

INDICATORS OF INTERNATIONAL REMOTE SENSING ACTIVITIES

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ABSTRACT

METRICS, INC. recently completed a survey to determine the extent of worldwide remote sensing activities, including the use of satellite and high/medium altitude aircraft data. Data were obtained from numerous individuals and organizations with international remote sensing responsibilities.

Nine indicators were selected to evaluate the nature and scope of remote sensing activities in each country. These indicators ranged from attendance at remote sensing workshops and training courses through the spectrum of remote sensing activities to the establishment of earth resources satellite ground stations and plans for the launch of earth resources satellites. Each country was then classified into one of three categories (beginning, moderate/intermediate, or advanced) according to the ranking of its indicators.

Results of the survey indicate that more than 110 countries are involved in some form of remote sensing activity. Also, more than twenty international organizations are actively promoting the use of remote sensing data around the world. Furthermore, this technology constitutes a rapidly increasing component of environmental, land use, and natural resources investigations in many countries, and most of these countries rely on the Landsat satellites for a major portion of their data.

1. INTRODUCTION

This paper presents the results of a comprehensive data collection effort and evaluation concerning international remote sensing activities. The purpose of the project is to determine the extent of use of remote sensing data by each country. Remote sensing activities include use of satellite and high/medium altitude aircraft data for mapping, resource investigations, and environmental studies. The scope of the survey is the entire world, but includes only U.S. activities which involve a joint research project or cooperative venture with another country. Specific objectives of the survey are:

- * A country-by-country evaluation of remote sensing activities for all countries known to be actively involved in remote sensing;
- * Classification of each country into one of three categories according to the nature and extent of remote sensing data use; and
- * Evaluation of the remote sensing activities of international organizations.

To obtain the needed data, numerous individuals and organizations with international remote sensing responsibilities were contacted. Data were obtained from such organizations as NASA, USGS, the United Nations, the Canada Centre for Remote Sensing, several international development agencies, and a number of other organizations and individuals from around the world.

2. INDICATORS OF REMOTE SENSING ACTIVITIES

Nine indicators were chosen to use in measuring the nature and extent of remote sensing activities in each country. These indicators were selected to measure all levels of remote sensing activities from the earliest stages when training activities predominate through the most advanced levels of remote sensing technology including establishing satellite ground receiving stations and data distribution/analysis centers. The indicators are listed and discussed in the approximate order in which a number of countries have progressed in the use of remote sensing.

1. Attendance of personnel at remote sensing workshops, training courses, and symposia.
2. Hosting/co-sponsoring workshops, training courses, and symposia sponsored by international development agencies and/or countries with advanced remote sensing programs.
3. Receipt of international assistance in the use of remote sensing technology such as joint remote sensing projects or development projects with a remote sensing component.
4. Participation in the Landsat and/or Skylab research programs.
5. Active participation in regional cooperative remote sensing activities.
6. Existence of a national remote sensing agency and/or well developed remote sensing infrastructure.
7. Provision of international assistance in the use of remote sensing technology.
8. Existence of, or firm plans for, an earth resources satellite ground station.
9. Plans for development and launch of an earth resources satellite.

Each of these indicators is explained in more detail in the following paragraphs.

Attendance at Workshops, etc. Generally this is the first evidence of a country's interest in remote sensing activities. One or more individuals from the country will attend a workshop, training course, or symposium concerned primarily with remote sensing. Sponsorship of the individual's travel and fees might be by his government or an international aid program or a combination of the two. Generally, these attendees are high ranking government officials with planning/resource responsibilities.

Hosting/Co-Sponsoring Workshops, etc. After a country becomes seriously interested in the utilization of remote sensing data for its planning and resource studies, hosting and/or co-sponsorship of an international workshop or training course is a possibility. There are numerous recent examples of such workshops, sponsored by an international development agency, with attendees from the host country and several surrounding countries.

Receipt of International Assistance. Once a particular country has determined the usefulness of remote sensing techniques for its own purposes, it

is not unusual for it to apply to an international development agency for assistance. This is particularly true among the developing countries which often lack the financial and technical resources to start their own program without external support and assistance. Many resource development projects having a remote sensing component are currently underway around the world.

Participation in Landsat/Skylab Research Programs. This is an important indicator of interest in remote sensing activities, but it tends to overlap the first three indicators, at least in time, for many countries. Since funds for participation in NASA's Landsat and Skylab investigation programs are supplied either by the individual country or by an international development organization, it represents a financial commitment of a portion of the resources of that country to the use of remote sensing data. Hence this is an important step in the evolution of a country's remote sensing activities.

Active Participation in Regional Cooperative Activities. A further indication of interest in utilizing remote sensing data in an operational environment is regional cooperation. The cooperation may be solely among the neighboring countries or it may be joint cooperation with another country (e.g., the U.S. or Canada) or with an international development organization. This indicator is differentiated from the receipt of international assistance by extensive, active participation of high level technical and resource personnel from each of the cooperating countries.

Existence of a National Remote Sensing Agency. The formal establishment or designation of a national remote sensing agency carries significant implications for the future of remote sensing within a particular country. Establishment of such an agency will either formalize the existing remote sensing infrastructure or it will likely serve as the catalyst for the formation of a remote sensing infrastructure within the country. In either case, it tends to promote strongly the utilization of remote sensing technology. This step is frequently combined with the establishment of a national training center or a technical assistance program.

Provision of International Assistance. Providing assistance to other countries is generally a sign of a relatively advanced, and often an operational, remote sensing program within the country which provides the assistance. There are numerous recent examples of developed countries with advanced remote sensing programs cooperating with international development agencies in holding seminars, short courses, and symposia, in various parts of the world. In other instances technical assistance is provided directly to another country or to several countries in carrying out remote sensing projects of local or regional importance.

Existence of/Plans for an Earth Resources Satellite Ground Station. This indicates a substantial financial commitment to an on-going, operational remote sensing program by a country or regional association of countries. It also generally indicates substantial experience with and facilities for the analysis and interpretation of photographic and digital remote sensing data. An expenditure of this magnitude is also indicative of long-range plans for the use of satellite remote sensing data.

Plans for Earth Resources Satellite. At the present time, only a few countries (e.g., United States and USSR) have definite plans for the development and launch of earth resources satellites. However, there is a rapidly growing list of countries which are formulating plans for the launch of their own satellite or are cooperating with other countries in planning such a satellite.

The above list of indicators is not perfect by any means. They probably could have been ordered differently, or additional indicators could have been selected, or perhaps the indicators selected could have been further subdivided and refined. However, the nine indicators discussed are the ones selected for evaluation of the remote sensing activities of the countries involved. Use of these indicators in the evaluation process is discussed in detail below.

3. METHODOLOGY FOR EVALUATING REMOTE SENSING ACTIVITIES

Several hundred references as well as personal contacts from around the world were consulted in compiling this paper. The approach was to collect all available documentation and information relating to international remote sensing activities. Data from several sources were often merged to get a complete picture of remote sensing activities within a particular country or organization.

A relatively simple scheme for evaluating the extent of remote sensing activities is employed. It involves a determination of the highest level of activity (according to the ranking of indicators as presented previously) that a particular country has attained. Each country is then classified into one of three categories: advanced remote sensing programs; moderate/intermediate levels of remote sensing activities; and remote sensing activities in early stages of development.

Countries which exhibit involvement in activity indicators one through three only are classified as being in the early stages of developing their remote sensing activities. Countries which participate in programs involving indicators four or five are classified as having moderate/intermediate levels of remote sensing activity. Finally, countries which demonstrate evidence of the characteristics inherent in indicators six through nine are classified as having advanced programs.

International organizations (or national organizations with international responsibilities) involved in remote sensing activities were not ranked according to the level of their activities. With respect to such organizations, the present effort was limited to cataloging all such organizations with current or planned remote sensing activities. Some of these organizations are very advanced in their use and/or transfer of remote sensing technology whereas others have only recently become involved in such activities or are in the early planning stages for these activities.

All organizations included in this listing belong to one of two categories: (1) international organizations composed of or chartered by several (or many) countries or (2) national (i.e., government) organizations which have international responsibilities. The United Nations is an example of the former type of organization whereas the United States Department of State/Agency for International Development is an example of the latter. Private (i.e., non-government) organizations and universities are excluded from the list.

4. RESULTS

Results of the survey indicate that many countries and organizations are formulating operational remote sensing programs without the extended research phase which has preceded most operational remote sensing activities in the United States. Furthermore, many developing countries are using remote sensing data in a wider range of problem areas than those of the more developed countries.

The countries involved in remote sensing are categorized according to the extent of their activities in Table I. The international development organizations identified as users/promoters of remote sensing technology are identified in Table II.

Among the statistical results of the survey are the following:

- * More than 110 countries are participating in some form of remote sensing activity.
- * More than 600 organizations worldwide are involved in remote sensing activities.
- * More than 75 countries have utilized Landsat data in various types of resource and mapping studies.

- * More than 20 countries and/or international organizations have existing or proposed ground stations capable of receiving Landsat data.
- * More than 30 countries are classified as having advanced remote sensing programs.
- * More than 20 organizations are actively promoting the use of remote sensing data in less developed countries or are using this technology in conjunction with existing development projects.

5. DISCUSSION

There are some limitations to the scheme employed above. In particular, the dividing lines between categories are not sharp. Furthermore, it is possible that the sequence presented here simply does not represent the evolution of remote sensing activities in some countries. Nevertheless, it serves as a common point of reference for classifying the various activities of each country, and it parallels the development of remote sensing activities actually observed in a number of countries.

6. CONCLUSIONS

From extensive analyses of international remote sensing activities, METRICS, INC. concludes that this technology constitutes a rapidly increasing component of environmental, land use, and natural resources investigations in many countries throughout the world. In addition, there is a substantial demand for remote sensing training in those countries which have some, but as yet fairly limited, remote sensing activities. Finally, satellite data is the major remote sensing data source for the majority of the countries in the world.

7. ACKNOWLEDGMENTS

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TABLE I. CLASSIFICATION OF REMOTE SENSING ACTIVITIES

<u>Beginning</u>	<u>Moderate/Intermediate</u>	<u>Advanced</u>
Afghanistan	Austria	Argentina
Algeria	Botswana	Australia
Benin	Bulgaria	Bangladesh
Burma	Burundi	Belgium
Cameroon	Central African Republic	Bolivia
China (Formosa)	Chad	Brazil
Congo	Colombia	Canada
Cyprus	Costa Rica	Chile
	Ecuador	Czechoslovakia
Dominican Republic	Ethiopia	Denmark
El Salvador	Gabon	Egypt
Fiji	Greece	Finland
Gambia	Guatemala	France
Ghana	Guinea	Federal Republic of Germany
Guyana	Iceland	India
Honduras	Israel	Indonesia
Iraq	Ivory Coast	Iran
Jamaica	Kenya	Italy
Jordan	Korea (Republic of)	Japan
Laos	Kuwait	Mexico
Liberia	Lesotho	Netherlands
Madagascar	Libyan Arab Republic	Nigeria
Nepal	Malaysia	Norway
Nicaragua	Malawi	Pakistan
Panama	Mali	Philippines
Portugal	Mauritania	Romania
Qatar	Morocco	Spain
Rhodesia	New Zealand	Sweden
Rwanda	Niger	Switzerland
Saudi Arabia	Peru	Thailand
Sierra Leone	Senegal	USSR
Somalia	South Africa	United Kingdom
Syrian Arab Republic	Sri Lanka	United States
Togo	Sudan	Upper Volta
Tunisia	Swaziland	Zaire
Uruguay	Tanzania (United Republic of)	
Yemen	Turkey	
Yugoslavia	Uganda	
Zambia	Venezuela	

TABLE II. ORGANIZATIONS INVOLVED IN
INTERNATIONAL REMOTE SENSING ACTIVITIES

Canada Centre for Remote Sensing
Canada International Development Agency
Center for Natural Resources, Energy and Transport
Central Treaty Organization
Economic and Social Commission for Asia and the Pacific
Economic Commission for Africa
Economic Commission for Latin America
Economic Commission for Western Asia
European Space Agency
Food and Agriculture Organization
Inter-American Development Bank
International Bank for Reconstruction and Development (World Bank)
Liptako-Gourma Authority
National Aeronautics and Space Administration
Swedish International Development Agency
United Nations Development Programme
United Nations Disaster Relief Organization
United Nations Educational, Scientific and Cultural Organization
United Nations Environment Programme
United States Department of State/Agency for International Development
United States Geological Survey
World Health Organization
World Meteorological Organization
