Reprinted from

Eleventh International Symposium

Machine Processing of

Remotely Sensed Data

with special emphasis on

Quantifying Global Process:
Models, Sensor Systems, and Analytical Methods

June 25 - 27, 1985

Proceedings

A MICROCOMPUTER-BASED TRAINING CENTER FOR REMOTE SENSING AND RESOURCE ANALYSIS: THE INDONESIAN EXAMPLE

SEAN C. AHEARN, RALPH W. KIEFER, LARRY L. SEIDL

University of Wisconsin
Madison, Wisconsin

UUP S. WIRADISASTRA

Institut Pertanian Bogor
Soil Science Department
Bogor-INDONESIA

ABSTRACT

A microcomputer-based laboratory for digital image processing and natural resource analysis was installed at the Institut Pertanian Bogor, Indonesia, during November 1984. This laboratory is the result of a cooperative project between the Institut Pertanian Bogor (IPB) and the University of Wisconsin-Madison (UW).

Both IPB and UW personnel were responsible for hardware selection and software development and worked together at UW and IPB as part of the project's personnel exchange program. The hardware consists of five IBM-PC/XT microcomputers networked to a 160 MB disk drive, an 800/1600 BPI tape drive and a Gould DeAnza high resolution graphics terminal. The software includes a wide range of digital image processing programs for geometric rectification, image enhancement, and image classification, as well as a basic geographic information system capability.

A two-week workshop on the use of micro-computers for digital image processing was given in this new IPB laboratory during December 1984. Participants in the workshop included representatives from six government agencies and three major universities, demonstrating the tremendous interest generated by this newly-installed image processing system. It is anticipated that further development of this lab will establish IPB as the Indonesian national training center for remote sensing and natural resource analysis.

INTRODUCTION

Indonesia is an archipelago that consists of over 12,000 islands traversing three thousand miles of sea and ocean. Accessibility is very restricted even on the most developed island of Java, which contains two-thirds of the nations 150,000,000 people. Natural resources are severely strained on Java and intensive management with frequent monitoring is a necessity for the sustained yield of agricultural products. The outer islands (Sumatra, Borneo, Irian Jaya, etc.), which contain one-tenth of the world's tropical forests, are rapidly changing because of logging, shifting agriculture and transmigration.

In order to develop a better information base for the country's natural resources, the Indonesian government, with the help of various international organizations, has begun to develop remote sensing and geographic information systems (GIS) at several government agencies. It has also set up a ground receiving station for remotely sensed satellite data.

While millions of dollars have gone into hardware and software acquisition and infrastructure development, a minimum investment has been made in the training necessary to realize the full potential of remote sensing technology. An Institute Pertanian Bogor (IPB) - University of Wisconsin-Madison (UW) remote sensing project has begun to remedy this imbalance. It has set up a microcomputer-based laboratory for remote sensing and geographic information systems and has expanded the IPB curriculum in both of these areas. In December 1984, a two-week training workshop on "the use of a micro-computer based image processing system for remote sensing and GIS" was given at the IPB. This paper describes the IPB/UW remote sensing project and explores its implications for the future.

PROJECT BACKGROUND

The IPB/UW cooperative remote sensing project was initiated in January 1983. At this time, a proposal was developed by a joint IPB/UW team at the IPB. Four areas of cooperative work were identified in the plan: (1) curriculum development, (2) personnel exchange, (3) development of a remote sensing image processing lab at IPB, and (4) the planning for cooperative IPB/UW research projects.

In June 1983, work began in the four areas identified above by the IPB/UW team at IPB. In August 1983 a workshop on curriculum development was given at IPB. Participants in the workshop included the Rector and Vice-Rector of IPB, the IPB remote sensing group, the UW remote sensing team, and representatives from the major government agencies that use remote sensing (BAKOSURTANAL - the Indonesian national mapping agency, the Department of Public Works, and the Ministry of Agriculture).

Three tasks were accomplished in the first phase of the project (June 1983 through August 1983): (1) a preliminary remote sensing curriculum was outlined, (2) a microcomputer based digital image processing system was designed, and (3) a plan for personnel exchange was developed.

The second phase of the project (September 1983 through October 1984) emphasized the IPB/UW personnel exchange and the development of the digital image processing system. The IPB remote sensing director visited the UW in Fall 1983, and two staff members visited the UW for a period of nine months during 1983-84. The objectives of the staff members were: to take courses that contribute to their degrees, to design courses for the IPB remote sensing curriculum, to work on the development of the computer system for digital image processing, and to conduct preliminary research towards their dissertations. By the end of the second phase, the IPB-UW team had worked jointly in the development of the digital image processing system and the team was in a position to use the system for course development and the execution of joint research projects.

This phase of the project saw continued development of the digital image processing system and included a second visit to UW by the IPB remote sensing director. During his visit in October 1984, the December 1984 IPB training workshop in remote sensing and GIS was outlined.

In the final phase of the two year project (November 1984 - March 1985) the IBM PC-based image processing system developed at UW was installed at the IPB remote sensing lab in Bogor. After installation, a two-week training workshop on "the use of a microcomputer based image processing system for remote sensing and GIS" was given by a joint IPB/UW team.

DEVELOPMENT OF REMOTE SENSING AND GIS IN INDONESIA

There are three main government centers in Indonesia that have been involved in remote sensing: LAPAN - the Indonesian space agency, BAKOSURTANAL, and Public Works. A ground receiving station for Landsat MSS, NOAA AVHRR, and GEMS data is operated by LAPAN. In 1985-86 LAPAN will also be able to receive Landsat TM data and SPOT data. The primary government centers for data analysis are BAKOSURTANAL and Public Works. BAKOSURTANAL, with World Bank funding, has set up a large system for digital image processing and geographic information systems. Public Works has a smaller image processing system that was set up by the Japanese.

Most of the training in remote sensing and geographic information systems at these institutions has been done by short-term consultants. While this gives hands-on training to personnel, it fails to provide the in-depth knowledge necessary to understand the systems. It also presents the material principally from the perspective of the company that developed the hardware and software system. Growth, research and development in the areas of remote sensing and GIS are limited in such environments.

An institutional structure is needed that covers the basic theoretical aspects of remote sensing and GIS as well as the applications of the theory. This assures the proper use of a technology that can be easily abused. It also provides a fertile environment for research and development.

A logical setting for a training institute in remote sensing and GIS is the university environment. Presently there are only two Indonesian universities working in this area: the Institut Pertanian Bogor (IPB) in Bogor and Gaja Mada University in Jogjakarta. The IPB remote sensing system is a microcomputer-based system that stresses accessability of software code and continued development and expansion at both IPB and UW. The system at Gadja Mada University is a "turn key" system with protected software that can not be analyzed and expanded by the in-house scientists as readily as the IPB system.

DATA UTILIZATION

At present LAPAN is capable of receiving Landsat MSS, NOAA AVHRR, and GEMS data. The MSS data are the only data of the three that are presently being utilized. The AVHRR and GEMS data, which have traditionally been used for meteorological purposes, are being stored on CCTs. While the data tapes continue to accumulate, there has been no training program established to teach users how to analyze the AVHRR or GEMS data. Recently, personnel at the IPB remote sensing lab have begun to investigate calculating a vegetation index from the AVHRR data to assess the vegetation cover of Indonesia.

DATA TRENDS

The greater spatial and spectral resolution of the TM and SPOT remote sensing systems has led to an increase in the detail and volume of information.

The volume of data received from satellites is a function of both the resolution of the system and the number of wavelength bands recorded. The shift from the Landsat MSS, with four bands and a nominal resolution of 80 meters, to the SPOT system, with 20 meter resolution in three bands and 10 meter resolution in one band, results in a thirty-fold increase in the volume of data for a given ground area.

Unlike the Landsat MSS data, the level of information that can be derived from TM and SPOT data is useful for site-specific analysis. This makes these data appropriate as an input into local and regional information systems.

DATA DECENTRALIZATION

The present structure in Indonesia has placed emphasis on centralized analysis of remotely sensed natural resource data. With the increase in spatial resolution of the remote sensing systems and the resulting increase in information and data volume, it must be asked whether it is feasible or even desirable for a central agency to analyze the data. A decentralized approach to data analysis seems necessary.

LOCAL/REGIONAL ANALYSIS AND CENTRALIZED COMPILATION

Decentralization puts the data in the hands of the people who know their region best and can, therefore, do a better job of the analysis. The role of the central level would be to gather the information obtained by local data analysis and compile that information to obtain national trends in natural resource exploitation. This information could then be used at the central level for national projections, planning, and policy formulation and implementation.

SYSTEM UNIFORMITY AND KNOWLEDGEABLE USERS

For the decentralization to work, three ingredients are necessary: a well trained and knowledgeable team at the local/ regional level; consistency in the software/hardware system used by the localities; and a centralized training center that can provide support for training, research, and development of new analysis techniques. Indonesia is in its initial stage of remote sensing/GIS development and is still in a position to realize this scenario.

INSTITUT PERTANIAN BOGOR - A NATIONAL TRAINING CENTER FOR REMOTE SENSING AND GIS

A centralized training center would make the shift in natural resource data analysis from the central level to the local/regional level possible. The center would provide training to both local/ regional and central-level personnel. It would remain state-of-the-art through research, development and interaction with the international community, and would keep local personnel in touch with central levels of government and other localities.

The Institut Pertanian Bogor is an ideal setting for a national training center in remote sensing and GIS because:

It is the largest agricultural university in Indonesia and has strong departments in soil science, agronomy, forestry, entomology, agrometeorology, and other agriculturally related areas.

It is in close geographic proximity to LAPAN, BAKOSURTANAL, Public Works, and Transmigration and has a working relationship with each of these institutions.

It has developed a microcomputer-based image processing and GIS system that would be very appropriate at the local/regional level.

It offers a wide range of courses in remote sensing and GIS and is involved in the expansion of these curricular areas.

It has given a training workshop in remote sensing and GIS and has experience in both areas.
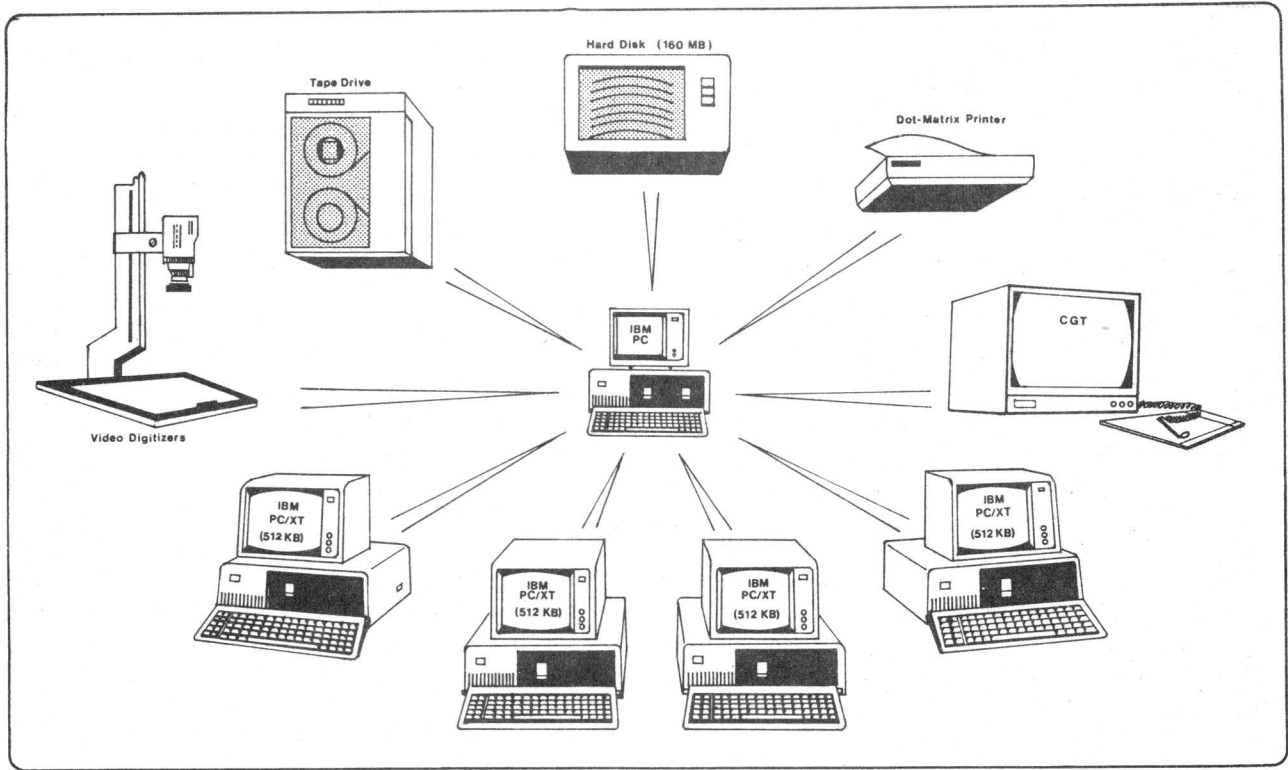
FIGURE 1 - IPB-UW IMAGE PROCESSING SYSTEM HARDWARE

It has a strong quantitative base in statistics, computer science and physics.

IPB MICROCOMPUTER-BASED IMAGE PROCESSING AND GIS LABORATORY

The shift from expensive, difficult to maintain mainframe/minicomputers to inexpensive, reliable, and easily maintained microcomputers has made the decentralization of data more technologically feasible. Regional/local centers can perform their analyses on a microcomputer-based system with most of the capabilities that exist on the very large systems.

IPB's remote sensing/GIS microcomputer based system was developed with decentralization in mind. As shown in Figure 1, the system consists of five IBM/PC XT microcomputers networked to a 160 MB disk drive, an 800/1600 BPI tape drive, a Gould DeAnza FD 5000 high resolution color graphics terminal and a dot matrix printer. A video digitizer will be added to the system. A subsystem, consisting of two IBM PC/XT's and a Gould DeAnza terminal, has been installed at the University of Wisconsin, for software development and for use by visiting IPB scientists. Ultimately this subsystem will also be installed in the IPB lab. Software for the system includes a wide range of digital image processing programs for geometric rectification, image enhancement, and image classification, as well as basic GIS functions. What distinguishes the IPB system from commercial systems is that the software is unprotected and can be actively modified and expanded by within house scientists.

One of the important policy decisions that the government will make in the near future is which system for image processing and GIS should become the standard for Indonesia at the regional/local level. The IPB system was developed by an IPB/UW team and is therefore fully understood by the IPB remote sensing team. This increases self reliance and decreases the dependency on outside experts to respond to Indonesia's unique and changing needs in the area of resource inventory and analysis.

IPB WORKSHOP: "THE USE OF MICROCOMPUTERS
FOR IMAGE PROCESSING AND GIS"

The IPB training workshop given from
December 3-14, 1984, demonstrated the role
that IPB could play as the central
training center for remote sensing and
GIS.

Material covered in the workshop included
an introduction to the electromagnetic
spectrum, visual interpretation of aerial
photographs, digital image processing,
instrumentation, classification theory,
the geometry of digital images, and
geographic information systems. The
workshop also emphasized hands-on
experience with the microcomputer system
in the IPB remote sensing lab.

The work shop was attended by 24
participants from three universities and
six government institutions. University
representatives came from Gajah Mada, the
Institut Tecknikal Bandung, and the
Institut Pertanian Bogor. Government
agency representatives came from the
Department of Transmigration, LAPAN,
BAKOSURTANAL, the Soil Research Center,
BIOTROP and the Department of Forestry.

Several objectives were achieved by the
workshop:

Participants were exposed to theory and
application in the areas of remote
sensing and image analysis.

Government participants learned about
the capabilities of the system and its
relevance to their activities.

The IPB remote sensing group gained
experience in the preparation and
execution of a remote sensing workshop.

The groundwork has been laid for an annual
workshop or conference at IPB in the area
of remote sensing and geographic
information systems.

CONCLUSION

The need for a centralized training center
in remote sensing and geographic infor-
mation systems will become greater as data
volumes increase and data decentralization
becomes the mode of the future. The
Indonesian institution that is presently
in the best position to fulfill this role
is the Institut Pertanian Bogor, given its
strong academic base and extensive
experience in the fields of remote sensing
and GIS. It can only be hoped that the
international funding agencies will begin
to realize the importance of building up

human resources in equal proportion to
capital resources and support the
development of an Indonesian national
training center in remote sensing and GIS.

REFERENCES

Ahearn, S.C., R.W. Kiefer, A. Rambe, and
M.A. Raimadoya, "IBM-PC/XT Micro-
computer-Based Digital Image Processing
System for Remote Sensing Education in
Developing Countries - Case Study:
Indonesia", Technical Papers of the
American Society of Photogrammetry,
ASP-ACSM Annual Meeting, March 1984,
pp. 253-262.

AUTHOR BIOGRAPHIES

Sean C. Ahearn is a Ph.D. student in the
University of Wisconsin-Madison Environ-
mental Monitoring Program. He received a
B.S. from the College of Environmental
Science and Forestry at Syracuse (NY) in
1978 and an M.S. degree in Environmental
Monitoring from the University of
Wisconsin-Madison in 1982.

Ralph W. Kiefer has been a faculty member
at the University of Wisconsin-Madison
since 1962. He has B.S., M.S. and Ph.D.
degrees from Cornell University. At the
U.W., he is Professor of Civil and Enviro-
nmental Engineering and the Institute for
Environmental Studies and is Chairman of
the Environmental Monitoring Program, a
graduate program in environmental remote
sensing.

Larry L. Seidl is a staff electronics
engineer at the Institute for Environ-
mental Studies (IES) at the University of
Wisconsin-Madison. He received a B.S.E.E.
degree, with a specialization in digital
logic design, from the University of
Wisconsin-Madison in 1972. Since that
time, he has done instrumentation and
computer systems design for the IES Marine
Studies Center and Environmental Remote
Sensing Center.

Uup S. Wiradisastra is Head of the Department of Soil Science at the Institut Pertanian Bogor (IPB) in Bogor, Indonesia. He received a Ph.D. degree in Geography from the University of Sheffield (Great Britain) in 1977. He is Chairman of the IPB team for the application and development of remote sensing.