MOMS-02 AND ITS CONTRIBUTION IN FUTURE DEVELOPMENT OF NORTHEASTERN BRAZIL

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ABSTRACT. Although the Satellite data, such as Landsat, SPOT, RADAR and others are being used in different ways to analyse the natural resources of the region. Because of the high resolution and stereoscopic vision we have to use only the MOMS-02 photographs for detailed planning and management of the region. MOMS-02 is, as a continuation of MOMS-01, a development for digital mapping of the Earth's surface from space. It was the first instrument flown in Space using the push broom scan principle. It is fundamentally different from all existing remote sensing systems and thus pursues new and independent goals. The MOMS-02 system will be reflown in l996 on board of the Russian Space Station MIR/PRIRODA module for about 18 months under German-Russian Cooperation. The special characteristics of MOMS-02 (the combination of high resolution panchromatic images for 3-dimensional geometric information with multispectral images) are used for a wide range of environmental applications (erosion risk, natural hazards), radiometric correction of images and thematic applications. The MOMS-02 data are expected to enable improved interpretation and verification of natural phenomena and anthropogeneous changes. The purpose of this research is to show how the use of high resolution multispectral and stereoscopic MOMS-02 photographs might make a larger contribution in future development of northeastern regions of Brazil. Using the MOMS-02 data, the investigation for the development of the region may be concentrated in Brazilian/German institutions under the supervision and orientation of the Scientists and Investigators from the DLR (Germany) and INPE (Brazil) on the fields of natural resources, biomass estimation, agriculture, soil conservation, ecology, Coastal environmental, desertification, degradation, natural risk and urban/rural planning.

KEYWORDS: MOMS-02, MIR/PRIRODA, NATURAL RESOURCES, NE BRAZIL

INTRODUCTION

Northeastern Brazil composed of nine states, requires a better management and proper utilization of its natural resources, using up-to-date sattelite data of high resolution multispectral and stereoscopic photographs. such as MOMS-02.

MOMS-02 is, as a continuation of MOMS-01, a development for digital mapping of the Earth's surface from space. In order to fulfil the sophisticated data requirements of advanced digital mapping and GIS in scales around 1:25,000 including high information, MOMS-02 has been developed on the basis of the first spaceborne pushbroom Camera MOMS-01 since the mid eighties. The next mission of MOMS-02 on the Priroda platform in German-Russian Cooperation beginning mid

1996, will be helpful to solve the scientific problems in the frame work of PRIRODA project. The scientific problems may be: soil types mapping, soil erosion; vegetation classification, inventorying and mapping; control of the snow and ice cover state; control of the lower reaches, drainage/basins of large rivers, internal reservoirs state geological structures mapping; cloud cover structures investagation; control of the areas of ecological disasters and natural calamities etc.

Not only the research and scientific disciplines of the Universities and Institutions but also the administrative authorities/agencies and private sectors are also interested in using the results of high resolution satellite data within their running programs. Many administrative authorities

and private institutions are very busy in creating their own Information Systems. To get the fruitful results from the MOMS-02 data, the data must be available in a short period of time: processed, for low costs, quick, sure and continuous. Only then the scientific and administrative problems can be solved more efficiently, and the development of the region in each state can be started at a larger scale for each Municipality separately.

BACKGROUND DISCUSSION

Using the MOMS-02 data some work has been done at an experimental basis by German and other scientists for different parts of the world, such as Mexico, Chile, India, Ethiopia, Egypt, and Germany, and have been presented and published in the International Symposium of MOMS-02, held in KOLON (Germany) in the month of July 1995, as well as in summer course of MOMS-02 at the University of Munich. Because of the promising results of interpretation of MOMS-02 data, there is a great possibility and future perspective of the utilization of these data through out the World.

MOMS-02 experimental data acquired during the German Spacelab D2 mission will be used for a broad range of scientific objectives. The simultaneous acquisition of high spatial resolution, multispectral and stereo scenic data enables a real combination of thematic and topographic information, thus considerably improving the verification and interpretation of dynamic changes of the Earth's surface by means of remote sensing. (Bodechtal et al 1994).Kaufmann et al (1989) found that the width and center wavelength of visible (VIS), and near infrared (NIR) range of electromagnetic spectrun are optimized for the detection of the spectral response of vegetation and for the discrimination of Fe-bearing rock and soil surface due to significant absorption in the VIS/NIR spectral range. Kornus et al (1995) tested the MOMS-02 for photogrammetic point determination and found succesful and resulted in a mean absolute object point accuracy of about 1 pixel (13.5 m) in x,y, and z as derived from 43 independent check points. Kaufmann et al (1995) used the MOMS-02 in order to know the validation of spectral and panchromatic Modules. They selected a multisensoral approach which gave reasonable results about the qualitative and quantitative performance of the newly designed sensor in relation to other sensors.

Bodechtal et al (1995) tried the MOMS-02 data for geological purposes in Egypt. Images of MOMS-02 clearly show the ability of the combination of multispectral and high resolution data to improve the geological mapping that was done with Landsat-TM data in the past. The textural information derived from this investigation enhances the study of the regional tectonics and the

differentiation of geological surfaces. Stohr et al (1995) applied the MOMS-02 data for the mapping of erosion risk zones in the Lake Tana Region of Ethiopia and found that the MOMS-02 Stereo data are very valuable to prepare erosion risk maps and for the information for soil protection actions. Schneider et al (1995) used the MOMS-02 Mode 3 data for land cover mapping, fuel wood demand and supply analysis in the Lake Tana region of Ethiopia. They found that the land cover and relief perameters are both derivable and the classification results proved to be sufficient for regional planning purposes. Richter and Lehmann (1995) used the MOMS-02 data for spectral band selection. For 15 m ground resolution element at a 310 km orbit, 4 channels were chosen> 1) 450-505nm, 2)530-575 nm, 3)645-680 nm and 4) 770-880 nm. For 5 m ground resolution the spectral band 520-720 nm was selected. Lehner and Kornus (1995) used the MOMS-02 Mode 3 data of Mexico and Ethiopia as an experiment for photographic evaluation. They investigated that the imagery is possible for digital photogrammetric processing and leads promising
results.

DEVELOPMENT OBJECTIVES

Although the Satellite data, such as Landsat, SPOT, RADAR and others are being used in different ways to analyse the natural resources of the region. Because of the high resolution and stereoscopic vision we have to use only the MOMS-02 photographs for detailed planning and management of the region. The development of the region is mainly based on the following basic steps: Training, Education, and Research.

Training:

a) Lectures series in various Universities/Institutions of Brazil through German Scientists about MOMS-02: its fundamental, benefits, advantages and applications in different fields of scientific research.

b)Seminares in different Federal organizations, State institutions and private agencies.

b) Presentation and demonstration of MOMS-02 data analysis and applications in different fields of research during Science and Technical exhibitions.

Education

a) Short term courses of MOMS-02 and its applications in specific areas.

b) 2-3 months exchange program of German/Brazilian Scientists.

c) To add the MOMS-02 with other satellites, such as Landsat and SPOT, in the M.Sc and Ph.D teaching, research and extension programs of Brazilian Universities. It is already being taught in the remote sensing course of the CCA/UFPB, Areia/PB, Brazil.

d) One year course of Specialization in DLR on MOMS-02 in different fields of education and research.

Research :

Using DIBIAS and ERDAS softwares, the MOMS-02 photographs should be used on an experimental basis in different test sites over northeastern states of Brazil for the application and preparation of various thematic maps:

Land use and Land cover; Vegetation Index;
Forest types and Classification;
Soil Classification;
Soil Conservation and Land Management;
Natural Resources management; Surface Water and Drainage Pattern;
Geological, Hidrological, Ecological and Coastal environmental studies; Desertification/Degradation and natural risk;
Urban and Rural
Planning and Agriculture etc.
Land Information System/
Geographical Information System:

-Natural Hazard Detection
-Agricultural Land   Suitabilities
-Urban and Rural Infrastructure
-Agricultural Statistics
-Natural Resource Management
-Ecological Information System

PRODECURE

Experimental Sites:

Northeastern Brazil is composed of nine states: Bahia, Sergipe, Alagoas, Pernambuco, Paraiba, Rio Grande do Norte, Piaui and Maranha. The test sites for investigation should be selected in different climatic and physiographic zones of each state of NE Brazil,based on the research interest, year, availability, and quality of the MOMS-02 data. The region has different types of physiographical relief features and geomorphological forms. Crop production in the area is almost dependent on natural rains as very little area is irrigated with water of ponds and lakes

which collects during the rainy season. The area is cover by natural pastures, wastelands, vegetation and big water reservoirs. There is also a network of rivers, many of which are intermittent. Crop production and animal husbandry are the major agricultural and economic activities of the region.

Hardware/Software:

The digital data comprising satellite scenes should be available on computer compatible tapes and must be processed on a computer, using appropriate programs. A wide range of computer facilities might be used to process satellite data. There is also a wide range of systems specifically designed for interactive processing of satellite data. Output from the specified interactive systems should be obtained in essentially the same way, but these usually include software which permits the attachment of dot printers, of plotters using color pens and even Ink-jet/desk-jet printers, The main hardware/software, recommended for this project, are:

Hardware:

-Pentium CPU with all the   accessories and color printer. -80486 CPU (IBM or IBM   Compitable) with all the   accessories, Digitizing table,Multimedia kit and color   printer.
-SUN Workstation with all the   accessories.

Software:

Following softwares are recommended   to conduct this investigation:

-X-DIBIAS
-ERDAS Ver. 7.5
-ERDAS IMAGINE Ver. 8.1, 8.2
-ARCINFO

MOMS-02:

MOMS-02 is the technological continuation of MOMS-01, which was the ist instrument flown in Space using the push broom scan principle. The second generation of the Modular Optoelectronic Multispectral Stereo Scanner (MOMS-02) was flown during the German D@ mission aboard the space shuttle. The first results are very promising for application in forestry and land use management. (Mehl et al 1995).

  The technical features of the MOMS-02 Camera are oriented toward the requirements of the photogrammetric

and thematic sciences. The system layout is chiefly specified through such requirements as:

-three-fold streo imagery
-along-track stereo imagery
-high resolution imagery (5 m)
-multispectral imagery (15 m)
-combinations of stereo and   multispectral imaging

The system is to be compared especially with the Thematic Mapper (USA), the SPOT (France), and the Film Camera System Large Format Camera1 (USA), Metric Camera (Germany), and KFA-1000 (USSR). In the frame of a bilateral Russian/German agreement, the MOMS-02 as flown on the Spacelab D-2 mission will be refurbished and operated onboard the PRIRODA module of the Russian MIR space station in a preoperational manner.
(Figure-1)

The MOMS-2P esperiment is generally to be seen in the light of recent trends for improving the earth observation systems. On the MSS side there is tendency for higher geometric resolution and accuracy, in combination with more specific layout of the MS channels, and with additional support by three-dimensional information on relief, slope and exposition.

On photogrammetric side there is the general tendency for establishing an autonomous light-precision system with the particular capability for deriving from space digital terrain models of high accuracy (5 m) and for obtaining high resolution topographic information in order to make topographic mapping and land information systems genuine spaceborne products on accepted levels of professional standards.

The automatic derivation of digital terrain models for some specific areas should also investigated for the region. The combination of multispectral images and digital terrain models will help the interpretation and automatic classification of the area of interest at a larger scale.

Features Identification:

The major basic and applied activities during this program of MOMS-02 data will be as follows:

Basic activities: Special Enhancements, Contrast Enhencement, Multitemporal Data, Radiometric Correction, Geometric Correction, Multiple Enhancement, Principal Component Transformation and Frequency Distribution Histograms and Resolution etc.

Applied activies: Unsupervised Classification, Supervised Classification, Feature Indentification, Vegetational Classification, Stereo Processing, Accuracy Assessment, Spectral Refelectance Characteristics, Application and Thematic maps preparation for different natural resourcs, such as Soil, Forest, Hydrology, Geology etc.

Utilization Goals of the MOMS-02/D2:

MOMS-02 combines a high resolution three-channel stereo module with a four-channel multispectral unit. With these features, MOMS-02 is designed as complementry system to the existing programs, providing

-digital imagery of higher geometric resolution and geometric accuracy.

-along-track stereo capability, to be operated in the panchromatic mode alone or in various combinations with spectral channels.

-enhanced detection of surface materials by optimized position of bands.

-combination of high spatial resolution panchromatic band with spectral channels for the detection of small scale textures of Earth's surface.

As MOMS-02 is the first instrument offering operational stereo-capability using the three - line scanner concept the most important general task was to master the linear array geometry for deriving precise three-dimensional geometric object information.

Methods have been developed for an automatic derivation of high-precision Digital Terrain Models with a vertical accuracy of better than 5 m from the stereo-image data.

The Digital Terrain Models are basis for producing contour maps, orthphotos, elevation maps etc., and especially for GIS.

The design of the spectral bands with their bandwith and centering optimized for vegetation reconnaissance and the discrimination of rocks, soils, and minerals will contribute to a more sophisticated utilization of spaceborne remote sensing data.
The very high geometric resolution of the nadir optics of 6 meters pixel size closes the gap between satellite remote sensing and aerial photo surveys and thus is expected to foster spaceborne data applications in many new fields of application.

A very specified field of investigation concerns the combination and the mutual support of photogrammetric and thematic information. By merging the multispectral data with the third dimension it will be possible to detect and differentiate lithological and above all tectonic phenomena, which express themselves morphologically, instable slopes (areas endangered by land-slides), to map watersheds and drainage areas, to model water amounts (recharge/discharge areas), in general to investigate in detail all phenomena, where geometric position and form are essential reconnaissance criteria.

MOMS/PRIRODA Mission Characteristics:

-Launch   April l996
-mission duration   18 months   min.
-orbit inclination   +- 51,6   degree
-altitude   380-405 km
-ground pixel sizes
   -nadir(ch.5)   5.6-6.0 m
   -Stereo fore and aft.
   (ch.5 and 6)   16.8-18 m
   -multispectral 16.8-18 m
   (channel 1,2,3,4)
-swath widths
   -nadir   46-50 km   -stereo fore
   and aft   97-105 km
   -multispectral 97-105 km
-data sampling modes
  -mode 1: full stereo with   high resolution
   (channles 5,6,7)
  -mode 2: multispectral , all   4 bands (channels
    1,2,3,4)
  -mode 3: high resolution and
      3 spectral bands   (channels 2,3,4,5)
  -mode 4: 2 multispectral   bands plus fore and
           aft stereo   (channels
1,4,6,7)

-mission operations by the German Space operations Centre Oberpfaffenhofen (GSOC) via ZUP, Moscow.
-dedicated global data acquisition on request with intermediate onboard storage
-transmission to ground stations in Germany (Neustrelitz) and Russia (Moscow).
-processing and archiving facilities (system corrected data) in Germany (Neustrelitz) and Russia (Moscow).

Application Themes for Development of the Region:

The development of the area will be based on the following application themes:

Application 1: Landuse/Cover

-Agriculture
-Crop Identification
-Surface Water/Drainage
-Settlements
-Rural Infrastructure
-Bare Surfaces

Application 2: Grassland and Natural Vegetation

-Development of Classification   and Mapping Criteria
-Assessment of productivity
-Monitoring of Growth   Conditions
-Change-Detection
-Ecosystem Definition and   Mapping

Application 3: Environmental Monitoring

-Desertification, Degradation, Erosion Risk Mapping
-Monitoring of Mangrove Ecosystem
-Ecological and Morphological Classification
-Natural Hazards
-Change-Detection
-Rural/Regional Planning
-Urban Planning

Application 4: Geology

-Soil Mapping and Classification
-Soil Conservation
-Physiography and Relief
-Land Classification
-Slope Gradients and Terrain
-Lithology
-Infrastructure
-Rock Identification
-Tactronics
-Oil Exploration

Other Applications:

-Engineering
-Telecommunications
-Defence

FUTURE PERSPECTIVE

To improve the remote sensing and GIS research program in our northeastern universities and other institutions the following suggestions should be adopted for the development of the northeastern regions of Brazil.

-Establishment of GIS/LIS and Remote Sensing Centers.
-Cooperation and Coordination
-Key role of the INPE and DLR.
-Methods for data acquisition and Processing.
-To alliviate the shortage of well qualified personals.
-Intensive training programs.
-Budget for research and education.
-Removal of ban from importation.
-The contribution of the CNPQ and CAPES.
-To avoid the burocracy from the research and education.
-Aid from the developed countires and world organizations.

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