possibilities exist for technology to change from the old to the new. This depends on economic and financial possibilities, on existing technological bases, and, more importantly, on efficiency of the new technology to resolve the problem. In a lot of cases, analogical equipment has been adapted using various types of alterations in order to process as much information as possible and gradually to pass on to higher levels of technology. This is the method generally used by state institutions and schools.

Important guidelines for this situation include:

- development of a plan for the resolution of the particular problem, anticipating all the tasks involved, with a schedule for its implementation;

* Original version of paper presented at GIS/LIS Conference, held in Budapest, Hungary, June 1995.

- full knowledge of existing topographic, mapping, and photogrammetric work in order to determine how much of this information is useful; and
- development of a financial plan to support the implementation of the plan.

We do not intend to deal with these problems in this report, for they have already been treated by our colleagues, Ahmet Jazoj, Spiro Lamani, and Leart Lira, in "Surveying and Mapping Strategy for Supporting the Emerging Land Market." We aim instead to focus on one aspect of this strategy, that is, the implementation of photogrammetry program mapping of index maps for the registration system.

2. PHOTOGRAMMETRY IN ALBANIA: ITS VALUE FOR PROPERTY MAP PRODUCTION

Aerial photography has been done by the Military Topographic Institute at scales of 1;300,000 to 1:40,000 in order to prepare 1:25,000 scale maps for the whole territory as well as for their updating. It was also done at scales of 1:12,000 to 1:18,000 for the compilation of 1:10,000 scale maps for the flat and low hill zones which cover mostly the western part of the country (Korça Plateau and Dropull Valley).

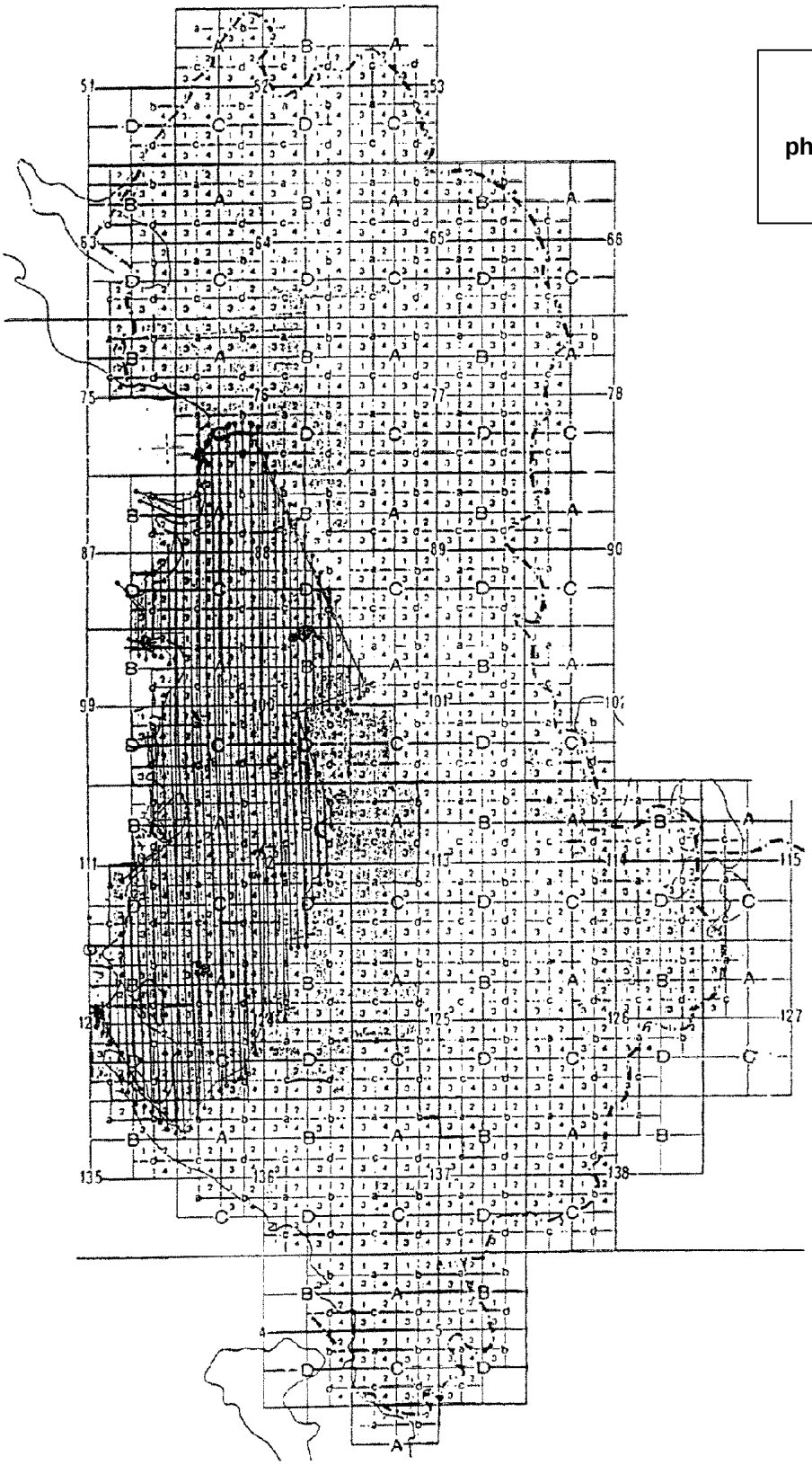
The methods and technology originally included aerial cameras with a focal length of 70 mm. The size of the photographic image was 18 cm x 18 cm. The technology was too limited to restitute large-scale map production, especially at scales of 1:2,500 and 1:1,000. The last aerial photography was done in 1978 over the western zone at an average scale of 1:12,000.

The geodetic base done by the Military Topographic Institute (ITU, Instituti Topografik Ushtrisë) for the production of 1:10,000 scale maps has been useful. Since analytical and digital technology is not available, photogrammetry work is based on a large number of control points surveyed on the field and identifiable on the photograph with an accuracy of m=±0.15 mm. Because of technical requirements, all triangulation points of leveling lines relating to the order of the points and the planimetric position of all the elevation points determined by geometric nivelation need to be identified on the air photos with monography. The compensation of phototriangulation is calculated with a half analytical method by strips. Even these points are identified on the photos. All these points will support the mapping of the property index maps with new photography from the geodetic point of view.

The first tests with existing aerial photography showed that the changes of the contour field were up to 80 percent of the contour elements in the urban centers. This is seen on the photo which covers the pilot village center of Lumth (see map 1). Checking on the terrain for the purpose of property identification, it was noticed that much work needed to be done on the topographic element. Other analog comparisons made it necessary to try new aerial photography.

In August 1994, Compania Generale Ripreseaere (Parma, Italy) did aerial photography covering the 4,200 km^2 of the western flat area, the most intensively worked and densely populated region of the country (see map 2). This aerial photography is at an average scale of 1:10,000. It will meet the broad needs of the economy and, in particular, the requirements for property map production at a scale of 1:2,500 for all rural zones. Also, air photographs at a


Lumuthit



MAP 2

Aerial photography of Aug. 1994

scale of 1:5,000 have been done for some urban areas for compiling index maps at a scale of 1:1,000. The aerial photography meets all the technical parameters as evaluated by Ordinance Survey International (England).

3. PHOTOGRAMMETRIC WORK FOR PROPERTY MAP PRODUCTION

We are working in several directions in order to utilize aerial photography more efficiently. Here we are speaking not of testing different methods, because they are already familiar to us, but rather of combining new aerial photography, modern and classical technologies, and acquired skills and experience. The idea is to use all methods that will help in completing the work. It is important that we combine these methods with the accuracy requirements for cadastral map production.

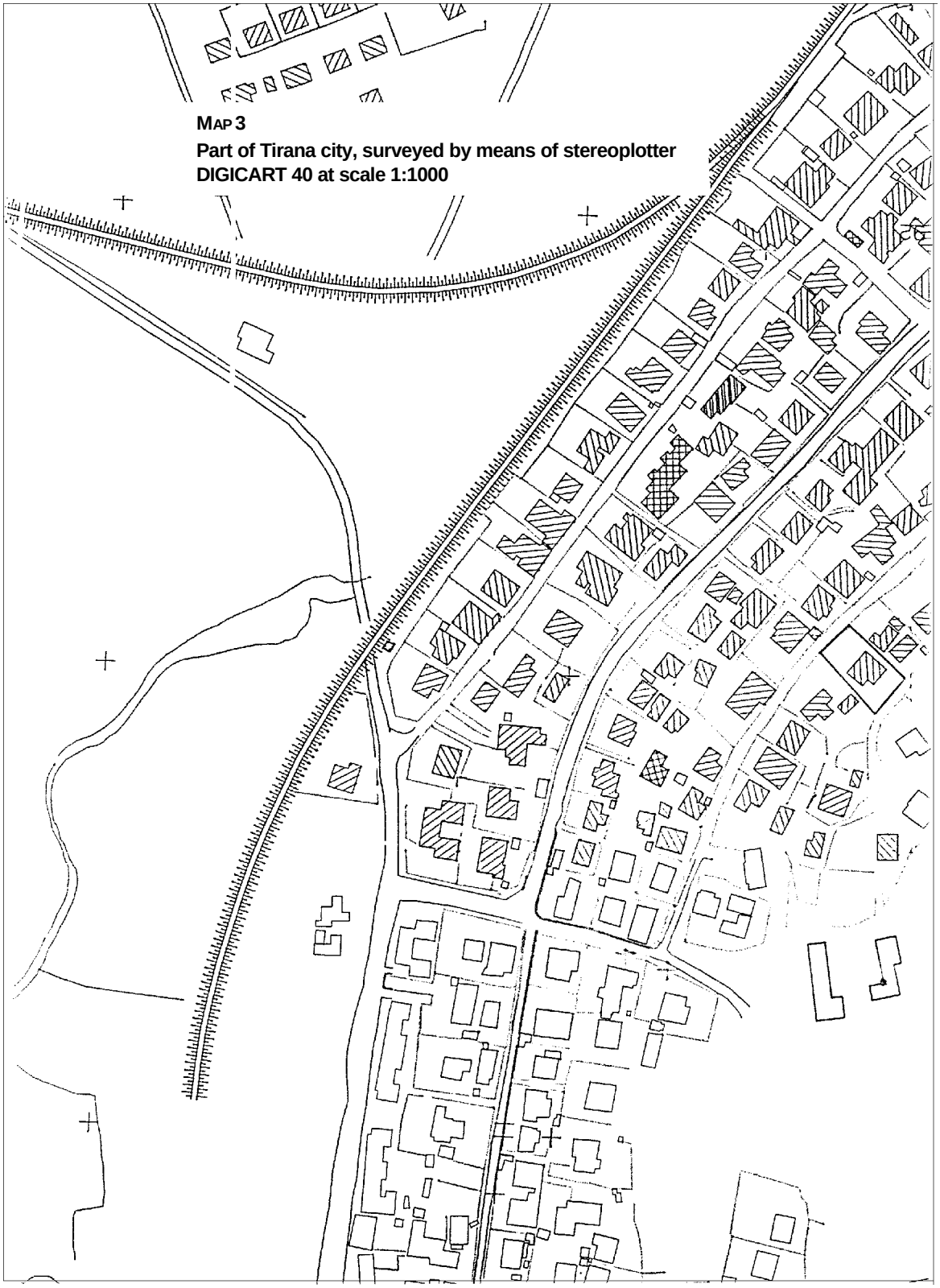
We are currently at the beginning of the photogrammetric work using analytical stereoplotters. We have already finished preparing property maps for Tirana at a scale of 1:1,000 (see map 3). We are going to proceed in the same way with the other cities. The importance of these urban maps goes beyond that of cadastral map preparation.

The classical method for map production involves the elaboration of a simplified model when the surveyed area is flat; it does not include stereoscopical surveying of the object obtained with projector equipment in conformity with the photogrametric methods. In the classical method we make use of aerial photography especially when transformation is required for graphic content elements of the photographic image and not the definition of their analytical or graphi-analytical coordinates. In this way interior orientation elements are known a priori; in the geodetic method model orientation is done according to the control points.

The following example demonstrates our method more clearly:

- On the photo being projected we identify four control points taken from the work previously done by ITU.
- A diapositive of the photograph is prepared.
- The sheet of paper is prepared by displaying the kilometric network at the proper scale and by drawing the control points identified on the aerial photograph.
- The diapositive is centered by aligning its center with that of the projector lens. The lens plane is leveled.
- The camera is moved to the proper altitude for the required map scale.
- Alignment of the common points is made by using the altitude change of the projector as well as the perspective corrections of the aerial photograph by means of the correction mechanic devices $\Delta\alpha$ and $\Delta\omega$ of the projector cameras.
- The projected elements are designed.

As seen from the example above, the topographic map of the urban center of Kamza, with more work on the ground according to the relevant privatization documents, is completed as a property cadastral map.



MAP 3

Part of Tirana city, surveyed by means of stereoplotter DIGICART 40 at scale 1:1000

MAP 4

Map sheet of Kamza Urban Center, scale 1:2500, prepared by means of aerial photography, Aug. 1994

The urban center map is produced by means of such a process. Few property elements are obtained because property boundaries are abstract elements of the photographic image.

This method will be used in the flat regions where maps do not exist. The work is easier in those areas where cadastral maps of large scale do exist and only big changes within the inhabited center need to be drawn (see map 4).

4. ANALYSIS OF EXPECTED ERRORS

According to the work done, let us analyze the least squares adjustment (LSA) by means of which the topographic presentation will be obtained. Excluding systematic and random errors, the LSA of the drawn elements will be the result of these errors:

1. The accuracy of the map pointing utilizing a drawn kilometric network overlay and the map position of the control points; considering that the accuracy of map pointing with an instrument is related to the instrument accuracy itself, we accept an error range of:

$m_1 = \pm 0.2$ mm

2. The error of the points alignment with the control points, which in this case is:

$m_2 = \pm 0.3$ mm

3. The error of drawing elements which is accepted as the smallest visual division of a millimeter:

$m_3 = \pm 0.2$ mm

The following is the result of the three errors:

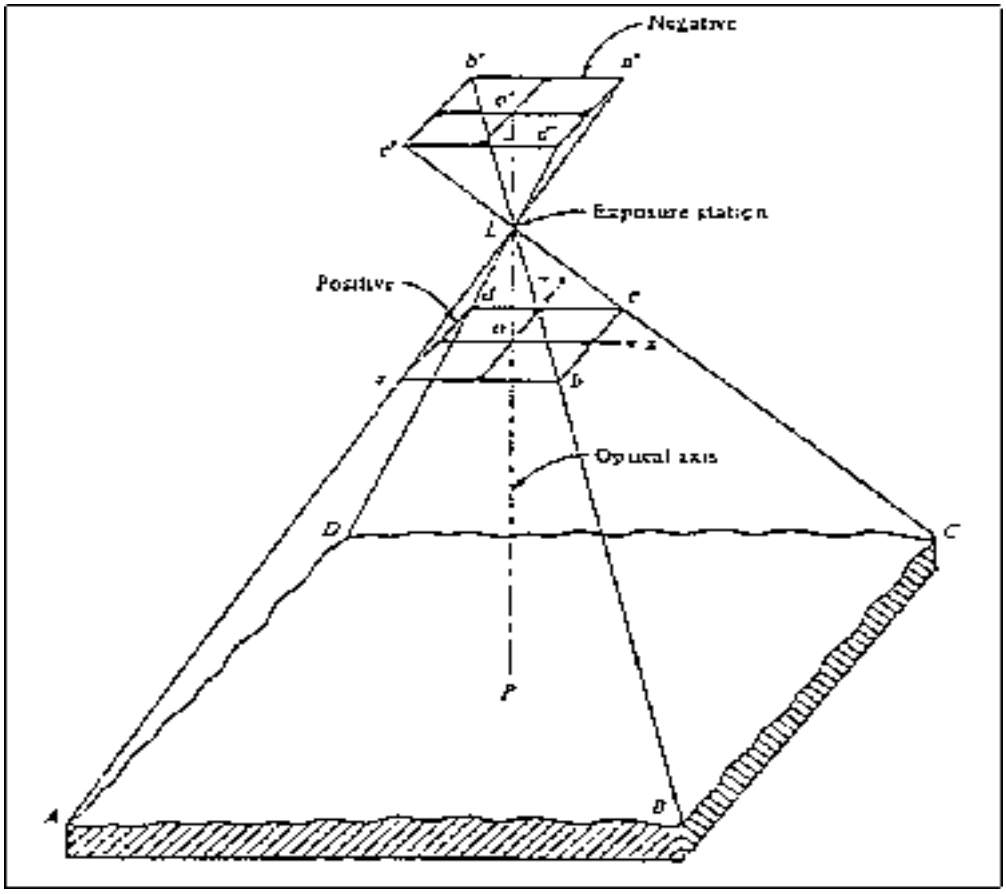
$$m = \pm\sqrt{\frac{m_1^2 + m_2^2 + m_3^2}{n}} \approx \pm 0.2\text{mm}$$

For the cadastral map this requirement is:

$m = \pm 0.4$ mm x SC

In the case when projection is done on the existing map, the LSA of paper distortion will be taken into consideration. In order to define them we should measure some of the distances of the square network, the theoretical distance of which is known. Measurement will be done in the direction of coordinates. The least accuracy in measurement will be ±0.2 mm which will be added to the values of the measured elements:

$$m = \pm\sqrt{\frac{\Sigma\Delta_x^2 + \Sigma\Delta_y^2}{n}}$$



5. CONCLUSION

For the production of the immovable property registration index maps, analytical methods will be used in addition to simple photogrammetric ones, taking into consideration that:

- The most recent topographic maps and information of the zone are taken into consideration.
- Simple photogrammetric methods will be used for the flat zones, without relief correction establishment. The scale of vertical photography over flat terrain is simply the ratio of the photo distance to the corresponding ground distance AB. That scale may be expressed in terms of camera focal length f and flying height above ground H' by equating similar triangles, ΔLab and ΔLAB as follows:

$$S = \frac{ab}{AB} = \frac{f}{H'}$$

The scale of a vertical photo over flat terrain is directly proportional to camera focal length. Inversely, for vertical photographs taken over variable terrain, there is an infinite number of different scales. This is one of the principal differences between a photograph and a map.

- The existing cadastral maps are often used for updating the topographic situation.
- Regarding the specific conditions of our country during the transition period, the efficiency of simple photogrammetric methods is considerable, considering the time and cost involved.

6. BIBLIOGRAPHY

Commissione Geodetica Italiana. N.d. "La formazione di Cartografie Generali a Grande Scala (1:2000, 1:1000)."

"Italian Cadastre: The Land and Geographic Information System." Sogei s.p.a.

Jazoj, Ahmet, Spiro Lamani, and Leart Lira. 1994. "Surveying and Mapping Strategy for Supporting Emerging Land Market." Albania Synthesis Series, Surveying and Mapping, no. 1. Madison: Land Tenure Center, University of Wisconsin.

Lamani, Spiro. 1995. "Unification of Cadastral Maps with Property Registration System." Paper prepared for ACSM/ASPRS Convention.

Vanderohe, Alan P., Robert F. Gurdo, Stephen I. Vantusa, and Peter G. Thum. 1991. "Introduction to Local Land Information Systems for Wisconsin's Future."