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for Western Asia

APPLICATION OF SATELLITE REMOTE-SENSING METHODS FOR HYDROGEOLOGY IN THE ESCWA REGION

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Foreword

With the creation of high resolution geo-information data from satellites, powerful tools for fast and efficient spatial assessment of natural resources have become available.

However, the satellite data are produced and supplied by various national institutions and private companies in the industrialized countries, and it will therefore be difficult for potential users in the ESCWA member countries to maintain up-to-date information on the available digital or image products that may serve their requirements appropriately and cost-effectively.

It was in this context that the ESCWA secretariat took the initiative to prepare the present document, which summarizes the features of satellite data available for the region at present and in the near future. Also reviewed are the data characteristics of selected satellite systems, their practical applications and their sources of acquisition.

Case studies from Jordan and the Syrian Arab Republic, and Oman and the desert areas of Saudi Arabia offer numerous examples that demonstrate the applications and value of remote sensing techniques for ground as well as surface water research studies.

It is my hope that the dissemination of this study, undertaken as part of a joint ESCWA/BGR (Federal Institute for Geosciences and Natural Resources of Germany) project entitled "Advisory services to ESCWA and the ESCWA member States" in the field of water resources, will encourage the national institutions to apply remote sensing techniques to a wider extent in the investigation of groundwater resources as well as in planning the exploitation and management of natural resources.

H. El Beblawi

Hazem El-Beblawi
Executive Secretary

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Abbreviations

ACRES	Australian Center for Remote Sensing
AVHRR	Advanced Very High Resolution Radiometer
BGR	*Bundesanstalt für Geowissenschaften und Rohstoffe, Hannover* Federal Institute for Geosciences and Natural Resources
BMZ	*Bundesministerium für wirtschaftliche Zusammenarbeit und Entwicklung* Federal Ministry for Economic Cooperation and Development
DLR	*Deutsche Luft und Raumfahrt Gesellschaft*
DVI	Differentiated Vegetation Index
EDC	see USGS EDC
EDC DAAC	Earth Resources Observation System Data Center Distributed Active Archive
EOS	NASA´s Earth Observing System (global earth observing program)
EOSAT	Earth Observation Satellite Company (now IMAGING EOSAT)
EOSDIS	NASA´s Earth Observing System Data
EROS	Earth Resources Observation System
ERS	European Radar Satellite
ERTS	Earth Resources Technology Satellite (former name of LANDSAT)
ESA	European Space Agency
ESCWA	Economic and Social Commission for Western Asia
ETM	Enhanced Thematic Mapper
EURIMAGE	European Satellite Data Distributer (Italy)
GAC	Global Area Coverage (NOAA-AVHRR-system)
GAF	*Gesellschaft für angewandte Fernerkundung* Company for Applied Remote Sensing (Germany)
GIS	Geographic Information System
GLIS	Global Land Information System (USGS EDC)
HDT	High Density Tape
HIRS	High Resolution Infrared Radiation Sounder (NOAA)
HRPT	High Resolution Picture Transmission (from satellite to ground station)
IDB	Islamic Development Bank
IFOV	The Instantaneous Field-of-View
IMAGING EOSAT	Space Imaging Eosat Corporation (U.S.A.)
IR	Infrared
IRS	Indian Remote Sensing Satellite
ISRO	Indian Space Research Organisation (IRS-development)
JERS	Japanese Earth Resources Satellite
JERS-SAR	JERS-Synthetic Aperture Radar
LAC	Local Area Coverage (NOAA-AVHRR-system)
LANDSAT	LANDSAT Satellite Program

LANDSAT TM
see TM and LANDSAT
LANDSAT MSS
see MSS and LANDSAT

LGSOWG	LANDSAT Ground Station Operations Working Group
LISS	Linear Imaging Self Scanning Sensor (IRS-Satellite)
MOMS	Modular Optoelectronic Scanner (ESA)
MSS	Multispectral Scanner
MSU	Microwave Sounding Unit
NASA	National Aeronautics and Space Agency (U.S.A.)
NASDA	National Aeronautics and Space Development Agency (Japan)
NDVI	Normalized Differentiated Vegetation Index
NIR	Near Infrared
NOAA	National Oceanographic and Atmospheric Administration (U.S.A.)
NOAA-AVHRR	NOAA-Advanced Very High Resolution Radiometer
NSLRSDA	National Satellite Remote Sensing Data Archive (U.S.A.)
OPS	Optical Scanner (JERS)
SAR	Synthetic Aperture Radar
SPOT	Système Probatoire d´Observation de la Terre (SPOT IMAGE)
SSU	Stratospheric Sounding Unit
SWIR	Short Wave Infrared
TIR	Thermal Infrared
TM	Thematic Mapper
TDRS	Tracking and Data Relay System
UNEP	United Nations Environmental Program
USGAU	US Government and Affiliated Users
USGS	US Geological Survey
USGS EDC	United States Geological Survey EROS Data Center
VI	Vegetation Index
VIS	Visible Infrared
VISSR	Visible and Infrared Spin Scan Radiometer (METEOSAT)
WV	Water Vapor

Summary

This study presents recommendations for the application of actual and future satellite remote sensing systems for groundwater research programs in the ESCWA region.

An aquifer case study from Jordan/Syria and preliminary evaluations of three selected studies from northern Jordan, the Oman Mountains, and the desert area of Saudi Arabia and Oman demonstrate the application of remote sensing and its limits.

Basalt Aquifer Study

The aquifer case study from Jordan/Syria was carried out in the basalt area of northern Jordan and southern Syria. A new synoptic geologic model of the Neogene and Quaternary basalt complex has been developed. LANDSAT TM-data gave detailed information about distribution and differentiation of the basaltic series. The geotectonic frame of the basalt series is predominantly defined by two NW-SE and NNW-SSE tensional systems which are combined with the emplacement of basaltic magma. The Neogene basalt complex derives from "fissure fillings" which are connected to major NW-SE and minor E-W trending faults. The basalt is intercalated by tuff layers. The thickness of the Neogene basalt is assumed to reach more than 1300 m in the region of Jabal Al Arab.

The Quaternary series consists of basaltic flows, scoriaceous cones and shield basalt. They derive from NNW-SSE trending major lineaments (tensional fracturing from the Red Sea event of Pliocene / Pleistocene time?). Quaternary basaltic flows or shield basalt reach maximum thickness of about 150m.

The distribution of the Neogene basalt complex and the knowledge about shallow groundwater occurrences in the surroundings of the fractured Neogene basalt are evident for groundwater recharge. The maximum thickness of 1300m of Neogene basalt is promising for deeply situated groundwater resources.

Karst Aquifer of northern Jordan

A preliminary investigation of satellite images from the karst aquifer from northern Jordan reveals a high potential of aquifer vulnerability due to urbanization and intensive agriculture. With the aid of satellite imagery soil covered aquifer rocks can be distinguished from unprotected aquifer rocks.

Karst Aquifer of northern Oman and northern United Arab Emirates

The Musandam Peninsula of the northern Oman and northern United Arab Emirates is composed of allochtonous Late Paleozoic until Mesozoic carbonatic units in the north-east and of autochthonous Mesozoic melange in the south. Preliminary satellite image interpretation of the mountainous area shows a tectonic pattern which is not mentioned on existing geologic maps.

Areas of visible vegetation are restricted to irrigation areas inside the outlines of gravel plains which are bordering to the western mountain range.

Umm As Samim sabkha from Oman

Satellite images of the desert area of south-eastern Saudi Arabia and western Oman show the depression of the Umm As Samim Sabkha which is covered by evaporites, desert dunes and moistured salinated soil. The large extension of dune-sand covering evaporites and easterly bordering alluvial fans are evident for a prevailing humid phase, probably during ?Pleistocene/early Holocene time. From that time on no intensive humid phase took place in this area. ?Late Pleistocene sand fans and now existing Holocene sand dunes are covering Pleistocene alluvial channels. Groundwater outcroppings are not present.

The lack of vegetation on top of the alluvial fans and the large extension of the evaporites in the whole area of the sabkha may indicate that now no near surface fresh water is present. Probably, deeply situated groundwater levels which are caused by recharge and groundwater migration from remote areas (e.g. from the eastern Oman mountains and/or from the south-western Hadramaut wadis) can be expected at certain depths. Here the limits of satellite remote sensing can be drawn where no ground data is available.

Satellite Systems and their Application

Data characteristics of selected satellite systems, their practical applications, and their sources of acquisition are collected in a comprehensive file.

With the aid of the present data collection the hydrogeologic/hydrologic expert groups of the ESCWA member countries are enabled to select the specified data types for own groundwater studies, to get into contact with global environmental working groups, and to acquire special satellite image data.

Technical information about future planned sensor types and space-borne missions with special respect to their specified applications for groundwater studies are mentioned.

Recommended satellite systems for hydrologic research programs are the NOAA-AVHRR and the LANDSAT programs. The NOAA-AVHRR weather observing project guarantees continuous data supply over the next years. The LANDSAT program is planned to be continued with LANDSAT 7 satellite.

An archive of satellite images from hydrologic sensitive areas of the ESCWA region is recommended to be installed at the UN-ESCWA headquarter. Low cost image processing hard- and software is mentioned as a recommended tool for hydrologic expert groups who are interested in remote sensing techniques.

1. Introduction

The present study was carried out by a remote sensing expert in cooperation with the United Nations Economic and Social Commission for Western Asia (ESCWA) in Amman, in the framework of the Technical Cooperation project "Advisory Services to the ESCWA Member States (Figure 1) in the Field of Water Resources"

The satellite images which have been used in the frame of the study are archived in the ESCWA office, Amman.

The study is aimed at providing information and guidance to national institutions of ESCWA member states on the application of satellite remote sensing methods with respect to hydrogeological problems.

The following terms of reference have been defined

- introduction to the possibilities of satellite image interpretation for hydrogeologic studies in the ESCWA region for scientists and technicians of national institutions engaged in water resources studies and management,
- information about relevant features visible on satellite images,
- information about spectral and spatial resolution of different satellite systems
- availability and sources of acquisition of images for the region,
- processing requirements,
- costs of image acquisition and processing,
- defining mapping features relevant for hydrogeology, e.g. geological outcrops of aquifers and aquitards, geological structure and soil cover, hydrographic drainage pattern, sabkhas and lakes, land covering natural vegetation, irrigation areas, towns and villages and industrial areas,
- presentation of a satellite imagery case study for hydrogeology,
- recommendation of satellite imagery studies for hydrogeology,

- information about envisaged developments in the next few years.

The spatial resolution is the size of the pixel (picture element).
The spectral resolution is the number and width of scanned single bands of the electromagnetic spectrum.

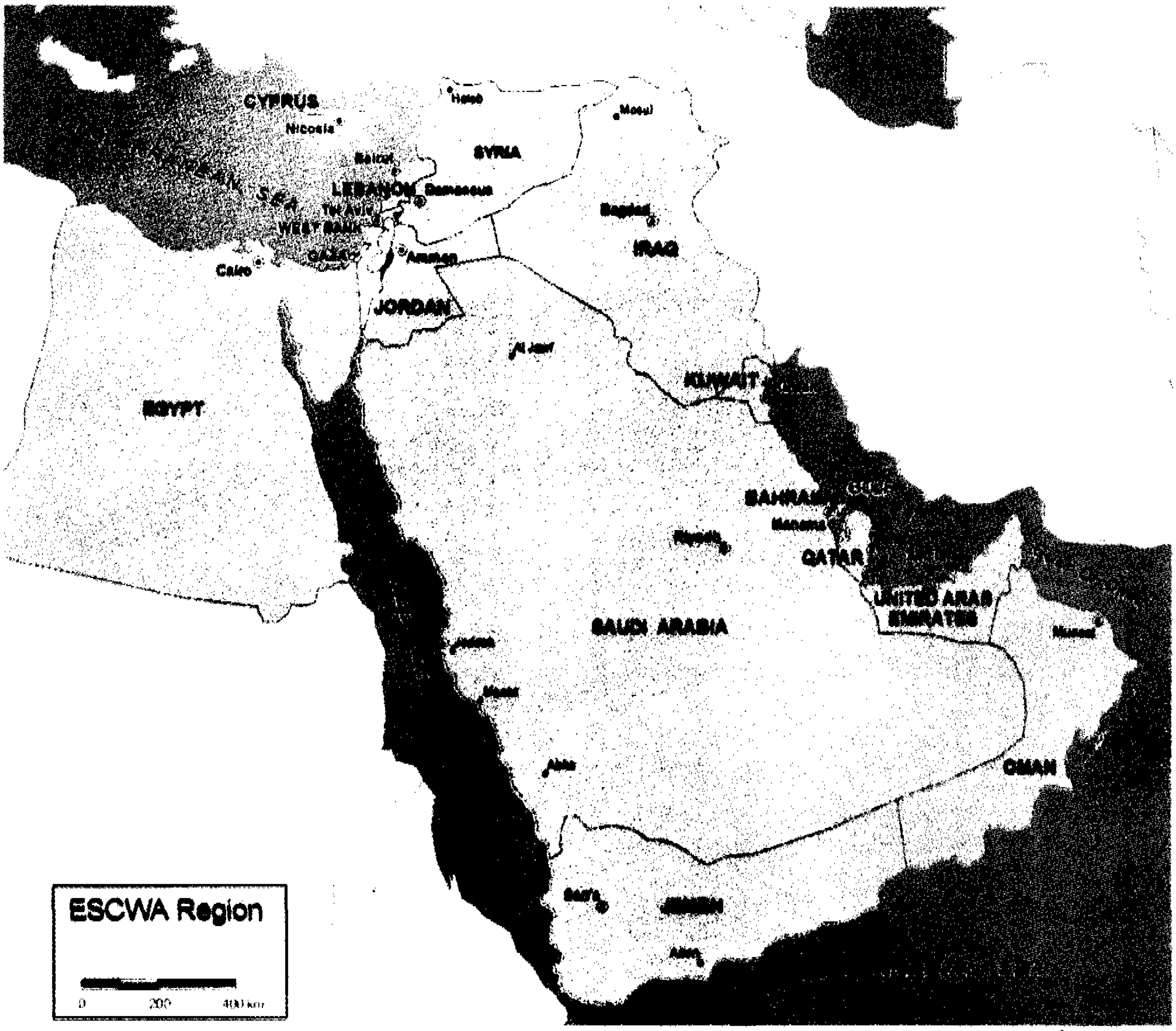


Figure 1 The ESCWA Member States

2. Satellite Remote Sensing

Only few satellite systems exist which are designed exclusively for land-use projects. Currently, the largest program is the Earth Observing System (EOS, annex 20) which comprises long termed earth observation with numerous polar orbiting satellite systems.

Satellite remote sensing involves gathering information about features on the earth´s surface from "active" and "passive" sensor systems. A "passive" system generally consists of an array of small sensors or detectors which record the amount of electro-magnetic radiation reflected and/or emitted from the earth´s surface. A multi spectral scanner like LANDSAT Thematic Mapper (TM) is an example of a passive system. An active system propagates its own electro-magnetic radiation and measures the intensity of the return signal. Synthetic Aperture Radar (SAR) is an example of an active system (Figure 2).

Satellite images give potential information for geologic, hydrologic and land-use studies, e.g. geological structures, drainage patterns, salinity, vegetation or crop types, bare soil surfaces and vegetated areas, irrigation areas, industrial areas, rural and urban coverage. Satellite remote sensing techniques are particularly useful tools for assessing the spatial and temporal distribution of land degradation. The advantage of satellite remote sensing is that an overview of extended areas can be frequently obtained.

The single bands of the different earth observing passive satellite systems are chosen as spectral intervals from the continuous spectrum of wavelengths within the so called atmospheric windows. The characteristics of these bands and proper applications are collected in Table 1 and Table 2.

A satellite image is the final product of numerous steps beginning from space-borne data collection, then sending to a receiving station, and finally processing by an image processing system. The amount of data depends on the swath-widths (length and form of the scanned field) and the single system configuration (see below for more detailed information and in the annexes).

In most of the satellite imagery applications the size of a satellite image is restricted to one data-"scene" (of polar orbiting systems). The data-scene is a defined amount of data from an endless data file. The scenes are numbered by paths (numbers of "re-visiting interval" orbits which are numbered from east to west with increasing numbers) and by rows (the numbered scenes of the single orbits, which are numbered from north to south with increasing numbers).

Polar orbiting systems move in a circle nearly from pole to pole. In most cases the polar orbiters are moving in sun-synchronous circles. They are passing the same *latitude at the same time, e.g. LANDSAT satellite is crossing the equator at 9:00 am* (Figure 3).

As an example, an illustration from available LANDSAT TM-scenes of Jordan/Syria area is given in Figure 4. The "re-visiting interval" means the temporal coverage of the same area by the same path and row. The re-visiting periods depend on the different satellite systems. The main factors are influenced by the altitude of the orbit, by the swath width and by the number of cooperating orbital systems (in cases of more than one satellite of the same kind). There are weather satellite systems which have a daily re-visiting (repetition rate). There are satellites with moderate resolution sensors and narrow swath width with a repetition rate of 16 days (LANDSAT TM) or 44 days (JERS). More days can be expected from high resolution military or photographic systems with less than 1 m resolution.

The swath width is defined as the width of the scanned field of a linear scanner.

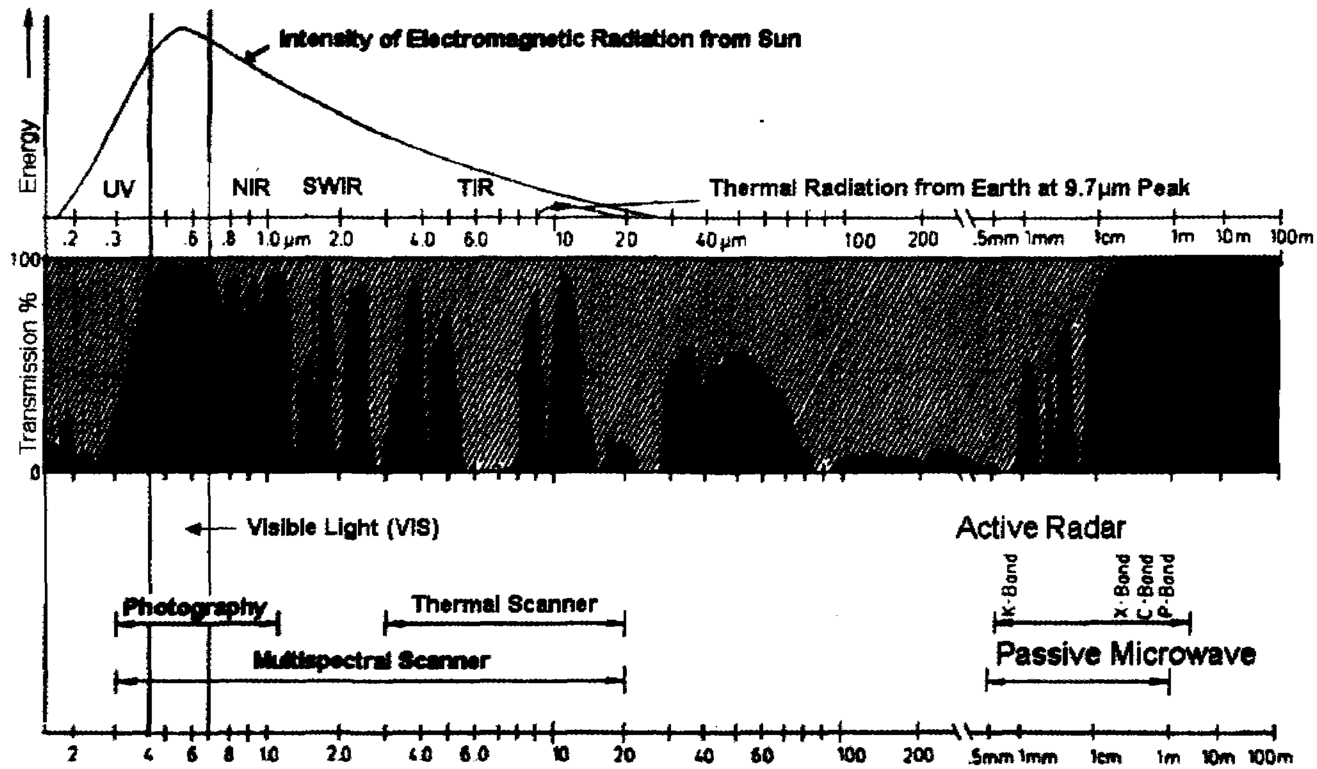
In the last decades more than one hundred earth observating satellite systems have been developed. A comprehensive survey of space borne missions and sensors is given by H.J. Kramer (1996).

At present time approximately 40 earth observating satellite systems are operating. In the near future this number will increase, because the end of the cold war gave the way free also for commercial remote sensing satellite systems on orbital platforms. Previously, satellite remote sensing technology has been developed mainly for military purpose. Simultaneously geoscientists got the chance to obtain those satellite data for geoscientific research. The evolution and application of satellite remote sensing improved rapidly in the last years. Worldwide national and international programs for weather forecast, protection of environment, assessment of natural resources, urban and rural planning, are intensely linked with satellite remote sensing technology.

Until the year 2005 more than one hundred earth observating satellites of all types are scheduled for launch, which is reported from U.S. Geological Survey-EROS Data Center (Figure 5 and annex 15).

Advantages of remotely sensed data are:
- continuous acquisition of data,
- regular revisit capabilities,
- broad regional coverage,
- different spectral resolution,
- different spatial resolution,
- ability to manipulate digital data,
- ability to combine satellite digital data with other digital data,
- cost effective data,

- map-accurate data,
- possibility of stereo viewing (special systems),
- large archive of historical data (special systems).



The Electromagnetic Spectrum, Atmospheric Windows and Wavelengths of Applied Remote Sensing

Figure 2

Table 1

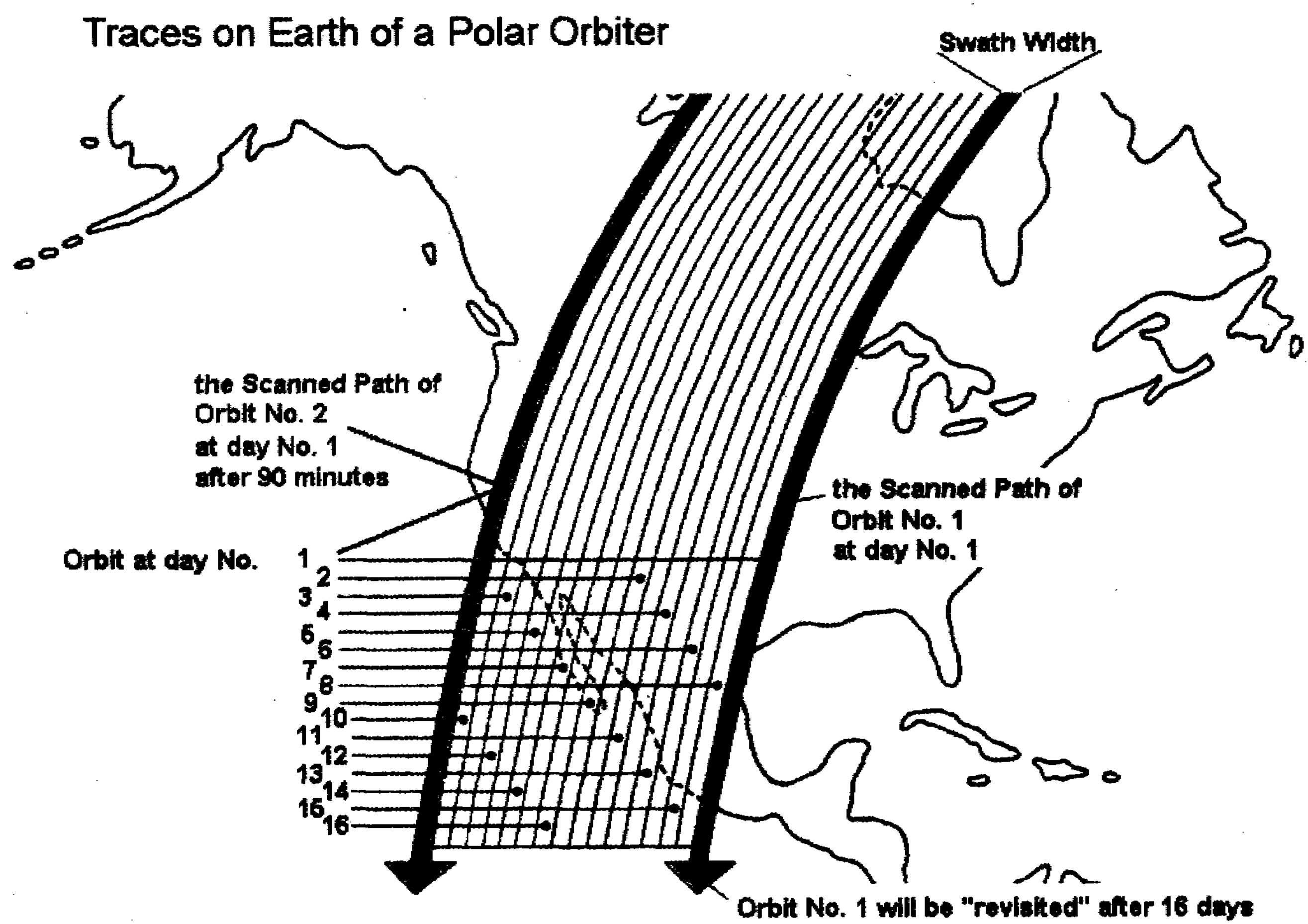
Table of Common Earth Observing Satellite Systems and their Physical Properties

Satellite System	Spectral Range	Swath width	Pixel size	Recoverage cycle
LANDSAT TM (7)	band 1 0.45-0.52 μm	185 km	30x30 m	16 days
	band 2 0.52-0.60 μm	185 km	30x30 m	16 days
	band 3 0.63-0.69 μm	185 km	30x30 m	16 days
	band 4 0.76-0.90 μm	185 km	30x30 m	16 days
	band 5 1.55-1.75 μm	185 km	30x30 m	16 days
	band 7 2.08-2.35 μm	185 km	30x30 m	16 days
	band 6 10.4-12.5 μm	185 km	60x60 m	16 days
	PAN 0.50-0.90 μm	185 km	10x10 m	16 days
SPOT IMAGE	band 1 0.50-0.59 μm	60 km	20x20 m	26 days
	band 2 0.61-0.68 μm	60 km	20x20 m	26 days
	band 3 0.79-0.89 μm	60 km	20x20 m	26 days
	PAN 0.51-0.73 μm	60 km	10x10 m	26 days
IRS-1A/1B/2P/1C	band 1 0.45-0.52 μm	74 km	32x37 m	24 days
	band 2 0.52-0.59 μm	74 km	32x37 m	24 days
	band 3 0.62-0.68 μm	74 km	32x37 m	24 days
	band 4 0.77-0.86 μm	74 km	32x37 m	24 days
1C	band 5 15.5-17.0 μm	148 km	70x70 m	24 days
	PAN 0.50-0.75 μm	70 km	5.8x5.8 m	24 days
JERS-1	band 1 0.52-0.60 μm	75 km	18x24 m	44 days
	band 2 0.63-0.69 μm	75 km	18x24 m	44 days
	band 3 0.76-0.86 μm	75 km	18x24 m	44 days
Stereo	band 4 0.77-0.86 μm	75 km	18x24 m	44 days
	band 5 1.60-1.71 μm	75 km	18x24 m	44 days
	band 6 2.01-2.12 μm	75 km	18x24 m	44 days
	band 7 2.13-2.25 μm	75 km	18x24 m	44 days
	band 8 2.27-2.40 μm	75 km	18x24 m	44 days
NOAA-AVHRR	band 1 0.58-0.68 μm	2600 km	1 x 1 km	1 day
	band 2 0.72-1.10 μm	2600 km	1 x 1 km	1 day
	band 3 3.55-3.93 μm	2600 km	1 x 1 km	1 day
	band 4 10.5-11.5 μm	2600 km	1 x 1 km	1 day
	band 5 11.5-12.5 μm	2600 km	1 x 1 km	1 day
MOMS 2	band 1 0.440-0.500 μm	78x43 km	13.5x13.5 m	-
	band 2 0.530-0.575 μm	78x43 km	13.5x13.5 m	-
	band 3 0.645-0.680 μm	78x43 km	13.5x13.5 m	-
	band 4 0.770-0.810 μm	78x43 km	13.5x13.5 m	-
	PAN 0.512-0.765 μm	37x27 km	4.5 x 4.5 m	-
METEOSAT VISSR	0.4 - 1.1 μm (VIS)		2.5x2.5 km	25 minutes
	5.7 - 7.1 μm (WV)		5.0x5.0 km	25 minutes
	10.5 - 12.5 μm (TIR)		5.0x5.0 km	25 minutes

Table 2

Band Characteristics of Common Earth Observating Satellite Systems and Spectral Behavior of Relevant Land-Surface Appearances

Absorption	Reflection	Satellite Systems
Fe^{2+},Fe^{3+} moistured soils	**sealed bright surfaces**	**LANDSAT TM band 1** **IRS-1A/1B/2P/1C band 1** **MOMS-02 band 1**
green vegetation <	dry vegetation	**LANDSAT TM band 2** **SPOT IMAGE band 1** **JERS-1 band 1** **MOMS-02 band 2**
Chlorophyll <dry soil< (green vegetation)	**dry vegetation**	**LANDSAT TM band 3** **NOAA AVHRR band 1** **SPOT IMAGE band 2** **IRS-1A/1B/2P/1C band 3** **JERS-1 band 2** **MOMS-02 band 3**
Fe^{2+},Fe^{3+} (dry vegetation)	**Chlorophyll** (green vegetation)	**LANDSAT TM band 4** **SPOT IMAGE band 3** **IRS-1A/1B/2P/1C band 4** **JERS-1 bands 3 and 4** **NOAA AVHRR band 2** **MOMS-02 band 4**
	Fe^{2+},Fe^{3+} **Mica**	**LANDSAT TM band 5** **JERS-1 band 5**
OH^-, CO_3^{2-},H_2O **Mica** **Kaolinite, Montmorillonite,** **Chlorite, Serpentine,** **Carbonates,** **gypsum, halite**	**Fe^{2+},Fe^{3+}**	**LANDSAT TM band 7** **JERS-1 bands 6,7,8**
Kaolinite, Montmorillonite		**JERS-1 band 7**
Chlorite, Serpentine, **Carbonates**		**JERS-1 band 8**



Scetch Map of LANDSAT 5 Satellite "revisiting rate"

Figure 3

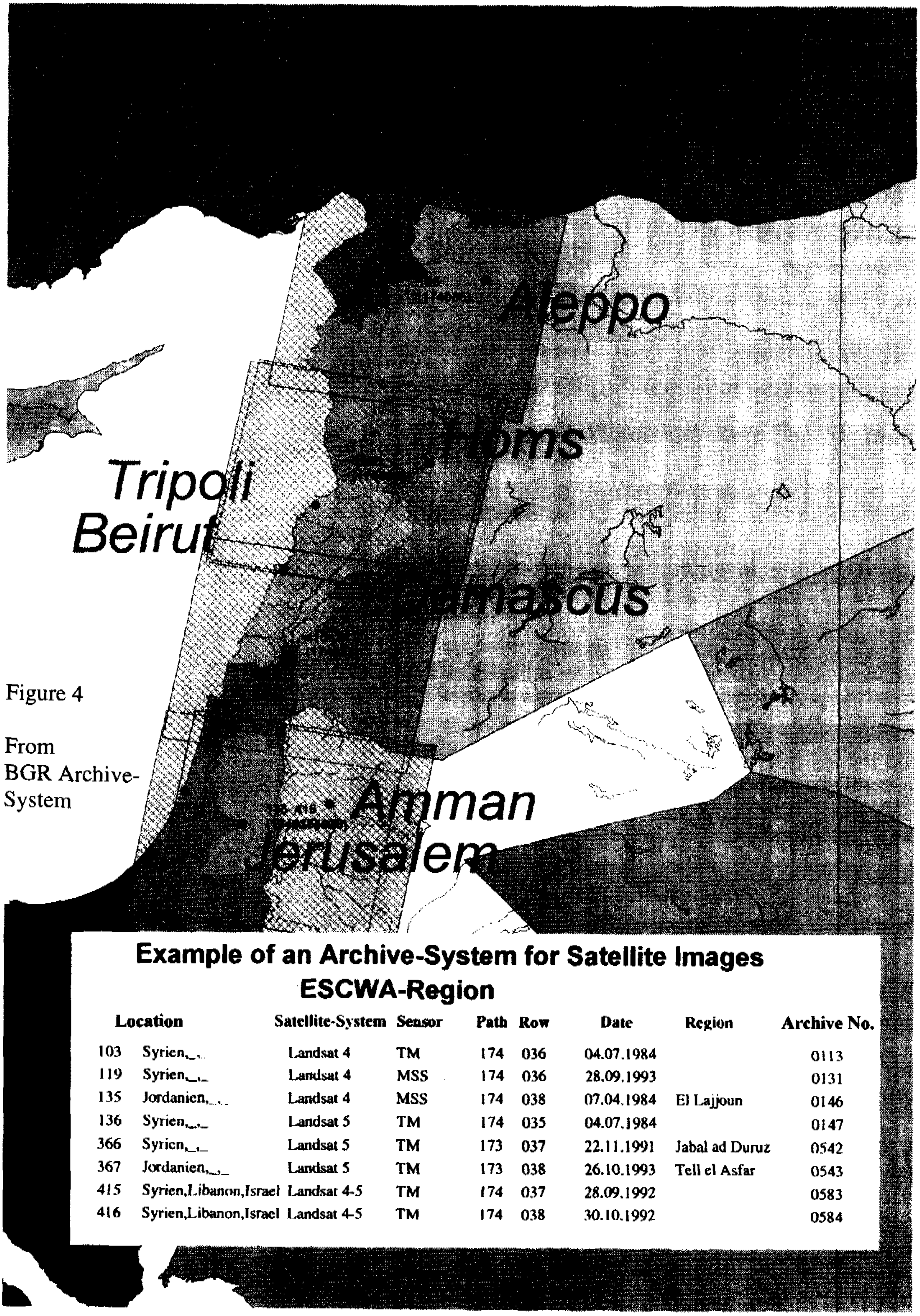


Figure 4

From BGR Archive-System

Example of an Archive-System for Satellite Images
ESCWA-Region

Location		Satellite-System	Sensor	Path	Row	Date	Region	Archive No.
103	Syrien,_,_	Landsat 4	TM	174	036	04.07.1984		0113
119	Syrien,_,_	Landsat 4	MSS	174	036	28.09.1993		0131
135	Jordanien,_,_	Landsat 4	MSS	174	038	07.04.1984	El Lajjoun	0146
136	Syrien,_,_	Landsat 5	TM	174	035	04.07.1984		0147
366	Syrien,_,_	Landsat 5	TM	173	037	22.11.1991	Jabal ad Duruz	0542
367	Jordanien,_,_	Landsat 5	TM	173	038	26.10.1993	Tell el Asfar	0543
415	Syrien,Libanon,Israel	Landsat 4-5	TM	174	037	28.09.1992		0583
416	Syrien,Libanon,Israel	Landsat 4-5	TM	174	038	30.10.1992		0584

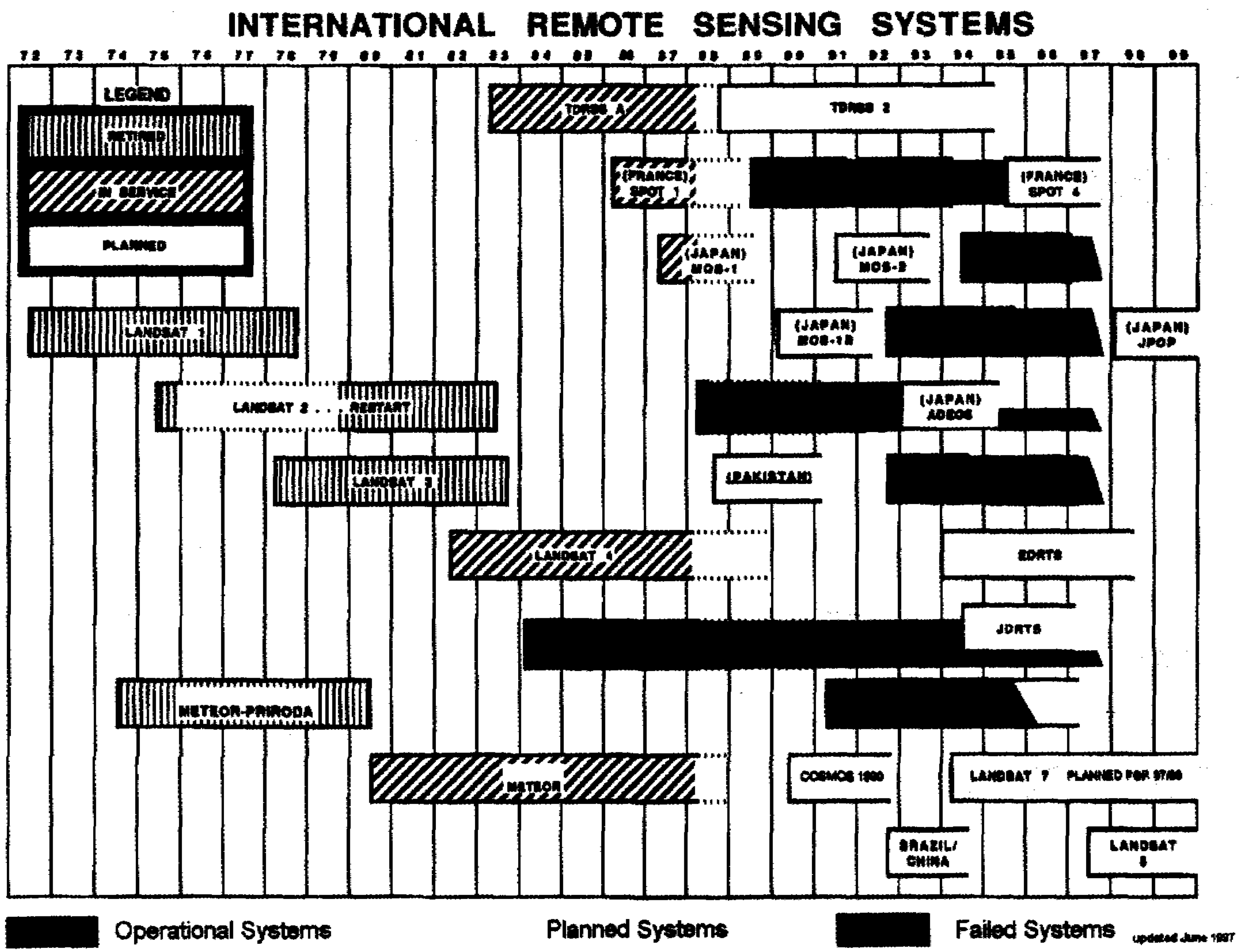


Figure 5 Selected Operational and Planned International Remote Sensing Systems

3. Application of Satellite Imagery in ESCWA States

The application of satellite imagery depends on the orbital or geostationary coverage of the region of interest. Most earth observating satellite systems which cover the ESCWA region in total are global operating systems. Currently these systems range in the spatial resolution from 10 - 30m until several km pixel size. They have been developed for global scientific research and environmental monitoring.

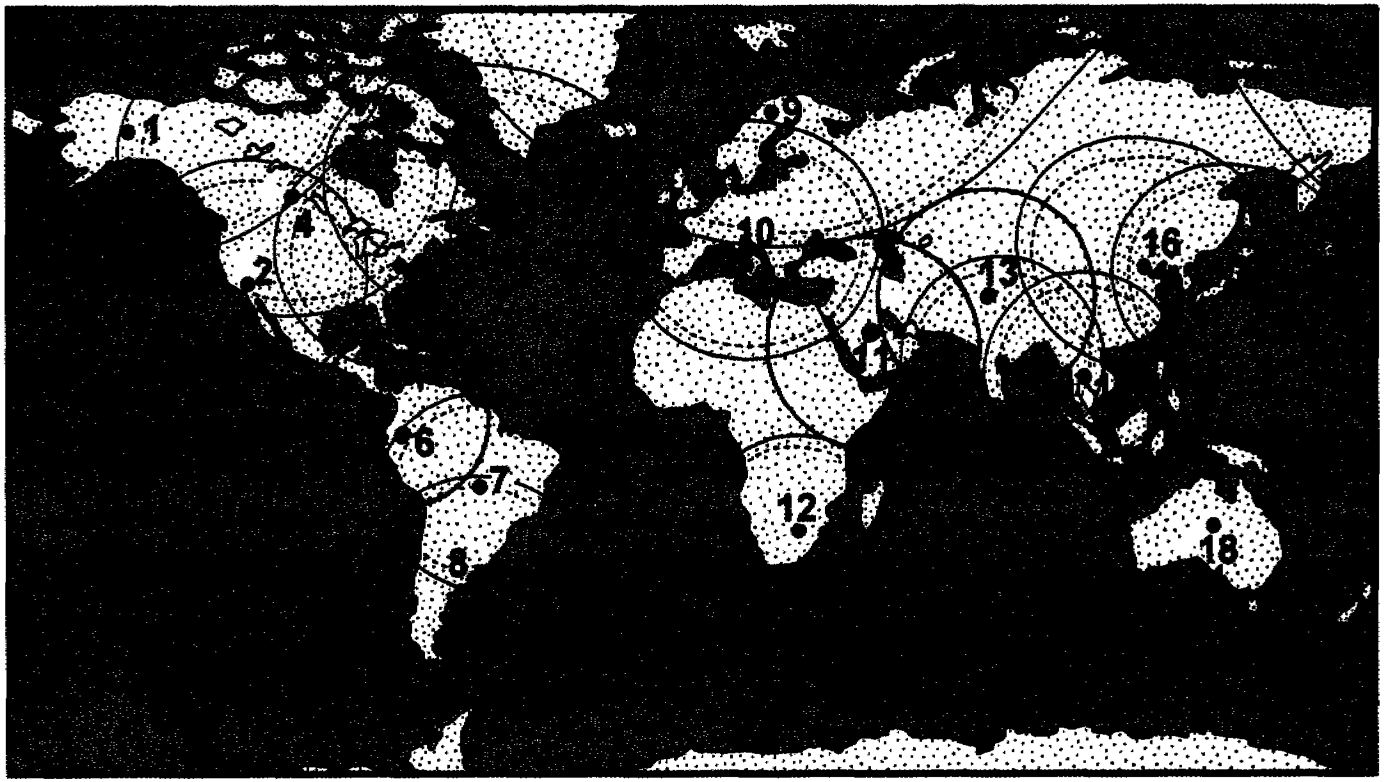
A pixel (picture element) represents the size of the instantaneous field of view (IFOV) which defines the spatial resolution (annex 17).

Applied satellite remote sensing in geology and hydrogeology is one important aspect of satellite imagery. This technique comprises the extraction of information from satellite images and the correlation with field data or previous published data. The reader may be reminded that a satellite image never is equal to a geologic map. Satellite imagery requires always ground data ("ground truth"). The distinguishing marks of reflective data are differing from one scene to the other. They depend on the statistic distribution of all pixels, and on the intensity of all pixels in one processed data file.

The geologic interpretation of satellite images is a highly adequate method to support geologic/hydrologic projects and programs in ESCWA countries, because scarce vegetation and scarce soil cover in most arid or semi-arid regions provides favorable conditions for the discrimination of surface conditions and the detection of geologic structures from space. With the support of remote sensing environmental changes can be monitored on a regional scale, such as progressive desertification and development of intensive agriculture which have complex hydrologic implications. Monitoring systems on a regional scale can be based on satellite systems with a high repetition rate (frequent "re-visiting" or "repeat coverage cycle") and low spatial resolution, e.g. NOAA-weather satellites (U.S.A.). Detailed studies require a high spatial resolution like LANDSAT TM (U.S.A.), SPOT Image (France), IRS (India) or JERS (Japan) (chapter 5 and 6). Detailed technical descriptions of satellite systems are given in the annexes. Special applications are mentioned in annexes 10-1, 15-1, 17 and 19.

In Figures 6 and 7 the global distribution of LANDSAT and IRS ground-stations is demonstrated.

At the Royal Jordanian Geographical Center (R.J.G.C) in Amman, already a Training Course on "Using Remote Sensing Data and GIS Techniques in Hydrology and Hydrogeology" has been held on 2-12 December of 1995. This course was commissioned by the UN-ESCWA. After that a final Report and a comprehensive data collection about the water resources assessment in the ESCWA region (using remote sensing and GIS techniques) has been prepared (ESCWA,UNEP,IDB), .

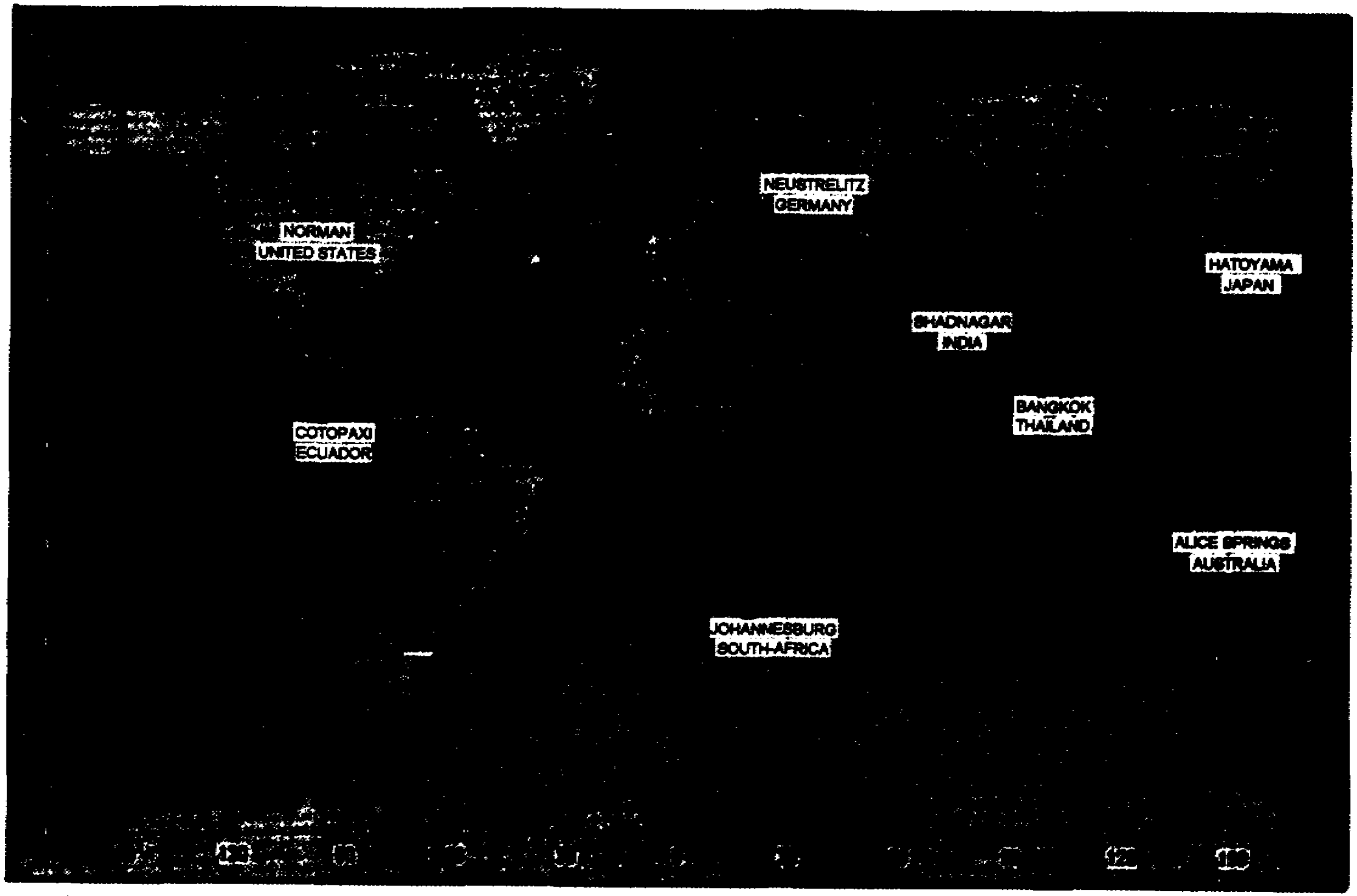


1: Fairbanks, Alaska
2: Goldstone, California
3: Goddard, Maryland
4: Prince Albert, Canada
5: St. Johns, Canada
6: Cotopaxi, Ecuador
7: Cuiaba, Brazil
8: La Plata, Argentina
9: Kiruna, Sverige
10: Fucino, Italy
11: Riyad, Saudi Arabia
12: Johannisburg, South Africa
13: Islamabad, Pakistan
14: Hydarabad, India
15: Bangkok, Thailand
16: Peiping, China
17: Tokio, Japan
18: Alice Springs, Australia

LANDSAT Satellite Receiving Stations - direct read-out areas -

Figure 6

IRS-1C Network of International Ground Stations



Indian Remote Sensing Satellite (IRS) Coverage: Contact Space Imaging EOSAT for actual assessment and availability of data.

Figure 7

3.1 Geology

Favorable conditions for geologic research by satellite imagery are given in ESCWA countries. Recently numerous research activities have been carried out in the region by international and national institutions, e.g. in the Republic of Yemen by Kruck and Schäffer (1991), and Robertson Research Group (1990).

3.1.1 Geologic Lineaments

Geologic lineaments can give important information to the hydrogeologist. In distinct geologic environments, e.g. igneous or metamorphic complexes or in fractured carbonates, groundwater recharge and relatively high aquifer permeabilities are often related to fractures and fault systems.

Laterally extending structural patterns such as deep faults can be delineated by satellite imagery, because satellite imagery provides the experts with an overview of extended areas. Additionally, with special image enhancing methods (image processing, chapter 5.2) structural patterns can be enhanced in the images. With the aid of aerial photograph interpretation wide extending camouflaged faults cannot be delineated or in outline only (chapter 4.2.2).

3.1.2 Soil Cover

Different reflectance properties of soil and rock enables the expert to differentiate between soil covered rocks and outcropping rocks. Even if the soil derives directly from the underlying rock , the reflectance differs due to chemical and/or physical weathering processes.

The monitoring (continuous acquisition of data) of soil cover and existing vegetation gives the user important information about the degree of desertification and land degradation.

3.1.3 Aquifers and Aquitards

Geologic interpretation of satellite images can be used for delineating outcropping aquifers and aquitards. An existing geologic map sometimes gives not sufficient information about outcropping rocks or soil covered aquifer rocks. On the other hand with new and frequent satellite data the rural and urban development can be monitored which gives important information required for groundwater protection in areas with aquifer outcrops (chapters 3.3.3 and 3.3.4).

3.2 Hydrography

3.2.1 Drainage Pattern

Interpretation of LANDSAT TM images can provide precise information about the surface drainage pattern. An example is given from TM scenes of the basalt aquifer of northern Jordan and southern Syria. Due to different TM-band combinations and processing methods the drainage pattern can be enhanced (chapter 4.1.3). The drainage pattern appears always as a strong element in the image.

3.2.2 Sabkhas and Lakes

Open lakes with clear water appear in the reflective spectral range outside the visible spectrum (VIS) in black. If the water is shallow or contains impurities, the resulting color differs considerably (chapters 4.1.1 and 4.2.3). A reflecting bottom of a lake in combination with high water transparency can affect the signal in the VIS down to water depth of 40m.

3.2.3 Salinity

Dissolved salt components in open water have no influence on the absorption and reflecting signal, but salt precipitations cause strong reflection in the VIS (bright surface in the visible part of the spectral range) and strong absorption in the short wave infrared (SWIR).

Salt covered or salt containing soils or rocks can be delineated by satellite imagery as it is demonstrated by the study in the region around the Azraq springs in Jordan (chapter 4.1). A detailed remote sensing study of salt affected soils in Saudi Arabia has been carried out by Saleh, A.A. and Saud A.T. (1997).

Possibilities of an evaluation of the distribution of salt affected surface of the Umm as Samim Sabkha in the region of Saudi Arabia and Oman are discussed in Chapter 4.2.3.

The results of the investigation of salt covered terrains by satellite imagery can, in some cases, be translated into information about evapotranspiration and the degree of groundwater discharge in critical areas.

3.2.4 Evapotranspiration

As mentioned before, areas with a high degree of evaporation of water on the surface can be delineated by the visible amount of salt in surface soils or rocks.

Currently there is an evolutionary trend for "microwave" and "radar" satellite systems with applications for soil moisture estimations (X-SAR, annex 1 and JERS-SAR, annex 5). In the next future these systems will serve with reliable data and more detailed information can be collected. Nevertheless, at the moment not enough experience is available on these methods.

3.3 Land Cover

3.3.1 Vegetation

Tucker (1979) is one of the founder of vegetation monitoring with satellite remotely sensed data. He developed an algorithm between the reflective visible red and the photographic infrared which is called the "vegetation index". In the meantime numerous vegetation monitoring programs have been carried out on global and regional scales which are theoretically based on the characteristic absorption in the visible red and the reflection in the photographic infrared of the plant chlorophyll.

The "vegetation index" or the simple reflection of chlorophyll in the near infrared give a significant information about the situation of the vegetation. Depending on the seasonally restricted rainfall in ESCWA countries the visible vegetation gives information about irrigation activities and therefore groundwater discharge can be estimated from space (chapter 3.3.2).

Irrigated areas in dry zones or during the dry season can be mapped from satellite images. From the extent of irrigation areas, estimates of volumes of consumptive water use can be made. Crop differentiation, monitoring and computerized classification (chapter 6) serves the hydrogeologist with additional information about the consume of water.

Some parts of the ESCWA region have a strong topographic relief, e.g. the escarpments in western Yemen and south-western Saudi Arabia. The applicability of satellite systems which collect data in the 10m - 30m pixel size for vegetation differentiation is reduced in these mountainous areas. Due to the narrow designed agricultural terraces the collected data give non reliable "mixed pixel" information.

3.3.2 Irrigation Areas

In most countries of the ESCWA region irrigated areas have an important rating for agricultural intensions. Due to the arid climatic conditions which play a major role in the ESCWA region rainfed agriculture is restricted to limited areas where seasonal rainfall can be expected.

Irrigated areas can be delineated by satellite imagery due to the strong reflection properties of the chlorophyll in the near infrared (chapter 3.3.1). This particular feature can be applied especially from satellite data sets which have been collected during the dry season or for areas with scarce natural vegetation. The rough amount of groundwater discharge (pumping) can be estimated by the rate of coverage of existing vegetation with the aid of image interpretation (manual digitizing and labeling of polygons) or by a GIS classification (chapter 6).

Long-term effect of salinization from intense irrigation and unsustainable groundwater discharge from depleting aquifers can be monitored by satellite imagery (chapter 3.2.3).

3.3.3 Towns and Villages

Populated areas appear in an image which has a sufficient resolution (e.g. LANDSAT TM) with a typical irregular or troubled pattern. This pattern results from different composed small buildings which are in size similar to the spatial range of the pixel size. This effect is common for the most currently available satellite data in the spatial range from 10 to 30m pixel size. Additionally, detectable roads are crosscutting the settlements. The composites between detectable roads and the irregular pattern can be clearly delineated from the surrounding natural environment.

With the aid of LANDSAT TM-band 1 and MOMS band 1 which lie in the spectral range of 0.45-0.52 µm, sealed surfaces like roads and buildings can be distinguished from water bearing surrounding bodies. The reason for that is the transparency of clear water bodies, the absorption of moistured soils and areas with vegetation and the reflection of sealed surfaces.

An example of the applicability is given from a preliminary evaluation of an area for a land-use study in Jordan (chapter 4.2.1).

3.3.4 Industrial Areas

Large metal roofs of industry complexes can be delineated even in the 30m pixel range of LANDSAT TM. Examples are given in the area of greater Amman and greater Damascus.

The 10m resolution of the SPOT Image gives better results than LANDSAT TM, but the costs of data acquisition is relatively high.

The applicability of scientific multi spectral satellite imagery, e.g. LANDSAT TM or SPOT, for delineation of smaller industrial areas is limited. For many areas the spatial resolutions of the currently available multi spectral and panchromatic systems may be too low or costs too high.

Photographic systems have adequately high resolution from older space borne global operating missions like LANYARD from 1963 (chapter 5) for mapping of industrial areas, but give no information about the present situation of the coverage of industrial buildings and activities.

Other systems like the Russian RESOURCE-F and KOSMOS-XX satellites give actual photographic images at high resolution, e.g. with the KFA-1000 photographs. They can be purchased from SOVINFORMSPUTNIK company or from the German GAF (annex 11). For some years now, these high resolution space photographs have been increasingly used in the field of environmental monitoring and regional planning. The total coverage with new images of the ESCWA-region is currently not given.

In the near future it is planned to launch new satellite systems with high resolution and global coverage (chapter 6). The ESCWA region will be covered by a satellite of 1m resolution which is planned for ORBIMAGE (Orbital Sciences, Saudi Arabia). At present time there is no information about the future acquisition of data from that system.

3.3.5 Waste Deposits

Predominantly, the average surface-size of rural and urban waste deposits in the ESCWA region is covering the space of one or few pixels of currently available satellite data. Satellite remote sensing appears, therefore, generally not useful for identification of waste disposal sites.

4. Satellite Imagery Studies for Hydrogeology

Recently, numerous environmental studies which focussed on hydrologic questions combined with the application of remote sensing methods in the ESCWA region and neighboring regions have been presented and published, e.g. in the:

> Expert Group Meeting on the Implications of Agenda 21 for Integrated Water Management in the ESCWA-region (Amman, Jordan, 2-5 October 1995),
>
> Training Course on Using Remote Sensing Data and GIS Techniques on Hydrology and Hydrogeology at the Royal Jordanian Geographic Center

(Amman, Jordan, 2-12 December 1995),

Ninth United Nations Regional Cartographic Conference for Africa (Addis Ababa, Ethiopia, 11-15 November 1996),

Third Gulf Water Conference (Muscat, Sultanate of Oman, 8-13 March 1997).

Results of a basalt aquifer case study in the area of northern Jordan and southern Syria are presented below. The presentation includes detailed remarks about LANDSAT TM band characteristics, to give the reader an overview about reflexion and absorption properties of soils and rocks and the resulting sensor response (chapter 4.1 - 4.1.4).

Possibilities of future remote sensing studies of extensive aquifer are discussed for the Paleogene aquifer of Saudi Arabia/Oman, the Upper Cretaceous aquifer of Jordan and Syria, and by a Paleozoic until Mesozoic Limestone area of the Musandam Penisula from the U.A.E. and Oman (chapter 4.2). Areas and the distribution of the main Paleogene aquifer of the Arabian Peninsula are delineated in Figure 8.

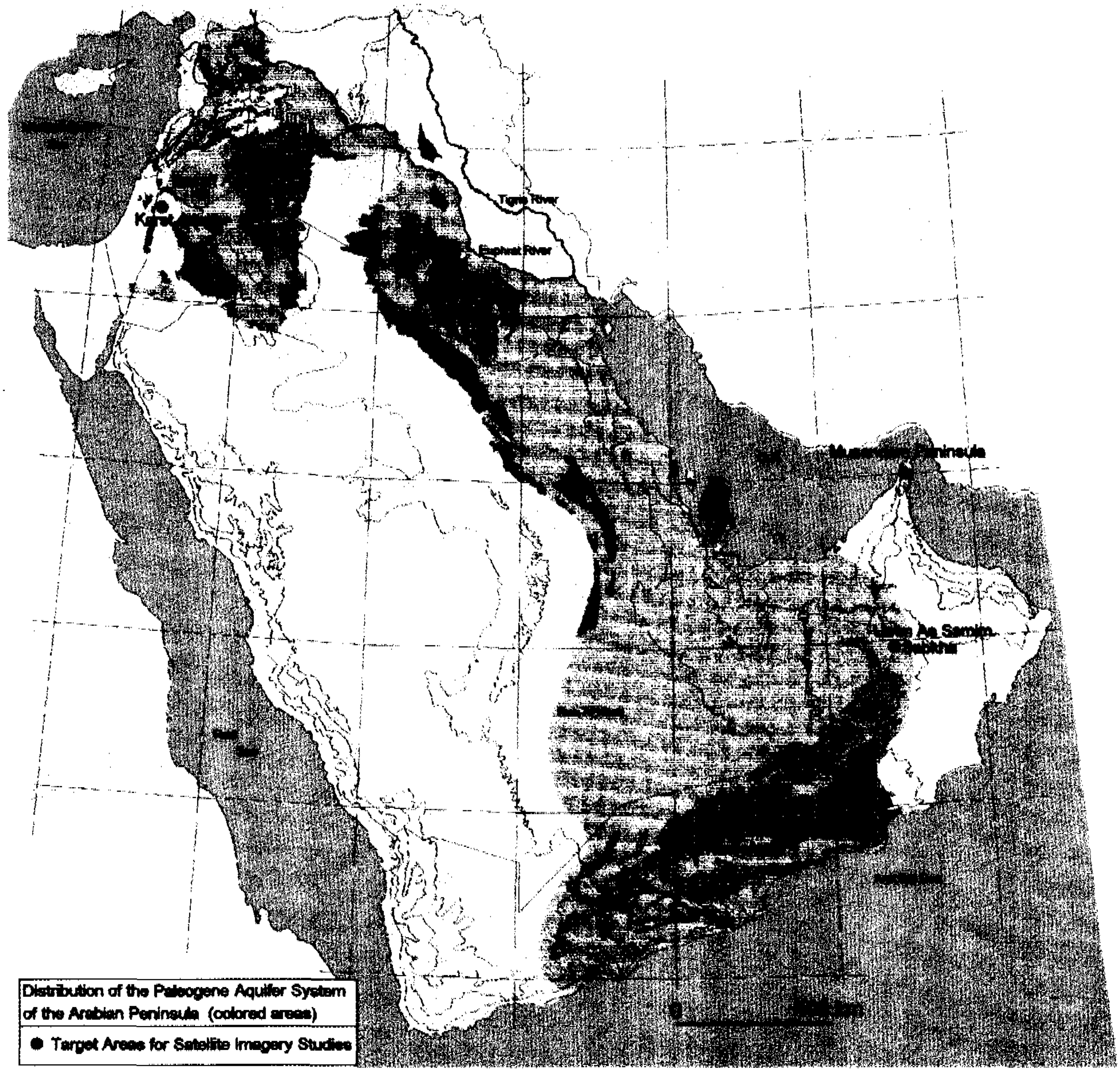


Figure 8 The Paleogene Aquifer System of the Arabian Peninsula

4.1 Basalt Aquifer Case Study in Jordan and Syria

4.1.1 Satellite Imagery

LANDSAT - THEMATIC MAPPER (TM) satellite imagery was carried out on the basis of different TM-band combinations in the basalt area of North-Jordan and South-Syria.

With the aid of satellite imagery a synoptic geologic model of the Neogene and Quaternary basalts has been developed. TM-data gave detailed new information about the distribution and differentiation of the basalt series (Figure 9).

For this study images of the Thematic Mapper (TM) multi spectral scanner on board the LANDSAT 5 satellite were chosen because of the favorable spectral and spatial resolution of the TM scanner. The LANDSAT 5 satellite was launched on 16 July 1982 into a circular sunsynchronous polar orbit. It passes all parallel latitudes always at the same time, e.g. the equator at about 09:00 am. One scanned full TM-scene has a size of 185 by 185 km (the size differs about few percentages depending on different processing methods from EOSAT or ESA-preprocessing) on the earth´s surface. The scene comprises about 240 megabyte of data. The scanner records 7 spectral bands, 3 in the visible, 3 in the infrared and 1 band in the thermal section of the spectral range. The spatial resolution is about 30 m, e.g. one picture element (pixel) covers 30m by 30 m on the earth's surface, except for the thermal channel (TM-band 6), which has a spatial resolution of 120m by 120 m. LANDSAT TM data reveal the best conditions for geological research, e.g. for lithologic discrimination including of alteration zones and the recognition of structures.

Standard processing revealed a high quality suitable for an appropriate visual interpretation. The processing included a topographical standard correction.

The TM-band 1 (0.45-0.52 µm) combined with a blue filter which is in the spectral range of the visible light (VIS, the visible blue part of the VIS) shows high reflectance of bright materials which have a high albedo, e.g. clay minerals and shows strong absorption of vegetation and minerals, rocks or soil which contain bivalent and/or trivalent iron (Fe^{2+} and/or Fe^{3+}).

The TM-band 4 (0.76-0.90 µm) combined with a green filter which is in the near infrared spectrum (NIR) shows high reflectance of chlorophyll, intermediate reflectance of clay and shows absorption of Fe^{2+} and Fe^{3+}.

BASALT AQUIFER SYSTEM IN JORDAN AND SYRIA

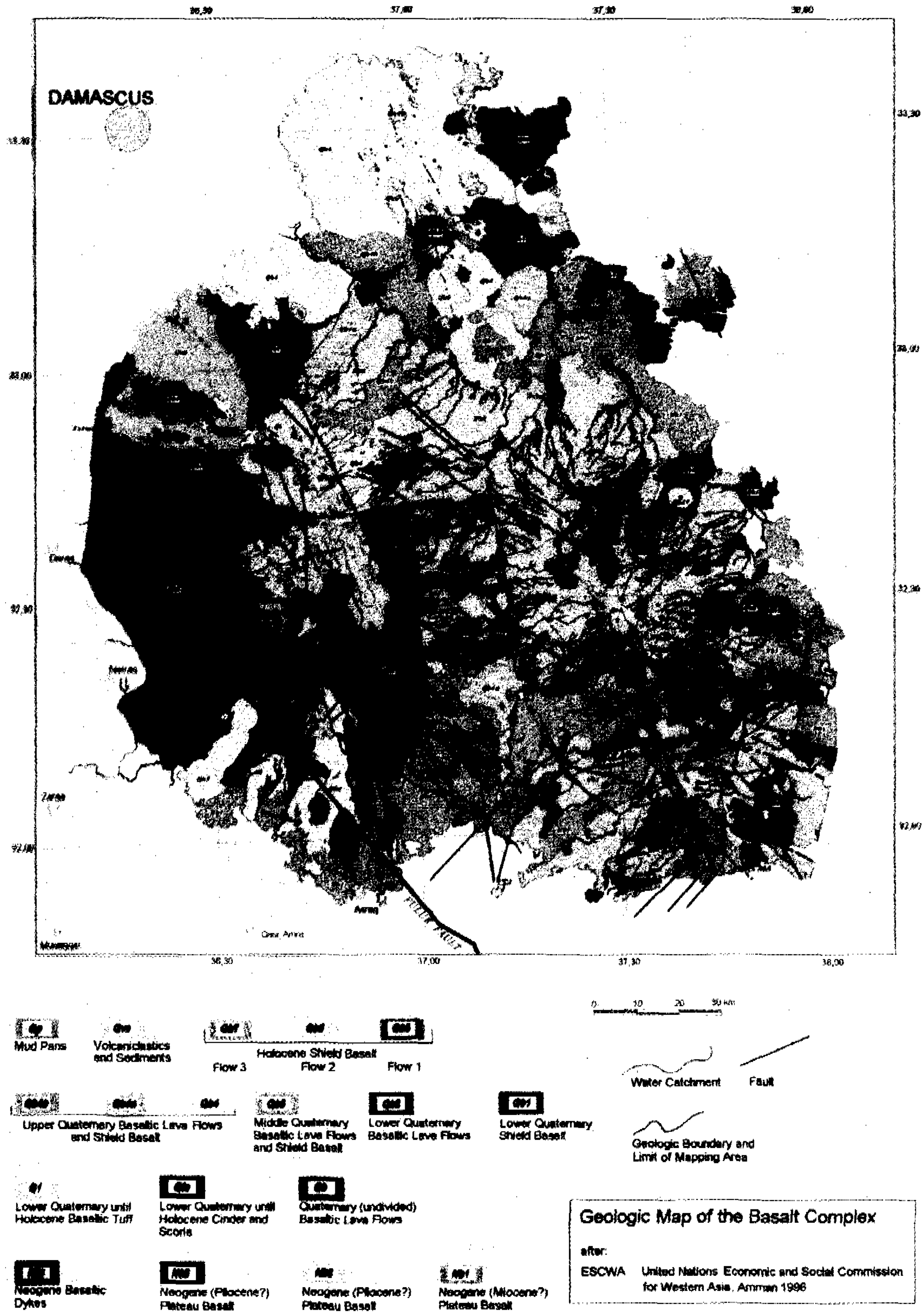


Figure 8 The Paleogene Aquifer System of the Arabian Peninsula

False-color composite of two LANDSAT TM scenes of northern Jordan and southern Syria. TM-band combination 1-4-7, color coded blue-green-red.

Dark brown and black colors: Different kinds of basalt
White and yellow colors: Limestone and desert sand
Green colors (few areas): Vegetation
Cyan colors: Evaporites
Red colors: Iron oxides, scoriae and cinder cones

Figure 10 Composite of two LANDSAT TM scenes of northern Jordan and southern Syria

The TM-band 5 (1.55-1.75 μm) and TM-band 7 (2.08-2.35 μm) which are in the range of the short-wave infrared (SWIR) show high reflectance of Fe^{2+} and Fe^{3+} containing material.

Additionally, the TM-band 7 shows absorption features of anions and molecules such as OH^-, CO_3^{2-} and H_2O resulting from lattice overtone and bending-stretching vibrations of the fundamental modes occurring at these longer wavelengths. Content of organic material or opaque accessories reduce the diagnostic absorption feature in the range of 2.3 μm.

Two Landsat TM satellite data sets (scenes) are covering the target area (Figure 10). The northern scene (path and row 173/037) was taken from the date of 22.11.1991 and the southern scene (path and row 173/038) was taken from the date of 26.10.1993. Data processing was carried out by the Gesellschaft für Angewandte Fernerkundung (GAF, München) and by the BGR (Hannover) in TM-band combinations (7-4-1), (7/1-4-1), (5/7-4-1) color coded red, green and blue. All hard copies (color photo prints) were carried out by the BGR (Hannover).

The hard copies are in the scales 1 : 100.000, 1 : 250.000, 1 : 500.000 and 1 : 1.000.000.

According to image processing the satellite images show a wide range of colors. The colors result from absorption and reflectance properties, image processing and from photographic laboratory work. The following colors are typical for the mineral groups mentioned before:

- Phyllosilicates (e.g. kaolinite, montmorillonite, mica incl. sericite, chlorite; also calcite). The color in the image using the red filter in band 7 is blue to green because low reflexion "reduces" the red in the resulting color.

- Iron hidroxides (goethite, limonite). The resulting color using the same red filter is red, because the high reflexion in band 7 intensifies the red in the resulting color.

4.1.2 The TM-band combination 7-4-1

According to absorption and reflectance properties the TM-band combination 7-4-1 color coded red-blue-green creates an image with characteristic features:

Red colors are displayed by iron-rich rocks or soil which have a low albedo (dark colored volcanic ash, weathered basalt surface etc.).

The albedo is the ratio of the amount of electromagnetic energy reflected by a surface to the amount of energy incident upon it.

Green colors predominantly represent vegetation.

Blue and cyan colors represent alteration zones, clay minerals, gypsiferous salt and carbonates which are free of impurities.

The colors representing basaltic material in the basalt area are reddish brown, brown, blueish brown, blackish brown, dark blue, black, dark grey and grey.

The present TM-band combination shows fresh basalt in dark black. Depending on the different climatic conditions the reflection properties of the basaltic rocks differ. Especially in the western area weathering processes with soil production increase the reflectance into shorter wavelength due to increasing content of mica and clay minerals (TM-band 1). It results in blueish-blackish and greyish basalt because the red-component (TM-band 7) is over toned. In the eastern area increasing oxidation and precepitation of iron oxides and lower production of clay minerals and soil increases reflectance in the SWIR-range (TM-band 7). At this stage the basalts reach more brownish colour.

To the outermost W and SW of the southern scene Cretaceous limestone is exposed near the City of Mafraq and S of Amman (The city of Amman is not displayed on the image). Predominantly, the limestone is free of organic impurities which is evident by its whitish color.

South of the basalt field Cenozoic sediments are exposed in brownish, white, yellow, red and cyan colors. The brownish color derives from chert sediments which contain some amounts of iron oxides. The white and yellow colors reflect quartz-rich eolian and fluviatile sand. The cyan (or blueish-greenish) color which occurs in the Wadi Sirhan depression is assumed to be caused by kaolinitic-carbonatic evaporitic sediments with a distinct sodium salt content. The reason for the cyan color are bending-stretching vibrations of OH^- anions in evaporites with resulting absorption of TM-band 7 (red). The trace of cyan colored sediments can be followed up through the Wadi Sirhan until the Azraq well field area. Directly in the area of Azraq two red colored fields occur. The red color indicates absorption of TM-band 1 and TM-band 4 and reflectance in TM-band 7, due to lack of vegetation and occurrence of bivalent and/or trivalent iron. Obviously, this area is covered by dead or dry vegetation and plenty of iron oxides.

In an area S of the two Azraq springs the intensity of the blue and the red colors are reduced. A homogenous green field is assumed to be a dry pond of anomalous chemical composition, probably because of absorption in the visible wavelengths, especially in TM-band 1, due to charge transfer of iron-bearing minerals or soils and because of absorption in the SWIR-range of TM-band 7, due to bending-stretching vibrations of OH^- anions.

Open water occurrences in the region show different reflection properties. In the western part of Jabal Al Arab numerous lakes result from dam projects. Although the LANDSAT TM-scene has been taken during the dry season (22 November

1991) the lakes reveal large quantities of stored water resources in the western area of Jabal Al Arab. The image shows black color which results from normal water absorption properties. In the eastern part of the basalt area of investigation several small "lakes" are restricted to mud-pans (sabkha). All of them show distinct bluish reflection colors which indicate flat water conditions. On the other hand cyan-bluish colors are known from salt flats with gypsum content.

4.1.3 The TM-band combination 7/1-4-1

The TM-band combination 7/1-4-1 color coded red-green-blue was used to enhance the signal of reflectance of bivalent and/or trivalent iron for TM-band 7 in favor of fading over the absorption of bivalent and/or trivalent iron for TM-band 1. This effect is caused by the mathematical quotient calculated by TM-band 7 divided by TM-band 1 digital data. This method is called "iron-factor".

Intensive red colors indicate iron-rich volcanic cones and scoriaceous material. Predominantly, the Quaternary volcanic cones show this peculiar feature. A dense cover of volcanic cones is evident in the area of Jabal Al Arab.

Red color overtone exists overall in the Neogene basalt fields, whereas the Quaternary/Recent basalt flows are free of red colors. The latters occur blueish black.

4.1.4 The TM-band combination 5/7-4-1

The calculated quotient of SWIR-bands, in which values of TM-band 5 are divided by TM-band 7, enhances rocks which contain mica, calcite and gipsum. According to the absorption properties of the minerals in the spectral range of TM-band 7 distinct areas are delineated by red colors.

Generally, high reflectance in TM-band 5 and strong absorption in TM-band 7 is known from mica and clay minerals, e.g. chlorite, kaolinite and montmorillonite. Due to high amount of fine grained phyllosilicates in the water catchment areas the drainage pattern appears with bright bluish colors.

The top of the Tell As-Safa volcano and also two basalt fields bordering the center of the volcano in the NW and SE show a higher response in red color in comparison to the rest of the volcano. The red colored areas represent the latest volcanic eruption in the entire basalt field.

4.1.5 Results of Image Interpretation

The basalt area is composed of Neogene "plateau basalt", Quaternary and Recent "basaltic lava flows" and "shield volcanoes".

The following main lithostratigraphic units were defined:

Neogene plateau basalt,
Neogene basaltic dykes,
Quaternary shield basalt,
Quaternary valley-filling lava flows,
Quaternary cinder and scoria cones,
Volcaniclastics and sediments in wadis and morphological depressions.

The central part of the basalt field is occupied by the Jabal Al Arab mountain massif with elevations between 1300 and 1800 m asl. The western basalt area until Jabal Al Arab is influenced by Mediterranean climate with precipitation of, on average, 300 - 500 mm during the cold winter season. East and southeast of Jabal Al Arab mean annual precipitation decreases to less than 100 mm per year. Accordingly, main renewable groundwater resources occur on the Jabal Al Arab mountain massif and on the foothills and plains west of the mountain.

The top of the Jabal Al Arab is covered by Neogene shield basalts and by thin layers of Quaternary lava flows or basaltic tuff. The western foothills and plains are covered prevailingly by Quaternary shield basalt and valley-filling basalt flows.

The following relationships between properties of different types of basalt flows, visible on satellite images, and occurrence of groundwater and groundwater recharge are indicated:

Plateau basalts and shield basalts: Poorly developed surface drainage system, relatively favorable conditions for direct recharge, accumulation of low permeability layers of extensive basalt flows.
Valley-filling lava flows: Well developed drainage system, surface runoff prevails, limited lateral extent of lava flows, generally no perched groundwater.

The Miocene-Pliocene "plateau basalts" reach thicknesses of several hundreds of meters with thin soil and sedimentary interlayers. Deep vertical fractures (cooling cracks as result of contraction) are prominent in these "plateau basalts" and may provide favorable conditions for groundwater movement. Unconsolidated Quaternary tuff and scoria volcanoes and tuff and scoria terrains may have relatively high infiltration capacities, but are limited in extent.

The differentiated drainage pattern of Quaternary "valley-filling lava flows" and Quaternary weathered tuff terrains indicate rapid surface water runoff into morphologic depressions: mud pans, sabkhas and major wadis. The mud pans or sabkhas are covered by fine grained sediments (clay material) which reduce infiltration and recharge into underlying rocks. Due to evaporation the salinity increases in the sediment pans. Water collected in the pans is, to a considerable extent, lost by evaporation.

Basaltic dykes crosscutting the entire area can be deeply situated hydraulic barriers. They can separate, on local scale, areas of different groundwater level and differentiate the basalt aquifers into compartments with different groundwater flow conditions.

According to the geologic structure of the basalt complex, it can be assumed that the deeper subsurface of the Jabal Al Arab mountain massif is occupied by the main feeder zone of the Neogene basalt flows and constitutes a thick sequence of basaltic rocks as vertical dykes or in sill-type intrusions into sedimentary rocks. No extensive deep groundwater circulation is therefore expected in the core of the mountain massif.

4.2 Proposals for Satellite Imagery Studies for Hydrogeology in selected areas

4.2.1 Vulnerability of Karst Aquifer in Jordan, Syria, Lebanon and West Bank

The northwestern fringes of the ESCWA region comprises mountain chains and highlands with sub-humid Mediterranean climate. Outcropping karstified carbonate formations in these mountains and highlands provide productive aquifers with water resources of major importance in Syria, Lebanon, Jordan and West Bank.

Increasing population density, intensive land use and development of industrial activities are creating increasing stress on the water resources in these countries and cause particular hazards of groundwater contamination. Groundwater vulnerability assessment can be used as a tool for setting up strategies and measures for protecting groundwater resources against contamination. These results of groundwater vulnerability assessments are presented on maps which delineate areas of different vulnerability and sites of main contamination hazards. Hydrogeologic investigations for the vulnerability assessment can be supported by interpretation of satellite images. Valuable types of information that can be obtained for groundwater vulnerability assessment from satellite images are (Vrba and Zaporozec 1994):

distribution of high vertical drainage,
location of permanently wet areas,
existing land use,
vegetative cover condition,
variations of soil texture,
hydrogeologic complexes.

A preliminary interpretation of satellite images has been made for a selected area in north-western Jordan with a view to the possibilities of using remote sensing data for a fast and inexpensive definition of features related to aquifer vulnerability and contamination hazards.

Intensive recent urban and rural development can be delineated by satellite imagery with the aid of actual LANDSAT TM data (Figure 11). Polygon mapping of classified areas reveals a rapid increase of settlements and existing agriculture use, which are not yet delineated on available geographic maps (Figure 12).

The following features can be delineated by simple polygon mapping:

Outcrops of Cenomanian-Turonian carbonate aquifer,
Aquifer outcrops with thick soil cover,
Rainfed agriculture,
Irrigation areas,
Towns and villages.

Larger industrial areas in greater Amman and greater Damascus areas can be clearly identified from satellite images.

Remote sensing data can significantly support hydrogeologic and land use studies for aquifer vulnerability assessment and can, in particular, provide up-to-date information on recent land use developments.

An evaluation of present land cover in the area of extent of major karst aquifers in the northwestern part of the ESCWA region appears recommendable with a particular view to hazards caused by intensive land use developments to outcropping uncovered aquifers.

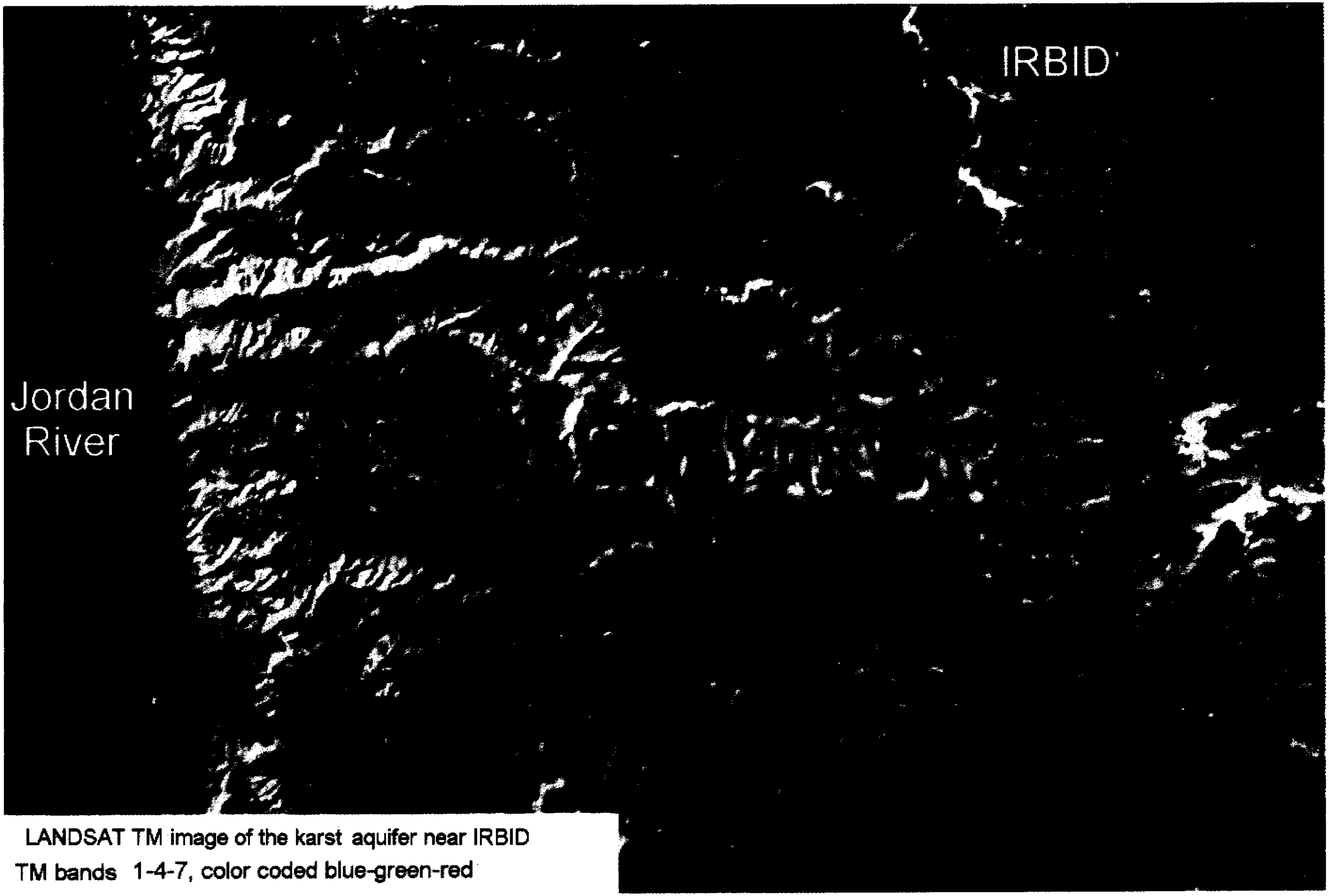


Figure 11 A selected area of a LANDSAT TM scene of northern Jordan covering the city of Irbid and large of the Santonian - Turonian main aquifer

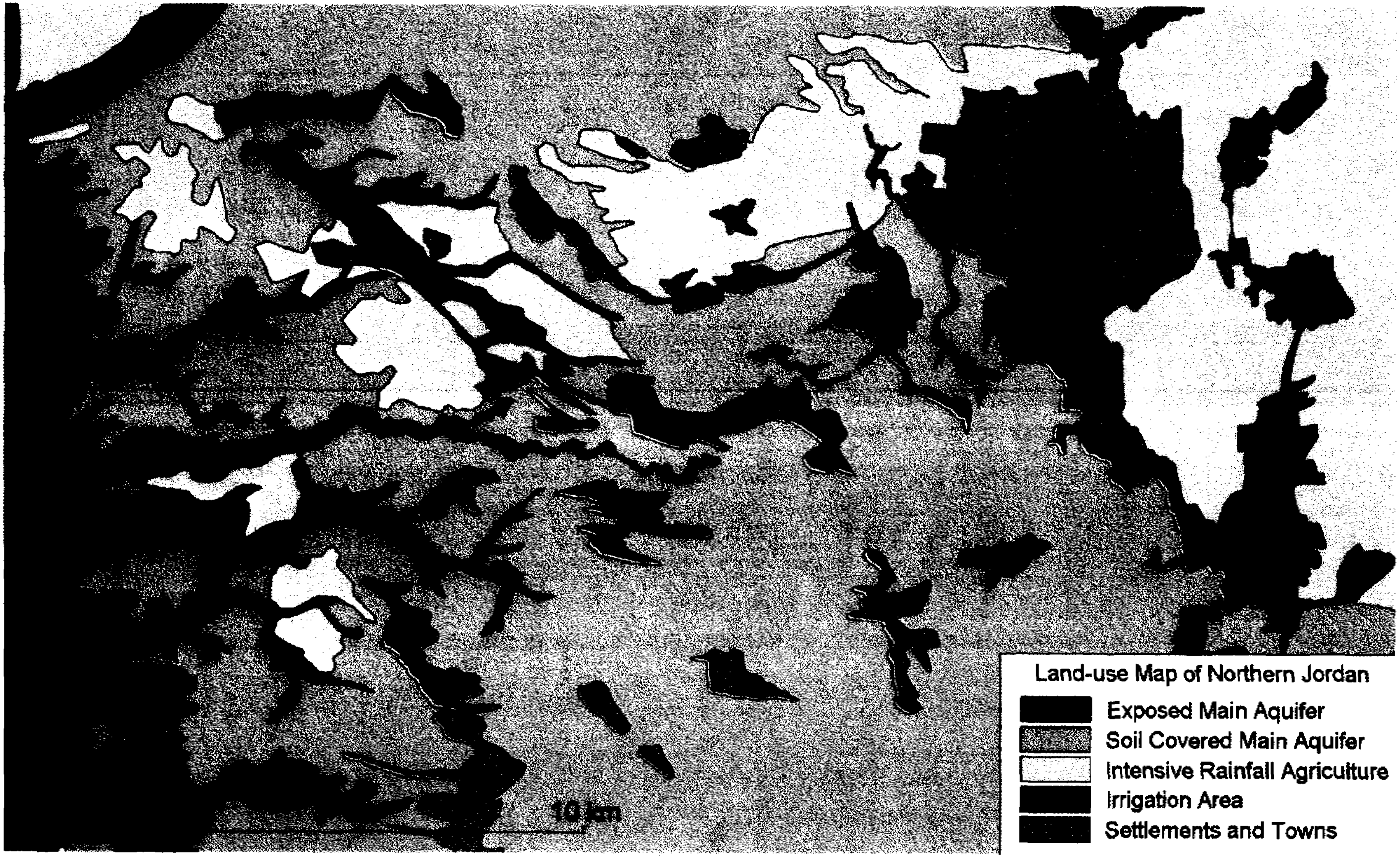


Figure 12 Visual interpretation (polygon mapping) of the LANDSAT TM data (compare to Figure 11)

4.2.2 Karst Aquifer of Northern Oman and United Arab Emirates

Satellite images of a LANDSAT TM scene were used to investigate the possibilities of improving the geologic information on the Musandam Peninsula from remote sensing data. The Musandam Peninsula is shared by the United Arab Emirates and Oman and constitutes a mountain massif extending as a promontory into the Gulf. The massif is composed of Paleozoic to Mesozoic limestones and dolomitic limestones, which provide a fissured to karstic aquifer.

The aquifer contains groundwater resources with fresh water quality underlain by brackish to saline water.

Two LANDSAT TM data sets of path/row 160/042 from 11.1.1988 and from 16.11.1993 have been chosen for a pre-evaluation of the geologic features of the karstified limestone (Figure 13).

Two modified geologic maps of the region (Figures 14 and 15) show the differentiated internal construction of the Paleozoic to Mesozoic limestones and dolomitic limestones.

A composite of geologic map and LANDSAT TM image gives information about different spectral reflection properties of different limestones and their geologic delineations (Figure 15, *this composite has been produced by simple image processing software* MICROGRAPHIX Picture Publisher 6.0 *under* Microsoft Windows 95).

The Late Paleozoic until Mesozoic limestone aquifer reveals a tectonic pattern which is not mentioned on existing geologic maps. Several extending major fault systems can be outlined in the mountainous terrain (Figure 16). Existing geologic mapping concludes extensive internal karstification of the carbonate sequence which reaches several thousand meters in thickness. In the wadi depressions, often nearby crosscutting fault systems, sporadic vegetation and existing open water can be observed on LANDSAT TM. This may indicate occurrences of near surface fresh water. Internal karstification cannot be directly defined from satellite images, but with satellite remote sensing methods an improved tectonic model can be established.

Relationships between the tectonic structure and fresh water occurrences and groundwater recharge pattern have to be determined through additional field interpretations. Experiences show that it is nearly impossible to investigate internal structures of karstified carbonates by satellite remote sensing methods only. A satellite imagery study for the Musandam Peninsula would therefore be an approach towards a geotectonic model and conclusions on hydrogeologic conditions would have to be supported by groundwater exploration data.

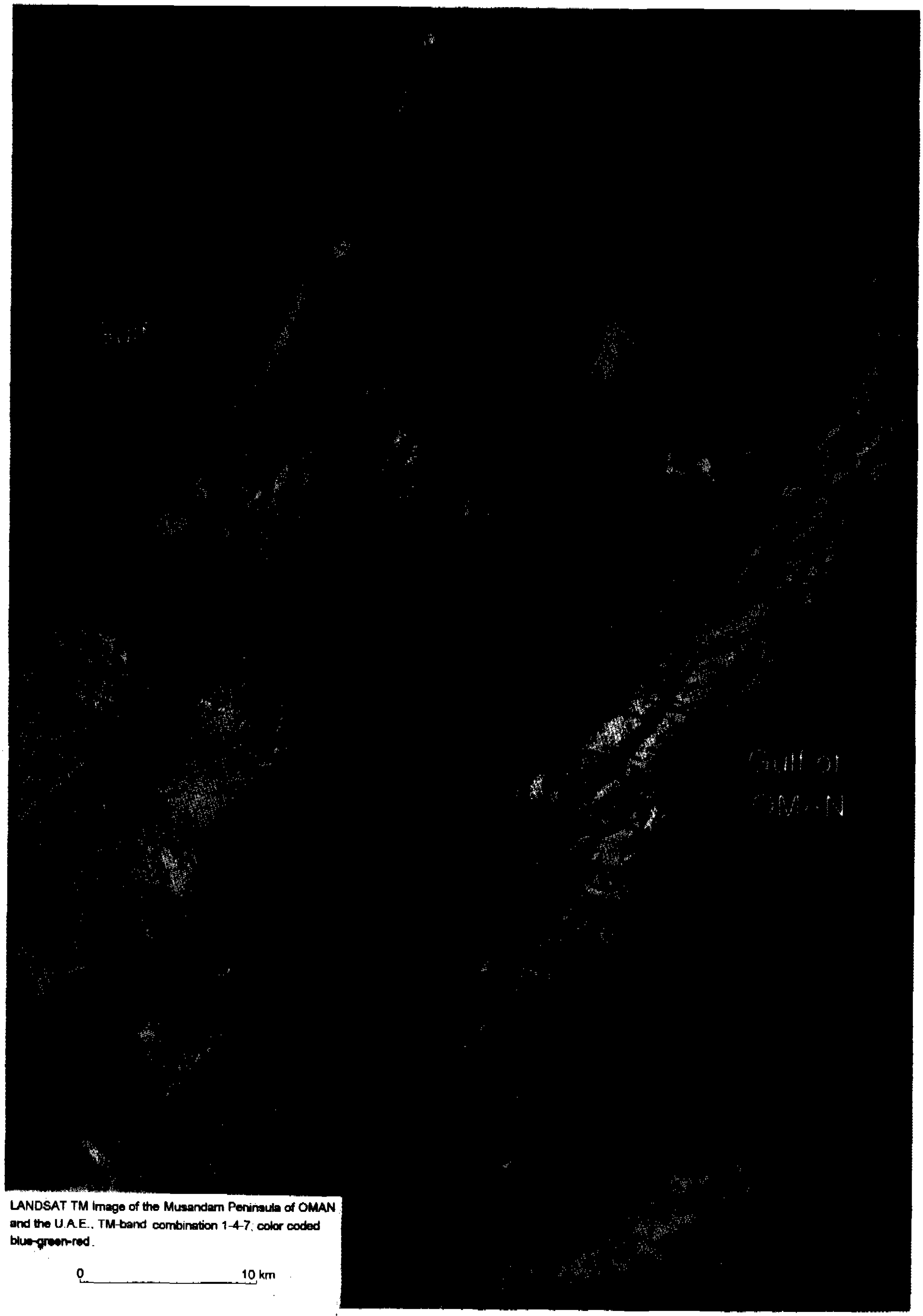


Figure 13 LANDSAT TM-image of the Musandam Peninsula of Oman and the U.A.E.

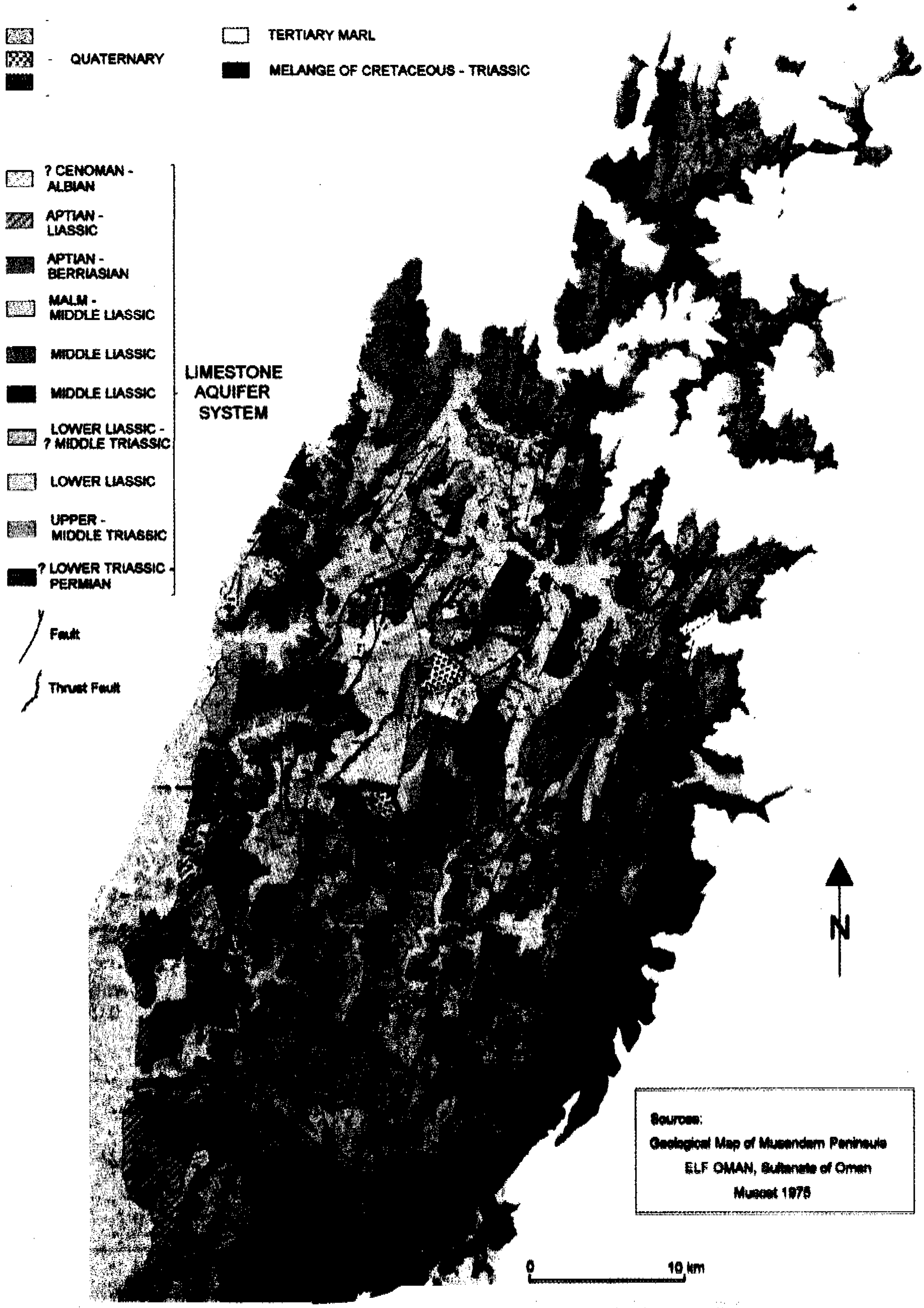
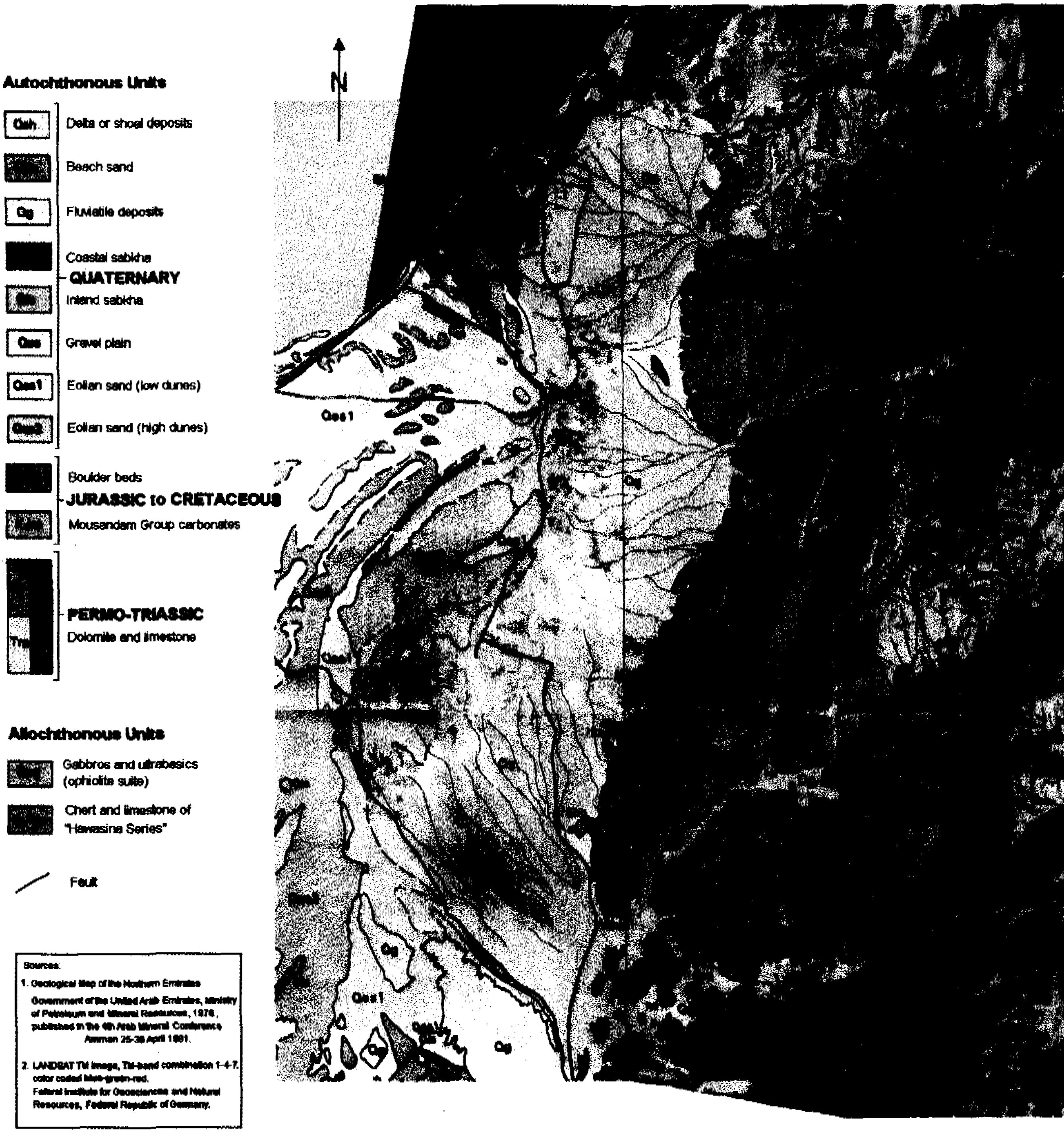


Figure 14 Symplified Geologic Map of the Northern Part of the Musandam Peninsula



Composite of LANDSAT TM data and geologic map in the region of the Northern Emirates (U.A.E.)

Figure 16 Enhanced LANDSAT TM image with visual interpreted fault pattern of the Musandam Peninsula.

4.2.3 Groundwater Discharge in the Umm as Samim Sabkha

The reflection properties of salt covered soils and rocks differ considerably from other surface phenomena (chapter 4.1.1). It is known that sabkhas of the Arabian Peninsula comprise sandy silt-sized carbonate sediments with certain content of anhydrite and halite.

Examples of successive evaporation with increasing salt precipitation are given in sabkha depressions as it has been demonstrated in the Basalt Aquifer Study (Schäffer, 1994) and in numerous previous published investigations from the ESCWA region (e.g. the study of the QATTARA Depression, Study Qattara-Depression, 1979).
Satellite images covering the Umm As Samim Sabkha were used to define possibilities of delineation of groundwater discharge areas and of mapping of the surface drainage pattern with a view to an assessment of volumes of groundwater discharge.

The Umm as Samim Sabkha which is located on the territory of the Sultanate of Oman and in the region of south-eastern Saudi Arabia comprises an area of about 10.000 square kilometers (Figure 17). Evaporation from a free water surface in the region of the central desert area around the Umm as Samim Sabkha is more than 3000 mm/a.

The most promising aquifer in the region of the Arabian Peninsula is known as the Dammam aquifer. The sabkha which probably is underlain by this aquifer is situated at the eastern rim of the Rub Al Khali desert (Figure 8).

For a preliminary interpretation one LANDSAT TM scene, path 159 and row 045 from 25 Jan 1987, has been chosen in the band combinations 1-4-7 color coded blue-green-red. This data set has been provided by the GAF in Munich, Germany (as fireplot, scale 1 : 1.000.000) and it was prepared as photo prints, scale 1 : 500.000 and 1 . 250.000, in the BGR-Hannover, Germany.

A preliminary satellite interpretation reveals sand-dune covered evaporites north, west and south-west of the central region of the sabkha. To the east and to the north-east of the center alluvial gravel plains of the eastern Oman mountains show drainage patterns (alluvial channels) which give evidence for former surface runoff into the sabkha.

Nearby the center of the sabkha a paleo-plateau can be delineated (Figure 17). This plateau is covered by evaporites which indicates former water coverage probably during the humid phase of Late Pleistocene (?) or Early Holocene. Probably, during that time the alluvial channels have been formed. The entire region of the sabkha originally was filled by water. Due to now existing evaporites and existing sand dunes in the entire region no near surface water from that time can be expected any more.

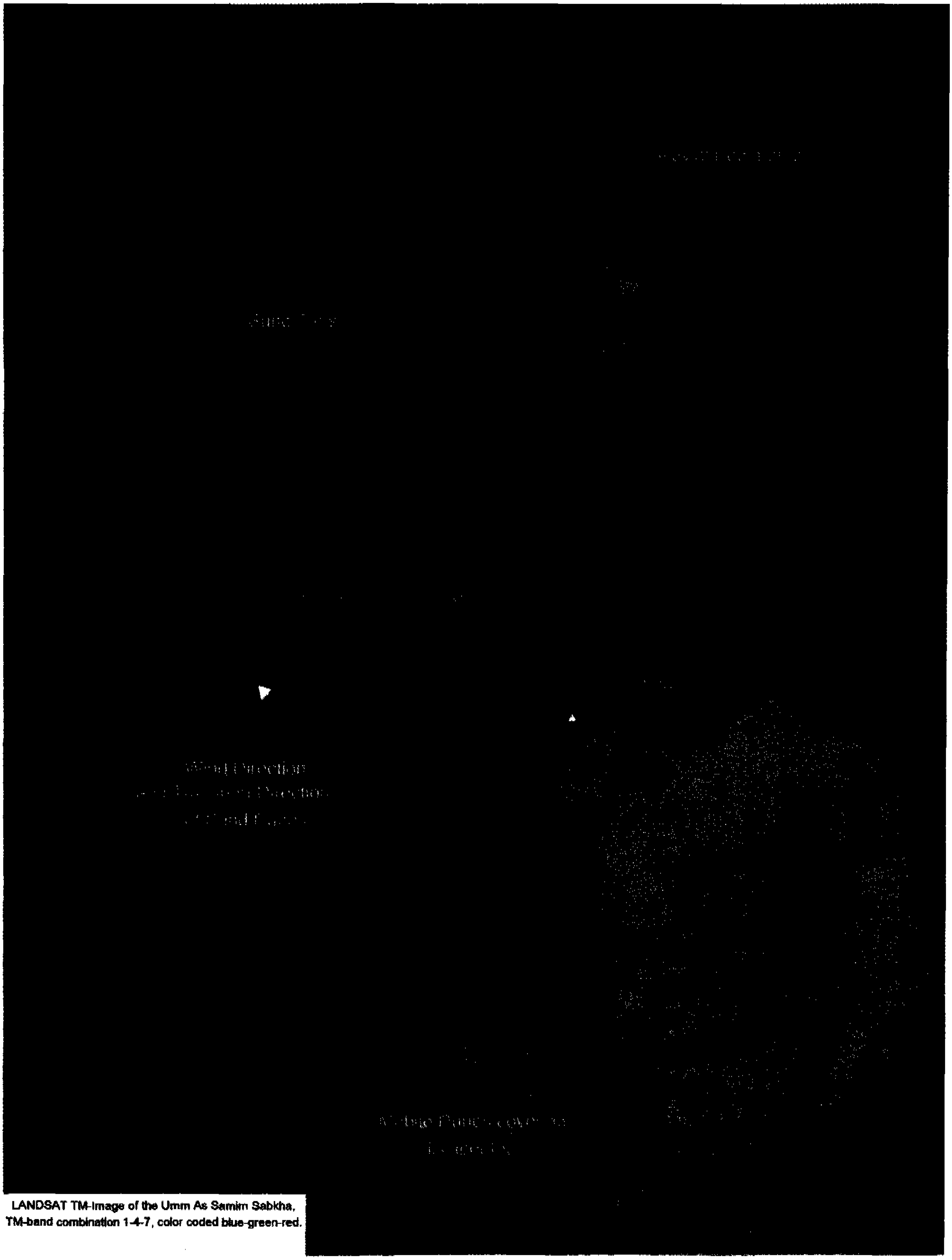
Two types of sand migration can be observed inside the central part of the sabkha. The older "sand fans" are slightly darker in color and they probably belong to the first aerial sediments which cover the north-western margins of the sabkha. They have been formed during Holocene time when all of the surface water disappeared. From that time on the younger "sand dunes" which are bright in color migrated from south-east to north-west over the whole sabkha area. Also the alluvial channels have been covered in part (Figure 18). It can be concluded from this observation that no considerable amounts of surface runoff happened during Holocene time.

The image from January 1987 shows a central part of the sabkha which has low reflection in the three TM-bands (1-4-7, Figure 17). At the moment only little can be concluded about the surface conditions only by satellite interpretation. The strong absorption may be caused by soil moisture in combination with high salinity. This can be observed in central parts of the Qattara Depression, where hygrophile salt-contaminated clay-minerals form irregular steeply dipping slabs which don´t reflect the incoming sunlight into the satellite sensor.

Permanent evaporation probably occurs from near-surface groundwater. This process may indicate groundwater inflow, probably from the eastern Oman gravel plains and possibly also from distant areas of Dhofar in southern Oman.

Earlier hydrologic studies indicate shallow groundwater movements into the sabkha from parts of the Rub Al Khali desert, from the Dammam aquifer. The eastern Yemen Hadramaut wadi system is assumed to be the source of occasional fresh water infiltration into the shallow Dammam Formation aquifer (Figure 19). An analysis of the water catchment in the region of the eastern Yemen Hadramout wadi system requires more detailed information. In this context an investigation of the Hadramout wadi system and the associated gravel plains are recommended by LANDSAT TM imagery.

It can be concluded that satellite image interpretation for the Umm As Samim Sabkha will not provide reliable information on groundwater discharge conditions from the Dammam aquifer, at the present stage of knowledge on local hydrologic conditions. Satellite imagery may, however, be a very useful tool for an assessment of the hydrologic region of the sabkha and its catchment area in the Oman Mountains and in the Rub al Khali in combination with hydrogeologic data evaluations and field studies.



LANDSAT TM-Image of the Umm As Samim Sabkha,
TM-band combination 1-4-7, color coded blue-green-red.

Figure 17 LANDSAT TM-Image of the Umm As Samim Sabkha

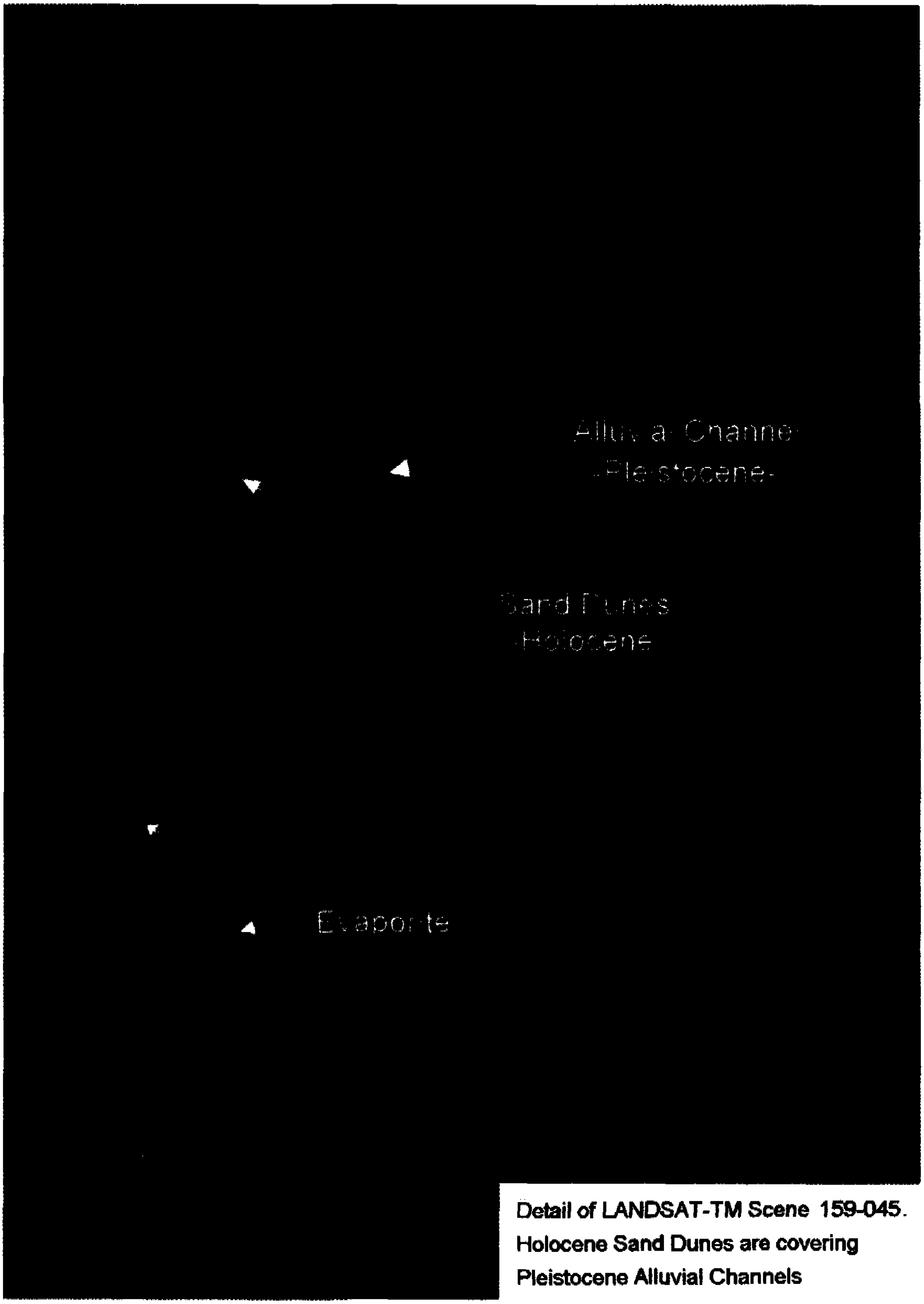
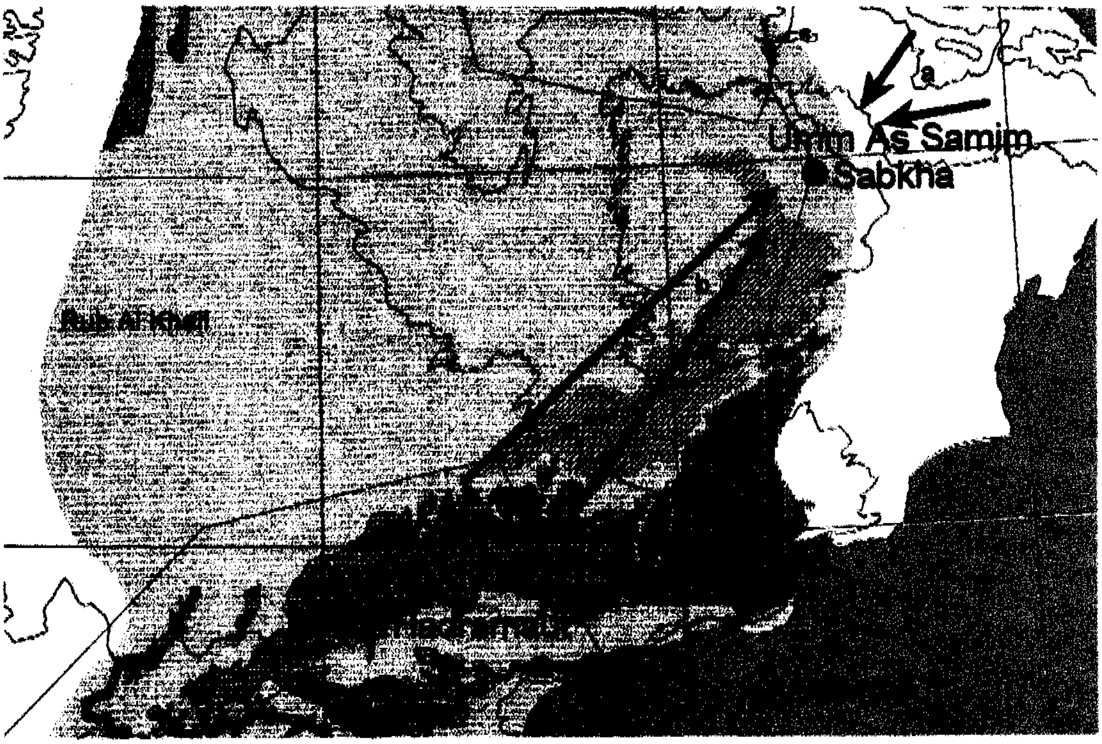


Figure 18 LANDSAT TM-Image from an area NNW of the central part of the Umm As Samim Sabkha



The Paleogene Aquifer of the Rub Al Khali area:

The main groundwater recharge of the Umm As Samim Sabkha is supposed to originate from the eastern Oman gravel plains (a).

A certain amount of groundwater recharge can be expected by infiltration of rainfall water deriving from the Hadramaut wadi system (b).

Figure 19

5. Acquisition and Processing of Satellite Images

In general, nearly all satellite data types can be bought from satellite data suppliers. Numerous world-wide operating governmental and commercial distributers are selling satellite data of different kind. The satellite data originate from ground receiving stations which are represented by licensed contractors of the satellite owner. Depending on the different satellite systems they are partly direct read out data from the satellite which passes the ground-station or they are onboard tape-recorded data which result from one or more orbits (tape-recorded SPOT-Image data are currently unavailable, because the on-board tape recorder is out of order). The acquisition data are raw-data or processed data stored on magnetic tapes or computer-Disks (CD-Rom). Depending on the image processing system of the customer the data type has to be reprocessed by the data distributer or by the customer himself. If the customer has no facilities for data processing and/or facilities for hardcopy production he can order from most of the suppliers ready processed hardcopies on photo-paper (satellite images).

The most proper source of satellite data is the existing World-Wide-Web on Internet communication. Most distributers offer so called "quicklooks" through the Internet communication also to the computer screen of the customer. Predominantly they are free of charge (except for the Internet and Telephone costs). The archieved quicklooks give an overview of the area of interest and the customer achieves a rough overview about the applicability of the offered scene. A comprehensive collection of available sources of quicklook images and their detailed descriptions is given in the annexes (chapter 9).

At present time (since 1996) high resolution images from the defense-technology LANYARD satellite (1963) are archieved by the USGS and for free marketing under the address: **http://edcwww.cr.usgs.gov/dclass/dclass,html**

5.1 Satellite Data Types and their Sources

It was mentioned before (chapter 3) that the practical use of different satellite data types is directly bound to the thematic questions. With respect to the thematic questions and the frame of a project, the scale, spatial and spectrometric resolution and the costs of acquisition have to be taken into consideration. For detailed geologic/hydrologic studies, scale 1: 250.000 or 1:100.000, at present time LANDSAT TM, IRS-1A/B/C SPOT Image or JERS data are recommended.

Global or regional vegetation monitoring requires continuous data supply at moderate acquisition costs. For that reason the NOAA-AVHRR data are recommended tools because a swath widths of about 2400 km and a daily coverage is given (annex 10, 10-1, 10-2).

The satellite data can be acquired from Space IMAGING EOSAT, the National Satellite Land Remote Sensing Data Archive (NSLRSDA) at the EROS Data Center (EDC), the EURIMAGE directly via EiNet www server (annex 4), and from International Ground Stations. The ESCWA region can be received directly from ground stations in Europe, Arab countries (Riyadh and Cairo) and India. Several examples of data acquisition are given in the annexes (chapter 9).

5.1.1 Coverage of Satellite Data with Respect to the ESCWA-Region

Due to the onboard storage of orbital data of most of the operating satellite systems a nearly world-wide coverage is given. For the ESCWA region direct data read-outs, e.g. SPOT Image, LANDSAT TM and NOAA AVHRR are possible from the receiving station in Saudi Arabia (King Abdulaziz City for Science and Technology -KACST-, P.O. Box 6086, Riyadh 11442). The south-eastern and the north-western part of the ESCWA-region can be directly received from the Indian IRS at ground stations in Germany (Neustrelitz) and India (Shadnagar). The south-western part is not covered (large areas of Saudi Arabia and the western part of the Republic of Yemen). IRS-data of this region are currently unavailable.

The Tracking and Data Relay System (TDRS) is a world-wide operating geostationary satellite-borne data relay system which enables the main receiving stations to receive data from every ground of the world.

5.1.2 Resolution Properties and Spectral Features

The optical "passive" sensors of the Japanese JERS give data sets at pixel size of 18 m which is sufficient for hydrologic investigations. Spectral properties of the single sensor bands are listed in Table 1 and in annex 5.

A particular feature of the JERS Optical Scanner (OPS) is given by the spectrometric resolution in the SWIR-range. JERS bands 6 (2.01 - 2.12 µm), 7 (2.13 - 2.25) and 8 (2.27 - 2.40 µm) are comparable to LANDSAT TM band 7 (2.08 - 2.35 µm), but they cover distinct absorption-peaks for differentiation of clay minerals like kaolinite and montmorillonite (2.20 µm) and chlorite, serpentinite and also carbonates (2.30 µm).

5.1.3 Acquisition of Satellite Data and/or Satellite Images

A comprehensive collection of data- and/or image acquisition sources is given in the annexes (chapter 9). The data can be acquired via www-server or by mail. The most important address for nearly all satellite data is the Space IMAGING EOSAT (annex 2) and the EROS DATA CENTER (EDC, annex 15), both are based in the U.S.A. Depending on the user defined acquisition date and the area of coverage the data sets have to be ordered from one of the two main distributers (more information is listed in annex 15 - 15-1).

Through on-line connections to the digital data catalogues like EURIMAGE (annex 4), SPOT IMAGE (annex 6), the German Remote Sensing Data Center-DFD (annex 1), the Company for Applied Remote Sensing (GAF, annex 11 and chapter 5.2.1), and to the constantly updated IMAGING EOSAT microfiche catalogue, an on-line servicer
can perform an instant search in these archives, check the availability of scenes and conduct an initial quality control of the data. When a scene is not available from the archive, or if new images are needed, a special acquisition can be performed by programming a satellite to acquire the image needed by the customer.

5.2 Processing Methods of Satellite Data

Due to the specific questions of the application of satellite imagery the data processing has to follow scientific problems. According to hydrological questions, e.g. on a regional scale, 1 : 250.000, full or quarter scenes of LANDSAT TM can be processed with band combinations 1-4-7, color coded blue-green-red. A geocoded rectification always is recommended. The data distributers offer specific services which allow all available band combinations and rectifications.

5.2.1 Commercial Processing Services

Most suppliers of satellite data offer processing services and photo prints (hardcopies). The above mentioned Space IMAGING EOSAT and several other governmental and commercial distributers offer a wide selection of processing services. As an example, technical support for image processing can be given by GAF company (annex 11) and by its cooperating hardware-company GEOSYSTEMS(http://www.geosystems.de/).

Detailed information and a list of companies are given in the annexes (chapter 9).

5.2.2 Costs of Data Acquisition and Processing Services

The costs of data acquisition differ considerably between the different satellite systems. There are data types which can be received free of charge, e.g. NOAA-AVHRR data through a private receiving station. Others, e.g. LANDSAT TM and SPOT IMAGE cost several thousand US$. Detailed lists of costs are given in the annexes (chapter 9).

LANDSAT TM-scenes which have been already previously ordered by the US government and affiliated users (USGAU) from EOSAT for which a copy is in the archive at Eros Data Center (EDC) are available to UNEP commissioned hydrological remote sensing projects for US$ 150,- per scene (annex 14). UNEP programs belong to non commercial affiliated users.

6. Recommended Future Earth Observating Satellite Projects for Groundwater Investigations in the ESCWA Region

The future will bring plenty of new satellite and sensor systems which will increase the possibilities for applied remote sensing techniques assigned to the range of hydrological questions.

The evolution of new systems and of a wide spectrum of applications is certified (chapter 9).

The data of the active SAR-satellites (Canadian RADARSAT, European ERS SAR and the Japanese JERS SAR) and the passive Microwave scanners of several satellite systems which have different and wide ranges of spectral bands reveal numerous options in the field of groundwater research activities for the future. At the moment there is not enough experience with these systems and the future development should be observed.

A large area of coverage which is combined with a high repetition rate (so-called "re-visiting") is given for polar orbiting weather satellites. The data of the NOAA-satellites (National Oceanographic and Aeronautic Agency) are currently also used for earth-surface observating programs. Onboard the NOAA-satellites the AVHRR-radiometer (Advanced Very High Resolution Radiometer) has a spatial resolution (pixel size) of 1 square kilometer with a spectral resolution from visible red (VIS) to thermal infrared (TIR) in 5 bands. The NOAA-program is planned continuing into the future with continuous data supply.

IRS-data (onboard tape-recorded "vegetation index"; the VIS, SWIR and TIR channels unstored) are distributed by EOSAT and by GAF. Currently the IRS non-recorded data are available only for limited areas of the ESCWA-region (chapter 5.1.1). Probably, in the future a total coverage of the entire ESCWA-region will be given and the application of IRS-data will be a recommended tool for future land-use studies.

Applied remote sensing investigation with respect to hydrologic questions is intensely linked to the identification, classification, and mapping of existing vegetation. LANDSAT TM data (annex 15-1), ERDAS Image Processing (annex 21) and ARC/INFO-GIS techniques (annex 22) are recommended tools for digitally mapping of existing vegetation and land cover type across large areas in the ESCWA-region. A data base layer can be built by integrating multispectral LANDSAT TM data with biophysical data (e.g. vegetation index) in a GIS. This process contains first manual digitizing and second labeling of polygons, a procedure used by GIS-working teams in worldwide operating programs, e.g. the Earth Observing System (EOS, annex 20).

The first step of discrimination and classification of vegetation areas can be carried out as an unsupervised classification of pixels. It uses a specially designed algorithm to identify spectral groups that simulate the enhanced color composite of TM-bands 3, 4, and 5. These bands are the most useful for vegetation analysis because they generally have the least spectral overlap among other types. In the classification program, the number of spectral groups is determined by two user-specified criteria:

1. The correlation between a pixel and a reference point in three-dimensional color space, and

2. The distance between a pixel and origin (0,0,0) in the color space. The former seeks to match a pixel' s color with the color composite, whereas the latter emulates its brightness (the farther from the origin, the brighter).

Pixels with similar colors and brightness belong to the same spectral group.

In the first stage, the algoritm employs a two-pass process. The first pass searches for pixels that do not meet the above user-specified criteria, defining another spectral group whenever either condition is not met. It also randomly selects one pixel to represent each spectral group; with random selection, the probability of a group being selected is equal to the population size of the group, so none of the large groups will be missed. (If a small group is missed, it can be manually added later). These randomly-selected "training"-pixels are stored and used in the second pass to classify pixels into spectral groups. The resulting pixel classification closely resembles the color composite in appearance. By this method, data are processed more quickly than with the commonly used ISODATA and MAXIMUM LIKELIHOOD classification methods.

After the second pass, classes are digitally regrouped with some modifications by the operator (an enormous time saver, because conventional unsupervised classification methods require the operator to manually regroup classes). The classified image is then smoothened using a filter to remove "salt and pepper" regions. This step improves the physical appearance of the image and greatly reduces the number of records in the GIS database. The smoothened image then undergoes an unique merging process to combine small regions with highly similar, larger neighbors, thus creating regions of the desired minimum area.

The second stage involves classification of regions, rather than individual pixels. The spectral groups are converted into an ARC/INFO GRID file, an attribute table is built, and attribute values for the different spectral and biophysical variables are assigned to each region. Ground truth data from existing vegetation maps, field plots, and aerial photographs are analyzed with spectral and biophysical data (including elevation, slope, aspect, and the other four TM bands) and used for a supervised classification of attributes by a nonparametric method called NEAREST MEMBER of GROUP. The resultant image is labeled according to vegetation cover types. Because the data are never converted from raster to vector format, many of the traditional limitations for building attribute tables are avoided, and large areas can be processed relatively quickly and efficiently.

An approach to monitor salt-affected soils by remote sensing classification methods has been carried out by Saleh and Saud (1997) in Saudi Arabia with LANDSAT TM data.

For the future the LANDSAT Program will be continued with the planned LANDSAT 7 satellite (currently LANDSAT 5 is operating probably until the Year 2000; annex 15 - annex 19).

Several high resolution commercial satellite systems are also planned which will have pixel sizes less than 1m; e.g. **Space Imaging** from Locheed Martin Corporation, **Quickbird** from Earthwatch (Bell Aerospace, Hitachi, Nuova Telespazio) and **Orbimage** from Orbital Sciences, Saudi Arabia. Future high resolution satellites are planned by France, Israel, Japan, Spain, South-Africa, Russia and the USA.

Nevertheless, as it was mentioned before (chapter 3 and 5.1) the application of different satellite systems for groundwater studies is limited to the frame of the single studies.

The costs of acquisition and the large amount of data are enormous and not economical for a general aquifer study, covering an entire area of regional scale; e.g. the "Paleogene Aquifer" which is extending from Syria through the eastern part of Saudi Arabia into the Hadramawt of Yemen, with high resolution satellite data. On the other hand, selected areas should be acquired with future high or moderate resolution data; e.g. LANDSAT TM as it has been practiced in the mentioned case studies (chapter 4). The entire Paleogene Aquifer of the Arabian Peninsula in total should be handled with low resolution data, e.g. with NOAA-AVHRR 1km pixel size. All these systems are reliable and the future data supply is warranted for several years.

7. Conclusions and Recommendations

In this chapter the results of the present study concerning the applicability of remote sensing methods for groundwater studies and the acquisition properties of remotely sensed data for the member states of the ESCWA-region are summarized.

The countries of the ESCWA region reveal favorable conditions for earth observation from space. The arid conditions guarrantee low cloud coverage in the dry season and significant vegetation indications during all seasonal periods. Over 70% of the region is desert and most parts are lacking sufficient water resources and adequate soils to support a settled population.

The application of remote sensing methods in the field of groundwater studies are demonstrated in an aquifer case study in the basalt region in northern Jordan and southern Syria. Based on drainage pattern and the distribution of the Neogene basalt of the Jabal Al Arab area, groundwater recharge conditions and relationships between geologic structure and groundwater occurrence at different depth in the basalt complex.
have been delineated by the interpretation of LANDSAT TM-data.

In the area of the Shared Upper Cretaceous Karst Aquifer of Jordan, Syria, Lebanon, and West Bank, intensive urban and rural development can be delineated by satellite imagery with the aid of actual LANDSAT TM data. Polygon mapping of classified areas reveals a rapid increase of settlements and extensive agriculture use which are as yet not delineated on available geographic maps. Town- and village- settlements, rainfall agriculture areas and irrigated areas, soil cover and outcropping karstified aquifer can be differentiated. This information supports land-use studies with data of the actual situation.

A re-evaluation of the present land cover is recommended for the entire area, because hazards groundwater quality deterioration have to be expected due to intensive land-use nearby the unprotected outcropping aquifer.

On LANDSAT TM image salt covered Paleogene limestone, chalk, marl and evaporite can be observed in the area of the south-eastern desert of Saudi Arabia and in the Umm as Samim Sabkha of the Sultanate of Oman. Large parts of the sabkha region are covered by recent desert dunes. Where the Paleogene rocks are exposed large salt fields can be delineated. The evaporated area indicates a large regional depression which was probably covered by water during Pleistocene(?) time. This depression covers large areas of south-east Saudi Arabia. An existing paleo-coastal line can be interpreted by satellite imagery from a small and flat plateau near the center of the sabkha. The actual situation shows the present center of the depression with indications of moistured soil in combination with high salinity. Obviously, the hydraulic pressure from saline surface-near groundwater causes the permanent and successive evaporation. This process may be an indicator for a certain fresh groundwater recharge, probably from the eastern Oman gravel plains and/or from the far south-western Yemen Hadramaut wadi system (Figure 19). The flat Dammam Formation aquifer is proposed as the most important aquifer in the region. It is recommended to investigate the Paleogene aquifer rocks which have been previously delineated in the available geologic maps covering the surroundings of the present sabkha. Satellite imagery (LANDSAT TM) gives not sufficient information about real existing outcroppings of the Dammam Formation.

Satellite imagery of the North-Oman Mountains (Musandam Peninsula) with its Late Paleozoic until Mesozoic limestone aquifer reveals a tectonic pattern which is not mentioned on existing geologic maps. Two lateral extending major fault systems can be outlined in the mountainous terrain. Geologic mapping concludes extensive internal karstification of the carbonate sequence which reaches several thousand meters in thickness. In the wadi depressions often nearby crosscutting fault systems sporadic vegetation and existing open water can be observed on LANDSAT TM which may indicate certain amounts of near surface fresh water or temporary rainfall runoffs. Few is known about the internal karstification and the runoff of seasonal rainfall water, but with satellite remote sensing methods a tectonic model can be re-evaluated which might give some hints about the direction of fresh-water runoff (into the sea or into internal karstified carbonates), or about the rate of groundwater recharge. Experiences show that it is nearly impossible to investigate internal structures of karstified carbonates by satellite remote sensing methods only. The recommended satellite imagery study is in this context only an approach towards a geotectonic model and it is recommended to handle any conclusions carefully.

One very important indicator for near surface water is the existing vegetation which can be easily distinguished by satellite imagery. Identification and differentiation of vegetation can be carried out by satellite imagery for the recommended studies of the North-Oman mountains, and in the karst aquifer in the region of Jordan, Syria, Lebanon and West Bank

The existing vegetation of the territory of the ESCWA member states reflects the actual situation of desertification and man-made land degradation.

The benefits of remotely sensed data and their thematic applications for hydrologic/-hydrogeologic studies in the ESCWA-region can be summed up as:

-monitoring of vegetation and land-use including crop-estimation,
-geologic synoptic overview of a region of interest,
-multispectral resolution with selected bands which can be applied for hydrography,

-rapid data access to digital geocoded data files (map-accuracy),
-compatibility of digital image data to digital hydrologic thematic data,
-large archive of historical data,
-cost effective data acquisition.

This study on Application of Satellite Imagery in ESCWA-states gives hints and recommendations for problem orientated satellite data acquisitions and application. Regarding the hydrologic questions for monitoring purpose, the spatial and temporal resolution of the available satellite data has to be taken into consideration.

The rules have to be considered,
- the higher the resolution the lower the "re-visiting rate" and the higher the costs of acquisition,
- the lower the resolution the higher the "re-visiting rate" and the lower the costs of acquisition

Due to the facilities and due to the programs of the working groups of the single ESCWA member states the acquisition procedures for satellite data may differ. The data can be achieved through mail order from commercial and governmental data centers or they can be ordered directly via Internet Communication from the main distributers which are all listed in the annexes (chapter 9). Data characteristics and proper applications, modern simple processing methods, and processing services are given.

An archive of satellite images from hydrologic sensitive areas of the ESCWA region is recommended to be installed at the UN-ESCWA headquarter. Low cost image processing hard- and software is recommended for simple image processing. A personal computer which is combined with a flatboard scanner, a color inkjet printer and adequate software enables the hydrologic expert to resemble, to copy and to modify existing satellite images.

Last information (Space Imaging EOSAT, May/June 1997)

Satellite Updates
The Indian IRS-1C, -1B, and P2 satellites are fully functional and downlink data on a regular basis for commercial sale. IRS-1B and -P2 downlink to Norman, Okla., and Shadnagar, India, while IRS-1C data is received at several stations (See following.)

Space Imaging EOSAT's one- meter remote sensing satellite, the world's first commercial satellite with this resolution, is on schedule for launch in late 1997 from Vandenberg Air Force Base, California. It will provide panchromatic imagery with one-meter spatial resolution and 1.5 meter ground accuracy. Resolution will be four meters in the multispectral bands.

Landsat 5 continues to collect and transmit data daily to Space Imaging EOSAT's Norman facility and to 15 ground stations around the world. The satellite is healthy and requires only normal maintenance and operational supervision.

IRS-1C Ground
Station Network Growing
Image data from the three sensors aboard the Indian IRS-1C satellite are being received at ground stations in Norman, Oklahoma, and Shadnagar, India, and at Euromap's Neustrelitz, Germany, facility.

Operators of existing ground stations in Thailand and Taiwan have signed agreements to downlink IRS-IC imagery, and are now preparing their facilities. Ground stations in Japan, South Africa and Australia have agreed in principle to receive the data and are expected to begin station preparation in early 1997.

Space Imaging EOSAT is in contact with all remaining Landsat ground stations to discuss downlink arrangements, according to Timothy Puckonus, Space Imaging EOSAT's IRS Program Director.

CARTERRA Samples
Easy To View
You don't need an image processing package to view sample **CARTERRA** imagery. All you need is Windows 95 or Windows 3.1 to display simulated onemeter space imagery from the TOPIX CD, now available from **Space Imaging EOSAT**.

-How to contact Space Imaging EOSAT, annex 13-.

TOPIX is the first in a series of evaluation CDs that enable users to view sample image products, plus a host of information about Space Imaging EOSAT, including the company's entire Web site (internet connection not required) and corporate video.
Also on the CD are two viewers: **ERDAS IMAGIZER**, developed for Space Imaging EOSAT using functions from ERDAS Inc.'s IMAGINE software, and City Viewer, developed by PADCO Inc. Both IMAGIZER and City Viewer offer the ability to retrieve images for display, adjust contrast, rescale the image to map coordinates, pan and zoom, and measure distances.

Two Transportable Ground Stations Being Installed
Small ground stations with transportable antennas continue to grow in popularity around the world.

Terra Systems Inc. of Honolulu, Hawaii, has completed installation of its 5X/A receiving station at the University of Hawaii in Oahu and has begun tracking and downlink tests with Landsat *5* and JERS-1. The station has a 5-meter antenna and is capable of receiving data from all current commercial remote sensing satellites. For more information, contact Dick Lunn in Hawaii at 808-539-3745.

Vexcel Corporation. of Boulder, Colorado, has been contracted by the Hiroshima Institute of Technology in Japan to provide a complete ground station to receive remote sensing data from any current commercial satellite. The station will feature Vexcel's 3D SAR Processing System and a 7.3-meter antenna. The Institute will use the station to train the next generation of Japan's environmental researchers in remote sensing techniques.

For information, contact Ron McCoy in Boulder, Colorado, at 303-444-0094.

New Space Imaging EOSAT Online - Browse Fee Waived
Space Imaging EOSAT's new, integrated Web site is now available at www.spaceimage.com. The new site includes information about the company after its merger in November of last year. The Web site also includes enhanced browsing capability through the Interactive CARTERRA archive. The new system is user friendly, rich in size and GROWING. The archive houses approximately 225,000 aerially and satellite derived Earth images. Customers are able to access the archive FREE OF CHARGE - annual fees have been waived. You can also place product orders directly online.

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9. List of Annexes:

The list of annexes contains information from July 1997 about existing satellite systems, acquisition forms of satellite data and addresses of governmental and commercial satellite data suppliers.

9.1 Explanatory Notes

The information which is given in the list of annexes has been collected from an INTERNET research study. Most of the printouts have been directly downloaded form the network.

All satellite data suppliers are present in the worldwide network. They offer acquisition forms and they give hints for applications of satellite remote sensing. The annexes contain the necessary information for an order of satelllite data. They can be understood as a guideline and an information catalog. As it has been mentioned before, depending on the specific thematic questions, a satellite system and a regional or an international data-supplier has to be choosen. If this has been done, the aquisition form can be ordered by telephone or fax. For this procedure an INTERNET connection is not absolutely necessary.

The reader must be reminded that due to improving technologies it is recommended here that the present guideline through the offers and applications of remotely sensed data should be updated continiously.

Annex 1 gives an overview of the German Aerospace Research Establishment (DLR) and its associated members. Although information about the radar satellite X-SAR and a quicklook are attached.

Annex 2 informs about addresses of the Space Imaging Eosat satellite data distributer and about selected current satellite constellations.

Annex 3 presents the Earth Watch Incorporated satellite data distributer.

Annex 4 contains information about quicklooks and E-mail addresses of the Eurimage satellite data distributer.

Annex 5 gives a comprehensive overview of available satellite data, application, technical data, acquisition and prices from the Australian Centre for Remote Sensing (ACRES).

Annex 6 contains data of the French satellite Spot Image and addresses of local satellite data distributers.

Annex 7 , annex 8 and annex 9 give Internet-addresses and current activities of the European data center Eurimage, the Japanese satellite JERS and the NOAA-AVHRR weather satellite.

Annex 10 is a comprehensive file which contains plenty of data about the Advanced Very High Resolution Radiometer (AVHRR) and its application.

Annex 11 informs about the German Company for Applied Remote Sensing (GAF), its activities and contact addresses.

Annex 12 gives an example of an archive system which is currently developed at the German Federal Institute for Geosciences and Natural Resources (BGR, Hannover).

Annex 13 provides information about access to LANDSAT data through contact addresses of the US EROS Data center and the Space Imaging Eosat company.

Annex 14 informs about the current status of the agreement between LANDSAT Program Management and EOSAT Corporation concerning pricing.

Annex 15 gives general data of the USGS EROS Data Center, programs and it presents the USGS Global Land Information System (GLIS). GLIS contains a series of routinely updated global land information.

Annex 16 describes LANDSAT TM Imagery in general and contact addresses of satellite data distributers are given.

Annex 17 describes LANDSAT TM data and its applications. Additionally a comprehensive description about the physical properties of the TM data-structure is given.

Annex 18 presents forms for LANDSAT TM data acquisition and an example of search criteria is attached.

Annex 19 describes the international currently operating ground stations which receive LANDSAT TM data.

Annex 20 gives information about the organisation of the worldwide operating Earth Observating System (EOS). The EOS is connected to the entire data archives.

Annex 21 informs about the most prominent ERDAS Image Processing system which is distributed worldwide. Addresses of local distributers of the ESCWA region are attached.

Annex 22 informs about the Arc-Info GIS. Addresses of local distributers are attached.

Annex 1	German Aerospace Research Establishment (DLR) German Remote Sensing Data Center (DFD) X-SAR User Kit X-SAR Datatakes, Sorted by Geographical Coordinates X-SAR Datatakes and Quicklooks, Sorted by Geographical Coordinates 185 X-SAR Quicklooks of ESCWA-Region X-SAR Quicklook Screen-Printout from Azraq spring field of Jordan
Annex 1-1	Information Catalog: **DLR**
Annex 2	EOSAT- Space Imaging Summary of Current Satellite Constellations Mapping Alliance Program (MAP)
Annex 2-1	Information Catalog: **EOSAT**
Annex 3	Earth Watch Incorporated
Annex 4	Ei Net WWW server Quick Looks (description of quick looks) Eurimage - on line services: Applications Zooming into the ESCWA Region
Annex 5	Australian Centre for Remote Sensing (ACRES) About Remote Sensing Remote Sensing Products and Services ACRES Products and Services Index ACRES Landsat TM Price List ACRES SPOT Price List Satellite - ERS ACRES ERS SAR Price List Satellite - JERS EOSAT JERS Price List Satellites - Indian Remote Sensing Satellite (IRS) EOSAT IRS Price List
Annex 6	Commercial Network Organisation SPOT IMAGE System Exploitation - Receiving Stations Local Distributors (ESCWA-Region)
Annex 7	Information Catalog: **Eurimage**

Annex 8 Information Catalog: **JERS**

Annex 9 Information Catalog: **NOAA** and **NOAA-AVHRR**

Annex 10 **AVHRR**-data collection:
Summary
Attributes
Data Center
Personnel
Reference

Annex 10-1 Advanced **V**ery **H**igh **R**esolution **R**adiometer (AVHRR)
Background
Extent of Coverage
Acquisition
    Processing Steps
Data Characteristics
    Spatial Resolution
    Temporal Coverage
    Spectral Range
Data Organization
Data Availability
    Procedures for Obtaining Data
    Products and Services
Applications and Related Data Sets
References
Appendix -data types and selection parameters-

Annex 10-2 Advanced **V**ery **H**igh **R**esolution **R**adiometer **S**earch **C**riteria

Annex 11 The Company for Applied Remote Sensing (**GAF**)
Gesellschaft für Angewandte Fernerkundung GAF mbH
Leonrodstr. 68, D-80636 München, Tel. 089-1211528-0

Annex 12 Digitales Nachweissystem für Satellitenbilddaten (DNS) of the Federal Istitute for Geosciences and Natural Resources (BGR, Hannover)
- currently the description is available only in German language-

Annex 13 Access to Landsat Data in the USA and from Non-US Ground Stations Eros Data Center on-line catalog systems
How to contact Space Imaging Eosat

Annex 1

German Aerospace Research Establishment (DLR)
German Remote Sensing Data Center (DFD)
X-SAR User Kit
X-SAR Datatakes, Sorted by Geographical Coordinates
X-SAR Datatakes and Quicklooks, Sorted By Geographical Coordinates
185 X-SAR Quicklooks of the ESCWA Region
X-SAR Quicklook Screen-Printout from Azraq spring field of Jordan

Deutsche Forschungsanstalt für Luft- und Raumfahrt e.V.
DLR
German Aerospace Research Establishment

Welcome to DFD

The German Remote Sensing Data Center (Deutsches Fernerkundungsdatenzentrum) DFD acts as a national infrastructure for remote sensing (especially earth observation) and focuses on the tasks acquisition of data, user oriented pre-processing, archiving and data storage, non-commercial data distribution and promotion of remote sensing applications.

Willkommen im DFD

Das Deutsche Fernerkundungsdatenzentrum nimmt die Aufgabe als nationale Infrastruktur für Fernerkundung (insbesondere Erdbeobachtung) wahr und ist mit den Aufgaben Datenbeschaffung, nutzerorientierte Vorprozessierung, Archivierung und Datenspeicherung, nicht-kommerzielle Datenverteilung sowie der Förderung von Fernerkundungsanwendungen betraut.

Deutsche Forschungsanstalt für Luft- und Raumfahrt
Deutsches Fernerkundungsdatenzentrum
Oberpfaffenhofen
D-82234 Weßling
Fax: +49 (0)8153 28-1137

e-mail: helpdesk@dfd.dlr.de

Welcome to the X-SAR User Kit!

Edited by Michael Eineder and Hartmut Runge

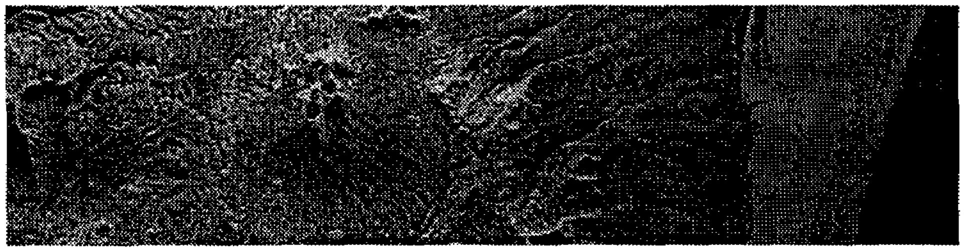


Figure: The first X-SAR scene ever processed: Kamchatka / Russia

What you get with this X-SAR User Kit

- about **5700 geographical maps** showing the ground coverage ... here is a sample
- **instructions** how to order the full resolution products at DLR
- **documents** describing the product types and their quality
- more than **14000 image quicklooks** (precision images with reduced resolution) ... have a look at one
- 4 full resolution **sample products** in CEOS format (320 MB, only on CD-ROM Version)

Starting Points into the User Kit

Simply navigate through the User Kit by selecting the blue, underlined references:

- Coverage of both missions (works best with (c) Netscape 2.0 and JAVA)

- Coverage maps of all data takes
- Ordering products at DFD
- DLR documents concerning products
- Sample Products in CEOS Format

Our Motivation

DARA and DLR are promoting the application of X-SAR data. In this User Kit you will find all necessary information about the project, the acquired data, documents and order forms. Furthermore, you will find a representative selection of images which you are invited to browse through.

However the space on this User Kit is limited and the number of processed images is daily growing. The Intelligent Satellite Information System (ISIS) allows you to access the complete, up-to-date DFD data catalog using advanced query methods.

Additional information:

- X-SAR Related Notes, Documents and Publications
- List of Contact Addresses
- ISIS, the Intelligent Satellite Information System
- The Most Important World Wide Web Locations for the SIR-C/X-SAR Missions

The Data Takes

The SIR-C / X-SAR data have been acquired in units of so called 'data takes' which are named by the major **test site** like 'Oberpfaffenhofen'. The data takes may be thousands of kilometers long and therefore span whole continents. On the other hand the X-SAR swath is quite narrow, typically 30km. The test sites have been acquired several times on ascending or descending orbits and with different radar parameters like resolution modes and incidence angles.

The instrument was switched on well before the test site at the so called **'DT start time'**. It hit the test site at the so called **'closest approach time'** and was switched off at the **'DT stop time'**.

On this User Kit we provide you with the complete X-SAR data take coverage plots showing you which areas have been acquired. They are sorted by coordinates and the by two missions. The latter two are furthermore sorted by the name of the data take, the Site ID and by acquisition time.

The Site ID
All SIR-C / X-SAR test sites have been assigned a three-character Site ID. The first character of the Site ID indicates the primary discipline of the investigations:

C = Calibration
E = Ecology
G = Geology
H = Hydrology
M = Electromagnetic Theory
N = Oceanography
T = Targets of Opportunity

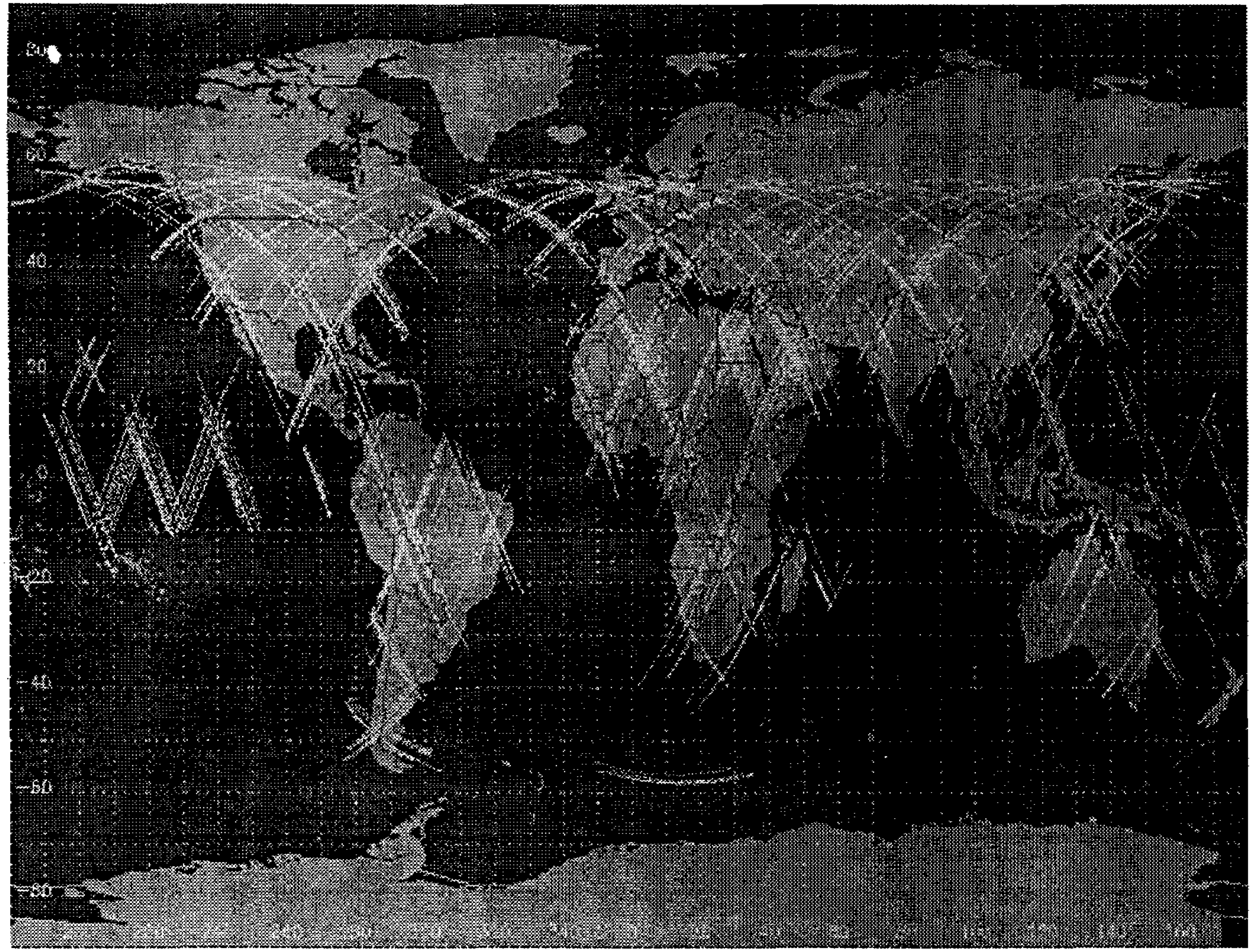
The second character of the Site ID is used to designate if the site is a Supersite (S), Backup Supersite (B) or Non-Supersite (any other character). The third character of the Site ID is used to distinguish between different site coverages (e.g. ascending or descending orbits).

A good overview about the test sites and the science investigations can be found in the JPL Publication 93-29, Dec. 15, 1993, "SIR-C / X-SAR Mission Overview".

X-SAR Datatakes, Sorted by Geographical Coordinates

All data of both X-SAR missions is accessible via geographical coordinates. Quicklooks and unprocessed data are presorted in tiles of 10 x 10 degrees.

If your browser supports client-side image maps (Netscape 2.0 and Explorer do) you may click directly on a tile in the world map. If your browser does not yet support client-side image maps you have to select your tile from a sorted list.



X-SAR Datatakes and Quicklooks, Sorted by Geographical Coordinates

Longitude : 030 ... 40 deg / Latitude : 030 ... 40 deg

Back to world map I Printable version of this page

Datatakes:

Found 27 matching data takes:

- X1 012.01 MS1 Safsaf, Egypt/Sudan
- X1 028.01 G20 Ha Meshar, Israel (2) 1
- X1 044.12 G20 Ha Meshar, Israel (2) 3
- X1 076.01 GS8 Bir Misaha, Sahara Sudan
- X1 097.06 GBZ Saudi Arabia C (2) 0
- X1 113.07 GBZ Saudi Arabia C (2) 0
- X1 129.06 GBU Saudi Arabia C (1) 0
- X1 140.01 GS7 Siwa/Largeau, Sahara Chad
- X1 145.05 GB2 Saudi Arabia C (2) 1
- X2 012.10 MS1 Safsaf, Egypt/Sudan
- X2 028.10 G20 Ha Meshar, Israel (2)
- X2 044.12 G20 Ha Meshar, Israel (2)
- X2 065.50 T09 Palmyra, Syria
- X2 076.10 GS8 Bir Misaha, Sahara Sudan
- X2 081.60 T09 Palmyra, Syria
- X2 097.60 GBZ Saudi Arabia C (2) 0
- X2 108.10 EXE Sahel Day 05 & 06
- X2 113.70 GBZ Saudi Arabia C (2) 0
- X2 124.20 GS7 Siwa/Largeau, Sahara Chad
- X2 129.30 CS1 Flevoland, Netherlands
- X2 129.40 GBU Saudi Arabia C (1) 0
- X2 140.20 GS7 Siwa/Largeau, Sahara Chad
- X2 145.30 CS1 Flevoland, Netherlands
- X2 145.40 GBU Saudi Arabia C (1) 0

- X2 156.20 GS7 Siwa/Largeau, Sahara Chad
- X2 161.30 CS1 Flevoland, Netherlands
- X2 161.40 GBU Saudi Arabia C (1) 0

Quicklooks:

Found 185 quicklooks

- Quicklook : X1 DT 012.01 MGD 10-APR-1994/03:28:21 North Akaba / Jordan / Israel
- Quicklook : X1 DT 012.01 SSC 10-APR-1994/03:28:21 Timna / Israel
- Quicklook : X1 DT 012.01 HRM 10-APR-1994/03:28:23 Timna / Israel
- Quicklook : X1 DT 012.01 MGD 10-APR-1994/03:28:27 North Akaba /Jordan / Israel
- Quicklook : X1 DT 028.01 MGD 11-APR-1994/03:09:47 'Ain Yarqa / Egypt
- Quicklook : X1 DT 028.01 MGD 11-APR-1994/03:09:59 El 'Agrud / Egypt
- Quicklook : X1 DT 028.01 SSC 11-APR-1994/03:10:08 Bikat Mahmal / Israel
- Quicklook : X1 DT 028.01 SSC 11-APR-1994/03:10:12 Ha Meshar / Israel
- Quicklook : X1 DT 028.01 MGD 11-APR-1994/03:10:15 Dimona / Israel
- Quicklook : X1 DT 028.01 MGD 11-APR-1994/03:10:27 Mezada / Israel
- Quicklook : X1 DT 028.01 MGD 11-APR-1994/03:10:39 Er Ruseifa / Jordan
- Quicklook : X1 DT 028.01 MGD 11-APR-1994/03:10:51 As Suwayda' / Syria
- Quicklook : X1 DT 028.01 MGD 11-APR-1994/03:11:03 Syria
- Quicklook : X1 DT 028.01 MGD 11-APR-1994/03:11:15 Sab'Abar / Syria
- Quicklook : X1 DT 028.01 MGD 11-APR-1994/03:11:27 Al Arak / Syria
- Quicklook : X1 DT 028.01 MGD 11-APR-1994/03:11:39 As Sukhnah / Syria
- Quicklook : X1 DT 028.01 MGD 11-APR-1994/03:11:49 At Tibni / Syria
- Quicklook : X1 DT 044.12 HRM 12-APR-1994/02:51:30 Sinai Peninsula / Egypt
- Quicklook : X1 DT 044.12 HRM 12-APR-1994/02:51:36 Gebel el Misheiti / Egypt
- Quicklook : X1 DT 044.12 MGD 12-APR-1994/02:51:38 Pharan / Israel
- Quicklook : X1 DT 044.12 HRM 12-APR-1994/02:51:41 Har Karkom / Israel
- Quicklook : X1 DT 044.12 HRM 12-APR-1994/02:51:47 Be'er 'Ada / Israel
- Quicklook : X1 DT 044.12 MGD 12-APR-1994/02:51:48 Ha Meshar I / Israel
- Quicklook : X1 DT 044.12 HRM 12-APR-1994/02:51:52 Nijil / Jordan
- Quicklook : X1 DT 044.12 HRM 12-APR-1994/02:51:57 'En Tamar / Israel

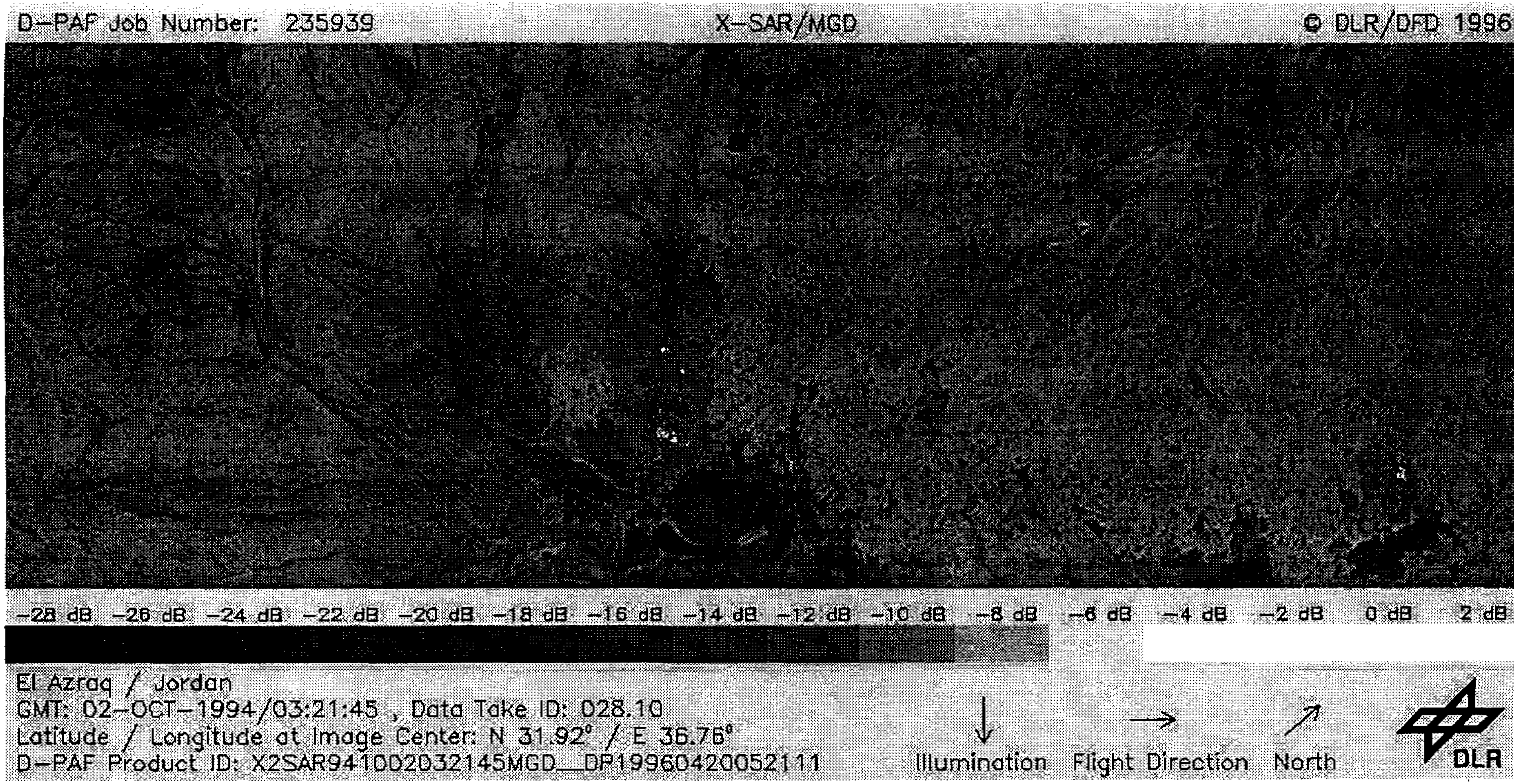
- Quicklook : X1 DT 044.12 MGD 12-APR-1994/02:51:59 Ha Meshar II / Israel
- Quicklook : X1 DT 044.12 MGD 12-APR-1994/02:51:59 Ha Meshar II / Israel
- Quicklook : X1 DT 044.12 HRM 12-APR-1994/02:52:04 Samara / Jordan
- Quicklook : X1 DT 044.12 HRM 12-APR-1994/02:52:09 Museitiba / Jordan
- Quicklook : X1 DT 044.12 HRM 12-APR-1994/02:52:16 Qasr Mushash / Jordan
- Quicklook : X1 DT 044.12 HRM 12-APR-1994/02:52:21 Syrian Desert / Jordan
- Quicklook : X1 DT 044.12 HRM 12-APR-1994/02:52:27 Tell Refa'i / Jordan
- Quicklook : X1 DT 044.12 HRM 12-APR-1994/02:52:34 Syrian Desert / Syria
- Quicklook : X1 DT 044.12 HRM 12-APR-1994/02:52:39 Syrian Desert / Syria
- Quicklook : X1 DT 044.12 HRM 12-APR-1994/02:52:45 Syrian Desert / Syria
- Quicklook : X1 DT 044.12 HRM 12-APR-1994/02:52:51 Rummana / Syria
- Quicklook : X1 DT 044.12 HRM 12-APR-1994/02:52:57 Syria
- Quicklook : X1 DT 044.12 HRM 12-APR-1994/02:53:03 Syria
- Quicklook : X1 DT 044.12 HRM 12-APR-1994/02:53:09 Bi'r Hajal / Syria
- Quicklook : X1 DT 044.12 HRM 12-APR-1994/02:53:15 Bi'r Najib / Syria
- Quicklook : X1 DT 044.12 HRM 12-APR-1994/02:53:21 Bi'ar Ghabaqhib / Syria
- Quicklook : X1 DT 044.12 HRM 12-APR-1994/02:53:27 Syria
- Quicklook : X1 DT 044.12 HRM 12-APR-1994/02:53:33 Syria
- Quicklook : X1 DT 044.12 HRM 12-APR-1994/02:53:36 Jabal Ma'zah / Syria
- Quicklook : X1 DT 076.01 MGD 14-APR-1994/02:12:46 Bir Abu Darag / Egypt
- Quicklook : X1 DT 076.01 MGD 14-APR-1994/02:12:58 Bir el Tawil / Egypt
- Quicklook : X1 DT 076.01 MGD 14-APR-1994/02:13:10 Bir Rod Salim / Egypt
- Quicklook : X1 DT 076.01 MGD 14-APR-1994/02:13:22 Rafah Sta / Egypt
- Quicklook : X1 DT 076.01 MGD 14-APR-1994/02:13:26 Karmiyya / Israel
- Quicklook : X1 DT 097.06 MGD 15-APR-1994/09:40:19 South Aleppo / Syria
- Quicklook : X1 DT 097.06 MGD 15-APR-1994/09:41:05 Al Umchaimin / Iraq
- Quicklook : X1 DT 113.07 MGD 16-APR-1994/09:19:38 South Aleppo / Syria
- Quicklook : X1 DT 113.07 MGD 16-APR-1994/09:19:38 Ar Ruwaydah / Syria
- Quicklook : X1 DT 113.07 MGD 16-APR-1994/09:19:40 'Uqayribat / Syria
- Quicklook : X1 DT 113.07 MGD 16-APR-1994/09:19:52 Tiyas / Syria
- Quicklook : X1 DT 113.07 MGD 16-APR-1994/09:20:04 Bi'r al Halba / Syria
- Quicklook : X1 DT 113.07 MGD 16-APR-1994/09:20:16 Syria
- Quicklook : X1 DT 113.07 MGD 16-APR-1994/09:20:27 Al-Anbar / Iraq

- Quicklook : X1 DT 113.07 MGD 16-APR-1994/09:20:40 Maqar an Na'am/Iraq/Saudi Arabia
- Quicklook : X1 DT 145.05 MGD 18-APR-1994/08:37:10 Libanon
- Quicklook : X1 DT 145.05 MGD 18-APR-1994/08:37:10 Jbail / Lebanon
- Quicklook : X1 DT 145.05 MGD 18-APR-1994/08:37:12 Harfel el Mreffi / Lebanon
- Quicklook : X1 DT 145.05 MGD 18-APR-1994/08:37:18 Damaskus / Syria
- Quicklook : X1 DT 145.05 MGD 18-APR-1994/08:37:24 Tall at Asfar / Syria
- Quicklook : X1 DT 145.05 MGD 18-APR-1994/08:37:36 Syrian Desert / Syria
- Quicklook : X1 DT 145.05 MGD 18-APR-1994/08:37:48 Zatab ash Shamah / Saudi Arabia
- Quicklook : X1 DT 145.05 MGD 18-APR-1994/08:37:59 'Aqran / Saudi Arabia
- Quicklook : X1 DT 145.05 MGD 18-APR-1994/08:38:12 Ar Raha / Saudi Arabia
- Quicklook : X1 DT 145.05 MGD 18-APR-1994/08:38:24 Ath Thayat / Saudi Arabia
- Quicklook : X1 DT 145.05 MGD 18-APR-1994/08:38:25 Harrat / Saudi Arabia
- Quicklook : X1 DT 145.05 MGD 18-APR-1994/08:38:36 Al Jawf / Saudi Arabia
- Quicklook : X2 DT 012.10 HRM 01-OCT-1994/03:39:39 An-Nafud / Saudi Arabia
- Quicklook : X2 DT 012.10 HRM 01-OCT-1994/03:39:45 Jordan
- Quicklook : X2 DT 012.10 HRM 01-OCT-1994/03:39:51 Jordan
- Quicklook : X2 DT 012.10 HRM 01-OCT-1994/03:39:58 Al'Isawiyah / Saudi Arabia
- Quicklook : X2 DT 012.10 HRM 01-OCT-1994/03:40:03 An-Nafud / Saudi Arabia
- Quicklook : X2 DT 012.10 HRM 01-OCT-1994/03:40:10 An-Nafud / Saudi Arabia
- Quicklook : X2 DT 012.10 HRM 01-OCT-1994/03:40:15 An-Nafud / Saudi Arabia
- Quicklook : X2 DT 012.10 HRM 01-OCT-1994/03:40:22 Umm Wa'al / Saudi Arabia
- Quicklook : X2 DT 012.10 HRM 01-OCT-1994/03:40:27 An-Nafud / Saudi Arabia
- Quicklook : X2 DT 012.10 HRM 01-OCT-1994/03:40:33 Syrian Desert, Al-Anbar / Iraq
- Quicklook : X2 DT 012.10 HRM 01-OCT-1994/03:40:39 Al-Anbar / Iraq
- Quicklook : X2 DT 012.10 HRM 01-OCT-1994/03:40:45 Ubaila / Iraq
- Quicklook : X2 DT 012.10 HRM 01-OCT-1994/03:40:51 Al-Anbar / Iraq
- Quicklook : X2 DT 028.10 MGD 02-OCT-1994/03:20:53 Gebel Umm Mafrud / Egypt
- Quicklook : X2 DT 028.10 MGD 02-OCT-1994/03:21:02 Har Gerofit / Israel
- Quicklook : X2 DT 028.10 MGD 02-OCT-1994/03:21:05 Gebel Suweiqa / Egypt
- Quicklook : X2 DT 028.10 MGD 02-OCT-1994/03:21:13 Jebel Mas'uda / Jordan
- Quicklook : X2 DT 028.10 MGD 02-OCT-1994/03:21:21 Jebel el Ata'ita / Jordan
- Quicklook : X2 DT 028.10 MGD 02-OCT-1994/03:21:33 Jeb.er Ruweifa / Jordan
- Quicklook : X2 DT 028.10 MGD 02-OCT-1994/03:21:45 El Azraq / Jordan

- Quicklook : X2 DT 028.10 MGD 02-OCT-1994/03:21:57 Tal Misma / Jordan
- Quicklook : X2 DT 028.10 MGD 02-OCT-1994/03:22:09 Bazounya / Lebanon
- Quicklook : X2 DT 028.10 MGD 02-OCT-1994/03:22:21 Badiyat / Syria
- Quicklook : X2 DT 028.10 MGD 02-OCT-1994/03:22:33 Bi'r al Marba'ah / Syria
- Quicklook : X2 DT 028.10 MGD 02-OCT-1994/03:22:45 Bi'r Muwaylih / Syria
- Quicklook : X2 DT 044.12 MGD 03-OCT-1994/03:02:16 Gebel el Gharra / Egypt
- Quicklook : X2 DT 044.12 MGD 03-OCT-1994/03:02:28 Gebel el Saisib / Egypt
- Quicklook : X2 DT 044.12 MGD 03-OCT-1994/03:02:33 Holot Agur / Egypt, Israel
- Quicklook : X2 DT 044.12 MGD 03-OCT-1994/03:02:36 Nizzana / Israel
- Quicklook : X2 DT 044.12 MGD 03-OCT-1994/03:02:42 Mashabbe Sade / Israel
- Quicklook : X2 DT 044.12 MGD 03-OCT-1994/03:02:43 Tel Yeshua / Israel
- Quicklook : X2 DT 044.12 MGD 03-OCT-1994/03:02:47 Be'er Shera / Israel
- Quicklook : X2 DT 044.12 SSC 03-OCT-1994/03:02:47 Be'er Shera / Israel
- Quicklook : X2 DT 044.12 MGD 03-OCT-1994/03:02:52 Dead Sea / Israel
- Quicklook : X2 DT 044.12 MGD 03-OCT-1994/03:02:55 Jericho / Jordan
- Quicklook : X2 DT 044.12 MGD 03-OCT-1994/03:03:07 Burma / Jordan
- Quicklook : X2 DT 044.12 MGD 03-OCT-1994/03:03:19 Shahba' / Syria
- Quicklook : X2 DT 044.12 MGD 03-OCT-1994/03:03:28 Golan streaks / Syria
- Quicklook : X2 DT 044.12 MGD 03-OCT-1994/03:03:31 Syria
- Quicklook : X2 DT 044.12 MGD 03-OCT-1994/03:03:43 Sab'Abar / Syria
- Quicklook : X2 DT 044.12 MGD 03-OCT-1994/03:03:55 Tadmur / Syria
- Quicklook : X2 DT 044.12 MGD 03-OCT-1994/03:04:07 Tall Thulaythawat / Syria
- Quicklook : X2 DT 044.12 MGD 03-OCT-1994/03:04:19 Ma'din Jadid / Syria
- Quicklook : X2 DT 044.12 MGD 03-OCT-1994/03:04:21 'Ayn al Bayda' / Syria
- Quicklook : X2 DT 065.50 MGD 04-OCT-1994/10:29:41 Karaca Dag / Turkey
- Quicklook : X2 DT 065.50 MGD 04-OCT-1994/10:29:53 HanobasI / Turkey
- Quicklook : X2 DT 065.50 MGD 04-OCT-1994/10:30:05 Aksaray, Nigde / Turkey
- Quicklook : X2 DT 065.50 MGD 04-OCT-1994/10:30:17 KamIslI / Turkey
- Quicklook : X2 DT 065.50 MGD 04-OCT-1994/10:30:29 Ceyhan / Turkey
- Quicklook : X2 DT 065.50 MGD 04-OCT-1994/10:30:41 Iskenderun / Turkey
- Quicklook : X2 DT 065.50 MGD 04-OCT-1994/10:30:53 Ma'arrat al Ikhwan / Syria
- Quicklook : X2 DT 065.50 MGD 04-OCT-1994/10:31:04 Al Andarin / Syria
- Quicklook : X2 DT 065.50 MGD 04-OCT-1994/10:31:17 Tadmur / Syria

- Quicklook : X2 DT 065.50 MGD 04-OCT-1994/10:31:25 Syria
- Quicklook : X2 DT 065.50 MGD 04-OCT-1994/10:31:32 Syria
- Quicklook : X2 DT 065.50 MGD 04-OCT-1994/10:31:44 Ghadir al Mulusi / Iraq
- Quicklook : X2 DT 065.50 MGD 04-OCT-1994/10:31:56 Al-Anbar / Iraq
- Quicklook : X2 DT 065.50 MGD 04-OCT-1994/10:32:08 Chayia / Iraq
- Quicklook : X2 DT 076.10 MGD 05-OCT-1994/02:23:39 Ghurd al Qattantyah / Egypt
- Quicklook : X2 DT 076.10 HRM 05-OCT-1994/02:23:50 Ashmun / Egypt
- Quicklook : X2 DT 076.10 MGD 05-OCT-1994/02:23:52 Shibin al Kawn / Egypt
- Quicklook : X2 DT 076.10 HRM 05-OCT-1994/02:24:00 Aja / Egypt
- Quicklook : X2 DT 076.10 MGD 05-OCT-1994/02:24:05 Dumyat / Egypt
- Quicklook : X2 DT 076.10 HRM 05-OCT-1994/02:24:09 Dumyat / Egypt
- Quicklook : X2 DT 076.10 HRM 05-OCT-1994/02:24:10 Dumyat / Egypt
- Quicklook : X2 DT 081.60 MGD 05-OCT-1994/10:10:09 Temelli / Turkey
- Quicklook : X2 DT 081.60 MGD 05-OCT-1994/10:10:11 Ikizce / Turkey
- Quicklook : X2 DT 081.60 MGD 05-OCT-1994/10:10:23 Sereflikochisar / Turkey
- Quicklook : X2 DT 081.60 MGD 05-OCT-1994/10:10:35 Ciftlik / Turkey
- Quicklook : X2 DT 081.60 MGD 05-OCT-1994/10:10:47 KamIslI / Turkey
- Quicklook : X2 DT 081.60 MGD 05-OCT-1994/10:10:59 Ceyhan / Turkey
- Quicklook : X2 DT 081.60 MGD 05-OCT-1994/10:11:10 Iskenderun / Turkey
- Quicklook : X2 DT 081.60 MGD 05-OCT-1994/10:11:23 Ma'arrat al Ikhwan / Syria
- Quicklook : X2 DT 081.60 MGD 05-OCT-1994/10:11:29 South Aleppo / Syria
- Quicklook : X2 DT 081.60 MGD 05-OCT-1994/10:11:34 Al Andarin / Syria
- Quicklook : X2 DT 081.60 MGD 05-OCT-1994/10:11:47 Tadmur / Syria
- Quicklook : X2 DT 081.60 MGD 05-OCT-1994/10:11:55 Syria
- Quicklook : X2 DT 081.60 MGD 05-OCT-1994/10:12:03 Syria
- Quicklook : X2 DT 081.60 MGD 05-OCT-1994/10:12:14 Ghadir al Mulusi / Iraq
- Quicklook : X2 DT 081.60 MGD 05-OCT-1994/10:12:27 Al-Anbar / Iraq
- Quicklook : X2 DT 081.60 MGD 05-OCT-1994/10:12:39 Chayia / Iraq
- Quicklook : X2 DT 097.60 HRM 06-OCT-1994/09:51:46 Tripoli / Libanon
- Quicklook : X2 DT 097.60 HRM 06-OCT-1994/09:51:46 Trablous / Lebanon
- Quicklook : X2 DT 097.60 HRM 06-OCT-1994/09:51:48 Libanon
- Quicklook : X2 DT 097.60 HRM 06-OCT-1994/09:51:50 Libanon
- Quicklook : X2 DT 097.60 HRM 06-OCT-1994/09:51:54 Tal'at Musa / Lebanon

- Quicklook : X2 DT 097.60 HRM 06-OCT-1994/09:51:56 Libanon
- Quicklook : X2 DT 097.60 HRM 06-OCT-1994/09:52:00 Jabal Ma Ma'lula / Syria
- Quicklook : X2 DT 097.60 HRM 06-OCT-1994/09:52:06 Syria
- Quicklook : X2 DT 097.60 HRM 06-OCT-1994/09:52:12 Syria
- Quicklook : X2 DT 097.60 HRM 06-OCT-1994/09:52:18 Tal Misma / Jordan
- Quicklook : X2 DT 097.60 HRM 06-OCT-1994/09:52:24 Qasr el Burqu / Jordan
- Quicklook : X2 DT 097.60 HRM 06-OCT-1994/09:52:30 Border / Syria / Jordan
- Quicklook : X2 DT 097.60 HRM 06-OCT-1994/09:52:36 Border / Jordan / Saudi Arabia
- Quicklook : X2 DT 097.60 HRM 06-OCT-1994/09:52:42 Qutayfat Tutayf / Saudi Arabia
- Quicklook : X2 DT 097.60 HRM 06-OCT-1994/09:52:48 Al-Harrah / Saudi Arabia
- Quicklook : X2 DT 097.60 HRM 06-OCT-1994/09:52:54 Jabal al 'Amud / Saudi Arabia
- Quicklook : X2 DT 097.60 HRM 06-OCT-1994/09:53:00 Al-Harrah / Saudi Arabia
- Quicklook : X2 DT 097.60 HRM 06-OCT-1994/09:53:06 An-Nafud / Saudi Arabia
- Quicklook : X2 DT 097.60 HRM 06-OCT-1994/09:53:12 Suwayr / Saudi Arabia
- Quicklook : X2 DT 097.60 HRM 06-OCT-1994/09:53:18 Mubarraz / Saudi Arabia
- Quicklook : X2 DT 108.10 HRM 07-OCT-1994/01:44:04 Alexandria / Egypt
- Quicklook : X2 DT 129.30 MGD 08-OCT-1994/09:07:23 Geyve / Turkey
- Quicklook : X2 DT 129.30 MGD 08-OCT-1994/09:07:35 Beydili / Turkey
- Quicklook : X2 DT 129.30 MGD 08-OCT-1994/09:07:47 Guenyuezue / Turkey
- Quicklook : X2 DT 129.30 MGD 08-OCT-1994/09:07:49 Goek Dag / Turkey
- Quicklook : X2 DT 145.30 MGD 09-OCT-1994/08:44:29 Geyve / Turkey
- Quicklook : X2 DT 145.30 MGD 09-OCT-1994/08:44:41 Beydili / Turkey
- Quicklook : X2 DT 145.30 MGD 09-OCT-1994/08:44:53 Guenyuezue / Turkey
- Quicklook : X2 DT 145.30 MGD 09-OCT-1994/08:44:55 Goek Dag / Turkey
- Quicklook : X2 DT 161.30 MGD 10-OCT-1994/08:21:36 TaraklI / Turkey
- Quicklook : X2 DT 161.30 MGD 10-OCT-1994/08:21:48 Sivrihisar / Turkey
- Quicklook : X2 DT 161.30 MGD 10-OCT-1994/08:22:00 Guenyuezue / Turkey
- Quicklook : X2 DT 161.30 MGD 10-OCT-1994/08:22:02 Suelueklue / Turkey


D-PAF Job Number: 235939
X-SAR/MGD
© DLR/DFD 1996
-28 dB -26 dB -24 dB -22 dB -20 dB -18 dB -16 dB -14 dB -12 dB -10 dB -8 dB -6 dB -4 dB -2 dB 0 dB 2 dB
El Azraq / Jordan
GMT: 02-OCT-1994/03:21:45 , Data Take ID: 028.10
Latitude / Longitude at Image Center: N 31.92° / E 36.76°
D-PAF Product ID: X2SAR941002032145MGD__DP19960420052111
Illumination
Flight Direction
North
DLR

Annex 1-1 Information Catalog: **DLR**

DLR - Forschungszentrum Braunschweig

Deutsche Forschungsanstalt für Luft- und Raumfahrt e.V. DLR Forschungszentrum Braunschweig. Zentrumsleiter: Dr. Heinrich Dissen E-Mail:... *http://www.bs.dlr.de/* - *size 2K - 3.Apr.97 - German*

DLR - Forschungsanstalt fuer Luft- und Raumfahrt e.V

DLR Homepage in English. Willkommen in der DLR. Luftfahrt. Energietechnik. Raumfahrt. Technologietransfer. DLR Schwarzes Brett. DLR Organisation. DLR. *http://www.dlr.de/* - *size 2K - 12.May.97 - German*

DLR WT-DV-IG Göttingen WWW Entry Point

Welcome to the DLR WT-DV-IG Göttingen WorldWideWeb Server. This experimental service of the DLR (German Aerospace Research Establishment) department.. *http://www.rz.go.dlr.de:8081/* - size 3K - 21.May.97 - English

DLR

http://rses.anu.edu.au/-iean/HTML Presentation/DLR/DLR.html - *size 350 bytes - 12.Nov.96*

Annex 2

EOSAT - Space Imaging
Summary of Current Satellite Constellations
Mapping Alliance Program (MAP)

How to Reach Us

9351 Grant Street
Suite 500
Thornton, Colorado 80229
Phone: +1 303-254-2000
Toll Free (U.S.): +1 800-425-2997
Fax: +1 303-254-2215
Email: info@spaceimage.com

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CENTRAL U.S.	EASTERN U.S.	WESTERN U.S.
Mindy Brown, Central Regional Sales Manager 9351 Grant Street Suite 500 Thornton, Colorado 80229 Phone: (303) 254-2063 Fax: (303) 254-2215 Email: mbrown@spaceimage.com **Tony Palizzi, Manager, Strategic Programs** 9351 Grant Street Suite 500 Thornton, Colorado 80229 Phone: (303) 254-2120 Fax: (303) 254-2215 Email: tpalizzi@spaceimage.com	**Ralph Mason, Director of Federal Programs** 4300 Forbes Boulevard Lanham, Maryland 20707 Phone: (301) 552-0558 Fax: (301) 552-5476 Email: rmason@spaceimage.com **Andrew Fisher, Manager, Eastern Region** 5850 T.G. Lee Boulevard Suite 650 Orlando, FL 32822 Phone (407) 856-7828 Fax (407) 856-9550 E-Mail: afisher@spaceimage.com **Tony Shupin, Director, International Sales** 33 Wood Avenue, South Suite 600 Iselin, NJ 08830 Phone (908) 603-9595 Fax (908) 603-8310 E-Mail: tshupin@spaceimage.com	**Eric Waldman, Western Regional Sales Manager** 50 California Street, Suite 1500 San Francisco, CA 94111 Phone: (415) 439-5345 Fax: (415) 439-5375 Email: ewaldman@spaceimage.com **Konrad Fry, Manager, Canada & Latin America** 1 Park Plaza, Suite 600 Jamboree Center Irvine, CA 92714 Phone: (714) 852-7370 Fax (714) 852-7371 E-Mail: kfry@spaceimage.com **Susan Sinclair, Director, Distributor Network** 1 Park Plaza, 6th Floor Jamboree Center Irvine, CA 92714 Phone: (714) 852-7373 Fax: (714) 852-7376 Email: ssinclair@spaceimage.com

Client Services

Dale Richards, Director, Client Services

4300 Forbes Blvd.
Lanham, MD 20706
Phone: (301) 552-0556
Fax: (301) 552-3762
Email: drichards@spaceimage.com

Vivian Stiggers, Customer Services Manager
4300 Forbes Blvd.
Lanham, MD 20706
Phone: (301) 552-0551
Fax: (301) 552-3762
Email: vstiggers@spaceimage.com

International Business Development

UNITED STATES	SOUTH ASIA
Timothy Puckorius, Senior Director, International Business Development 4300 Forbes Boulevard Lanham, Maryland 20707 Phone: (301) 552-0548 Fax: (303) 552-5476 En ail: tpuckorius@spaceimage.com	**Robert Noack, Regional Director, South Asia** 501 Orchard Road #21-00 Lane Wheelock Place Singapore 238880 Phone: (65) 738-7533 Fax: (65) 738-8861 Email: bnoack@spaceimage.com
JAPAN AND RUSSIA	MIDDLE EAST
Robert Clemons, Regional Director, Japan and Russia Kowa 35 Bldg. 1-14-14, Akasaka, Minato-Ku Tokyo 107 JAPAN Phone: 81-3-3588-6185 Fax: 81-3-3588-6186 Email: rclemons@spaceimage.com	**Adrian Zevenbergen, Regional Director, Middle East** Rostocklaan 10 1401 AG Bussum The Netherlands Phone: (31) 35-694-4467 Fax: (31) 35-694-9077 Email: awzeosat@pi.net
EUROPE AND TURKEY	SOUTH AMERICA
Mike Wasielewski, Regional Director, Europe Place de Longemalle 1 1204 Geneva, Switzerland Phone: (41-22) 310-43-24 Fax: (41-22) 311-45-24 Email: mwasielewski@spaceimage.com	**Fausto Calabria, Regional Director, South America** 4300 Forbes Boulevard Lanham, Maryland 20706 Phone: (301) 552-0553 Fax: (301) 552-3028 Email: fcalabria@spaceimage.com

Product & Application Information

CARTERRA(TM) Product and Application Development

Space Imaging EOSAT's Product Research & Applications group works closely with customers to develop products and applications according to market specifications. For information about products and applications in the following markets, please contact the noted business administrator.

Cathe Gehret (303) 254-2124 cgehret@spaceimage.com	Jeff Miller (303) 254-2123 jmiller@spaceimage.com	Monica Moroney (303) 254-2122 mmoroney@spaceimage.com
Agriculture Utilities Federal/Mapping Environment Transportation	Civil Government Exploration Exploitation Media	Real Estate Insurance Telecommunications Consumer Markets

Media Relations

Brian Webster, Director, Marketing Communications
Phone: (303) 254-2104
Email: bwebster@spaceimage.com

Linda Turner, Communications and Internet Coordinator
Phone: (303) 254-2106
Email: lturner@spaceimage.com

Fax: (303) 254-2215

SPACE IMAGING EOSAT™

Summary of Current Satellite Constellations

CURRENT GROUND STATION LOCATIONS

- Norman, Oklahoma, USA
- Shadnagar, India
- Neustrelitz, Germany
- Chung-Li, Taiwan

DATA DISTRIBUTION CENTER

EOSAT
4300 Forbes Boulevard, Lanham, MD 20706
Tel.:(301)552-0537 or (800)344-9933;
Fax:(301)552-3762; Telex 277685 LSAT UR
(EOSAT is the exclusive IRS data distributor outside of India)

SPECIFICATIONS ON IRS AND LANDSAT SENSORS

The India satellites acquire data with the Linear Imaging Self Scanning sensor (LISS) at spatial resolution of 72.5 m (comparable to MSS's 80 m) and 36.25 m (comparable to TM's 30 m), in four spectral bands. These bands, all of which are nearly identical to TM bands 1 through 4, are excellent for vegetation discrimination and land cover mapping.

IRS-1C carrys three sensors: the LISS-III, with 23 m spatial resolution; a panchromatic sensor, with 5.8 m spatial resolution and stereo capability; and a Wide Field Sensor (WiFS), with 188 m spatial resolution. The repeat coverage is 24 days. The WiFS has 5-day repeat coverage, 774 km swath, and two bands comparable to NOAA's AVHRR satellite (0.62-0.68 [red] and 0.77-0.86 [near infrared]). The chart below details the similarities between Landsat and IRS data:

Landsat

```
L5 Thematic Mapper Sensor
Blue              0.45-0.52 µm
Green             0.52-0.60 µm
Red               0.63-0.69 µm
Near Infrared     0.76-0.90 µm
SWIR              1.55-1.75 µm
SWIR              2.08-2.35 µm
Thermal           10.4-12.4 µm

30 m spatial resolution
Repeat coverage: 16 days at equator
185 km swath
```

- Landsat 5 was launched in 1984
- Worldwide coverage

IRS-1A & B

```
LISS-I and LISS-II
Blue              0.45-0.52 µm
Green             0.52-0.59 µm
Red               0.62-0.68 µm
Near Infrared     0.77-0.86 µm

72.5 m spatial resolution (LISS-I)
36.25 m spatial resolution (LISS-II)
148 km swath (LISS-I)
146 km swath (LISS-II A and LISS-II B)
Repeat coverage: 22 days at equator
```

- IRS-1A was launched in 1988
- IRS-1B was launched in 1991

- Coverage from Shadnagar, India and Norman, Oklahoma

IRS-1C 1995

Panchromatic
Pan 0.5-0.75 µm

5.8 m spatial resolution
70 km swath
Stereo
Repeat coverage: 24 days at equator
Revisit: 5 days with ± 26° off-nadir viewing

LISS-III

Blue	----
Green	0.52-0.59 µm
Red	0.62-0.68 µm
Near Infrared	0.77-0.86 µm
SW Infrared	1.55-1.70 µm

23 m spatial resolution for all bands,
except 70 m for SW Infrared
142 km swath Bands 2,3,4
148 km swath Band 5
Repeat coverage: 24 days at equator
Tape Recorder

WiFS

Red	0.62-0.68 µm
NIR	0.77-0.86 µm

188 m spatial resolution
774 km swath
Repeat coverage: 5 days at equator

SPACE IMAGING EOSAT™

MAP

The Mapping Alliance Program (MAP) is an innovative program that enables Space Imaging EOSAT to offer a broad array of high-resolution Earth information and derivative information products to customers worldwide. MAP combines the expertise and services of several leading aerial services and mapping companies in the United States with the unmatched space imagery capabilities of Space Imaging EOSAT in a first-of-its-kind alliance. MAP gives Space Imaging EOSAT and its partners the broadest array of Earth information resources available anywhere today, including aerial photography and space imagery ranging in resolution from a few centimeters to several meters, mapping services and value-added applications.

Participating firms in MAP are:

Aerial Data Reduction Associates, Inc. (Pennsauke, NJ)

AERO-METRIC, Inc. (Sheboygan, WI)

Analytical Surveys, Inc. (Colorado Springs, CO)

GEONEX Corp. (St. Petersburg, FL)

Annex 2-1 Information Catalog: **EOSAT**

LPM/EOSAT Agreement

Current Status and Summary of Agreement Between Landsat Program Management and EOSAT Corporation on Cost and Reproduction Rights for Landsat 4/5 Thematic..
http://geo.arc.nasa.gov/sge/landsat/apr11..html - size 5K - 1.May.97 - English

EOSAT IRS Prices

EOSAT IRS Price List. Last Updated - April 1996 IRS PRODUCTS. ACRES is an EOSAT Representative for sales of IRS data in Australia. To assist our...
http://www.auslig.gov.au/acres/prod ser/eoirspri.html - size 5K - 23.Oct.96 - English

Utility to write EOSAT Fast Format B tapes.

User's Guide. FSTFMTOUT. Function: Copies a LAS image to an EOSAT fast format B tape. Parameters: IN. Input image. IN may be a single or multi-band image.. *http://eoswww. essc. psu. edu/lasdoc/usr/ug/fstfmtout html - size 5K - 26.Apr.94 - English*

EOSAT JERS Prices

EOSAT JERS Price List. Last Updated - September 1996. ACRES is an EOSAT Representative for sales of (Japanese) JERS data in Australia. To assist our...
http://www.auslig.gov.au/acres/prod ser/eojerpri.html - size 6K - 23.0cL96 - English

Spatial WebBroker: Space Imaging EOSAT

Space Imaging EOSAT Interactive Global Archive. Genasys II, Inc have developed in conjunction with Space Imaging EOSAT an interactive image browse system..
http://www.genasys.com/homepage/applications/sie.html - size 5K - 22.May.97 - English

Development of the EOSAT United States Product Package

United States Department of the Interior MRLC Consortium Documentation Manual January, 1994 **GEOLOGICAL SURVEY EROS Data Center Sioux Falls, South Dakota...**
http://www.epa.gov/docs/grd/mrlc/sec3let2.html - size 2K - 24.Dec.96 - English

ACRES EOSAT JERS Distributors

ACRES Data Distributors for EOSAT JERS Data. Last Updated - May 1997. ACRES is a Representative for the Earth Observation Satellite Company (EOSAT), USA,.. *http ://www.auslig. gov.au/acres/jereodis.html - size 4K - JJ.May.97 - English*

OverVue from EOSAT

Retum to: [Home Page Image Databases 1 EOSAT Products & Info] or go to Overvue: [Product Info 1 Pricing] OverVue. Standard Product Specifications...
http://www.coresw.com/Databases/eosat/overvue/overvue info.html - size 2K -].Aug.96 - English

Prices EOSAT TM

EOSAT Landsat TM Price List. Last Updated - August 1996. ACRES and our Distributors act as agents for the sale of Landsat Thematic Mapper products from...
http://www.auslig.gov.au/acres/prod ser/eotmpric.html - *size 4K - 23.Oct.96 - English*

EOSAT Products and Services

Return to: [Home Page / Image Databases] or go to EOSAT: [Background / Products and Information] EOSAT Products Available from Core Software. The...
http://www.coresw.com/Databases/eosat/eosat products.html - *size 2K - 1.Aug.96 - English*

ACRES EOSAT Landsat Distributors

ACRES Distributors for EOSAT Landsat Data. Last Updated - May 1997. ACRES is a Representative for the Earth Observation Satellite Company (EOSAT), USA,...
http://www.auslig.gov.au/acres/leosdis.html - *size 4K - JJ.May.97 - English*

EOSAT Background

Return to: [Home Page / Image Databases] or go to EOSAT: [Background / Products and Information] Earth Observation Satellite Corporation. The Earth...
http://www.coresw.com/Dafabases/eosat/eosat_background.html - *size 3K - J.Aug.96 - English*

Earth Observation Satellite Company (EOSAT)

Earth Observation Satellite Company (EOSAT) Customer Services Department 4300 Forbes Blvd.Lanham, MD 20706 USA Phone: (301)552-0500 Fax: (301)552-3762....
http://www.techexpo.com/firms/eosat.html - *size 1018 bytes - 26Jul.96 - English*

Utilitv to read EOSAT Fast Format tapes (all versions).

User's Guide. FSTFMTIN. Function: Reads Thermatic Mapper (TM) images from EOSAT Fast Format tapes and writes them to LAS image files. All of the bands are.
http://eoswww. essc.psu. edu/lasdoc/usr/ug/fstfmtin. html - *size 12K - 26.Apr.94 - English*

ACRES EOSAT IRS Distributors

ACRES Data Distributors for EOSAT IRS Data. Last Updated - May 1997. ACRES is a Representative for the Earth Observation Satellite Company (EOSAT), USA,...
http://www.auslig.gov.au/acres/irseodis.html - *size 4K - JJ.May.97 - English*

EOSAT Releases Landsat MSS Data to Public Domain Distribution

The Earth Observer -- January/February 1993. EOSAT Releases Landsat MSS Data to Public Domain Distribution. After two years of assisting commercial...
http://spso2.gsfc.nasa.gov/eos_observ/1_2_93/p21b.html - *size 2K - 27.Apr.94 - English*

Keep in touch with Space Imaging EOSAT

nbsp; Space Imaging EOSAT wants to ensure satisfaction among our end-users, customers, associates, and industry colleagues. To help us learn more about...
http://www.spaceimage.com/home/feedback/ - *size 11K - 23.May.97 - English*

Space Imaging EOSAT Contact Info

How to Reach Us. 9351 Grant Street Suite 500 Thornton, Colorado 80229 Phone: ~1 303-254-2000 Toll

Free (U.S.): +1 800-425-2997 Fax: ~1 303-254-2215 Email:.
http://www.syaceimage. com/home/overview/contacts. html - *size 11K - 23.May.97 - English*

IRS-1 - Contact Addresses

Contact Addresses. United States. EOSAT and NRSA have signed an agreement that allows EOSAT to receive Indian data, and that makes EOSAT the exclusive...
http://www.belspo.be/telsat/irs/irsd_co.html - *size 2K - 15.Mar.96 - English*

Landsat - Scene Formats

Scene Formats. Products are available in different scene sizes, depending to a certain extent on the sensor (MSS or TM) and the source of the data (ESA or. *http://www.belspo.be/telsat/landsat/lapr_sc.html* - *size 1K - 15.Mar.96 - English*

IDI - PEDAGeOG Educational Software

LOW COST LANDSAT IMAGES from EOSAT. Remote Sensing educational products for schools and individuals."> INTERMOUNTAIN DIGITAL IMAGING, L.C. Scholar Series.. *http://www.idi-ut.com/scholar.html* - *size 5K - 21.Jan.97 - English*

Landsat Satellites: Thematic Mapper Imagery

Landsat Satellites: Thematic Mapper Imagery. Landsat TM: Before the Landsat commercialization contract was signed between the Department of Commerce and. *http://www. uni-sb.de/philfak/fb6/fr66/tpw/rem_sens/platform/landsat/landsatx. html* - *size 12K - 5.Jun.95 - English*

Research Svstems Inc. - ENVI

ENVI Related Sites. EOSAT Web Site. EOSAT is a commercial provider of Landsat and other data, remote sensing information, and various services. Site... *http://www.rsinc.com/envi/image.html* - *size 6K - 16.Dec.96 - English*

Landsat Sample Data

Return to: [Home Page 1 Image Databases 1 EOSAT Products & Info] or go to Landsat: [Tech Data 1 Samples 1 Pricing] Landsat Samples. Image of...
http://www.coresw.com/Databases/eosat/landsat/landsat samples.html - *size 1K - 1.Aug.96 - English*

No Title

LANDSAT IMAGE DATA FOR GIS SUMMARY OF LANDSAT DATA - Originally an experimental research project sponsored by the United States government. Now a... *http://corps_geol.usace.army.mil/geo/metadata/sec7input/landsat* - *size 12K - 13.Mar.95 - English*

Commercial remote sensing data vendors

Commercial remote sensing data vendors. EarthSat. Phone:1-301-231-0660 Fax: 1-301-231-5020 WWW: http://www.earthsat.com. EOSAT. Phone: 1(301)552-0500 Fax:
http://www.ermapper.com/product/datasrc.html - *size 3K - 17.Apr.97 - English*

Application Demos

Space Imaging EOSAT is the world's largest supplier of high-resolution Earth information and derivative products and services. The company's globally...

http://www.spaceimage.com/home/apps/appsdemos.html - *size 6K - 22.May.97 English*

Dragon Tape/CD Library

Dragon Tape/CD Library. Read satellite data from EOSAT and others on mag tape directly into Dragon/ips. Handles EOSAT TM 8mm Exabyte, Australian Center.
http://www.servicom.es/addlink/scishop/prodsIOOOOO637. html - *size 976 bytes - 23.Mar.95 - English*

No Title

Landsat Thematic Mapper Imagery. BRIEF. Landsat TM: Before the Landsat commercialization contract was signed between the Department of Commerce and the.. *http://www. uni-sb de/philfak/fb6/fr66/tpw/rem_ sens/platform/landsat/landsat1 .html* - *size 4K - 13.Oct.94 - English*

LANDSAT TM and MSS Characteristics

The following information is reproduced with the permission of the Australian Surveying and Land Information Group, Canberra.© COMMONWEALTH OF...
http://www.denr.sa.gov.au/rig/digimage/landdata.htmml - *size 10K - 7.May.97 - English*

Landsat TM - Background

Landsat TM - Background. Before the Landsat commercialization contract was signed between the Department of Commerce and the Earth Observation Satellite...
http://www.belspo.be/telsat/landsat/tmbg_OO1.html - *size 2K - 15.Mar.96 - English*

Landsat - Copyright

Landsat - Copyright. Confidentiality of Satellite Data. The Purechaser acknowledges that Satellite Data is a special, valuable and unique asset of EOSAT,.. *http://www.belspo.be/telsat/landsat/laco_ OO1.html* - size 2K - 15.Mar.96 - English

Landsat Image Data for GIS

Landsat Image Data for GIS. SUMMARY OF LANDSAT DATA. Originally an experimental research project sponsored by the United States government. Now a...
http://www. uni-sb.de/philfak/fb6/fr66/tpw/rem_sens/platform/landsat/landsat.. html. - *size 13K - 5.Jun.95 - English*

Landsat -References & On-line Guides

Landsat - References & On-line Guides. Books. EOSAT Catalog of Products and Services. EOSAT Purchasing Guide (Instructions and Order Forms) On-line Guides.
http://www.belspo.be/telsat/landsat/larf OO1.html - *size 988 bytes - 15.Mar.96 - English*

GeoPlace.com Dailv News - November 18. 1996

Previous Day's News. Today's News. Next Day's News. News Briefs. Space Imaging Buys EOSAT. November 18, 1996. Space Imaging, Thornton, C~o., agreed to...
http :/www. geoplace.com/news/daily/961118.html - *size 6K - 29.May.97 - English*

Satellite Imagery Available through the Internet

Satellite Imagery Available through the Internet. Advanced Earth Observing Satellite (ADEOS) ADEOS Total Ozone Mapping Spectrometer (TOMS) AVHRR data from.
http://umbc7.umbc.edu/~tbenjal/freedata.html - *size 3K - 3.jan.97 - English*

Landsat - Processing Steps

Processing Steps. MSS PROCESSING. Radiometrically corrected (spacecraft and sensor systematic parameters) MSS data were transmitted from the EOSAT data...
http://www.belspo.be/telsat/landsat/laps_OO/.html - *size 5K - J5.Mar.96 - English*

Landsat MS - Products

Landsat MS - Products. The MSS, which has been in use since 1972, has four spectral bands and a resolution of 80 m. The ESA archive contains MSS data... *http://www.belspo.be/telsat/landsat/mspr_OO/.html* - *size 2K - J5.Mar.96 - English*

GAF-NEWS

Projects, Publications, News, Press Releases. Last Update: 18.02.1996. EOSAT Press release February 1996. Germany First to Sign-IRS Ground..
http://206.104.52.]/GAF/www.gaf/news/press.html - *size 2K - 30.Aug.96 - English*

Remote Sensing, GIS. Geographic. Earth Sciences Resources

Remote Sensing, GIS, Geographic, Earth Sciences and GeoData Resources. Contents. Remote Sensing, GIS, Geographic and Earth Sciences / GeoData.Remote...
http://www. ccc. nottingham.ac.uk/~cczdao/geog.html - *size 17K - 8.Nov.96 - English*

Satellites IRS

Satellites - Indian Remote Sensing Satellite (IRS) The Indian Space Research Organisation (ISRO) has been responsible for the development and management...
http://www.auslig.gov.au/acres/prod_ser/irsdata.html - *size 7K - 23.Oct.96 - English*

Landsat - Basic products

Basic Products. Raw data. LANDSAT raw data is available, in a digital format, - for full, quarter and mini scenes for ESA data and. - for full scenes for.. *http://www.belspo.be/telsat/landsat/lapr_ba.html* - *size 1K - 15.Mar.96 - English*

TM

U.S. Geological Survey - National Mapping Information - EROS Data Center. Landsat TM Data Available From U.S. Geological Survey National Satellite Land...
http://edcwww.cr.usgs.gov/whatsnew/tm.html - *size 3K - 24.Mar.95 - English*

IDI - Indian Remote Sensing Satellites

INTERMOUNTAIN DIGITAL IMAGING, L.C. Indian Remote Sensing. The Republic of India is one of the few countries in the world that has successfully developed,.
http://www. idi-ut.com/irs.html - *size 7K - 21jan.97 - English*

Landsat - Processing Steps

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http://www.belspo.be/telsat/landsat/laps_OO/.html - *size 5K - J5.Mar.96 - English*

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http://206.104.52.]/GAF/www.gaf/news/press.html - *size 2K - 30.Aug.96 - English*

Remote Sensing, GIS, Geographic, Earth Sciences Resources

Remote Sensing, GIS, Geographic, Earth Sciences and GeoData Resources. Contents. Remote Sensing, GIS, Geographic and Earth Sciences / GeoData.Remote...
http://www.ccc.nottingham.ac.uk/~cczdao/geog.html - *size 17K - 8.Nov.96 - English*

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http://www.auslig.gov.au/acres/prod_ser/irsdata.html - *size 7K - 23.Oct.96 - English*

Landsat - Basic products

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TM

U.S. Geological Survey - National Mapping Information - EROS Data Center. Landsat TM Data Available From U.S. Geological Survey National Satellite Land...
http://edcwww.cr.usgs.gov/whatsnew/tm.html - *size 3K - 24.Mar.95 - English*

IDI - Indian Remote Sensing Satellites

INTERMOUNTAIN DIGITAL IMAGING, L.C. Indian Remote Sensing. The Republic of India is one of the few countries in the world that has successfully developed,.
http://www.idi-ut.com/irs.html - *size 7K - 21jan.97 - English*

Imported Products Service

Imported Satellite Data from Overseas Suppliers. Last Updated - July 1996. ACRES and many of our Distributors act as agents for a variety of satellite... *http://www.auslig.gov.au/acres/prod ser/imports.html* - *size 3K - 23.Oct.96 - English*

Landsat Data Access (USA)

ACCESS TO LANDSAT DATA IN THE USA AND FROM NON-US GROUND STATIONS. IN THE USA. Landsat Multispectral Scanner (MSS) and Thematic Mapper (TM) data are... *hup://geo.arc.nasa.gov/sge/landsat/daccess.html* - *size 5K-- 1.May.97 - English*

The Quick List

Landsat TM -- Collected after September 27, 1985. Status: CORE technologies provides an on-line... *http://developers.ivv.nasa.gov/rem_ sen/earth_ sci/landsat_ 2.html* - *size 2K - 23.May.97 - English*

SSC Satellitbild, LANDSAT Satellite Status

Landsat Status. The Landsat 5 satellite is healthy, still delivering data according to EOSAT, U.S.A. *http://rymd.ssc.se/ssc/sb/satstat/landsat.html* - *size 2K - &May.96 - English*

Satellite Imiage Processing Software

INTERMOUNTAIN DIGITAL IMAGING, L.C. SATELLITE IMAGE PROCESSING SOFTWARE. THIS IS YOUR SOURCE... for high quality, satellite image processing software and.. *http://www.idi-ut.com/s-soft.html* - *size 7K - 21.Jan.97 - English*

SatelliteslSensors - The best URL's

Satellites/Sensors - The best URL's. ALMAZ. GDS, index search on ALMAZ at the main menu level. DMSP. IDN, Source (Satellites, Platforms...) Descriptions... *http://www.belspo.be/telsat/annexes/anvl se.html* - *size 8K -]5.Mar.96 - English*

homepage

Digital Images. Space ImaginglEOSAT Satellite Images-- US - Landsat, TM Indian - IRS induding 5 meter IRS-IC (sample available on diskette). *http://www.atterbury.com/page7.html* - *size 6K - 21.May.97 - English*

IDI - Indian Remote Sensing Satellites

INTERMOUNTAIN DIGITAL IMAGING, L.C. Indian Remote Sensing. The Republic of India is one of the few countries in the world that has successfully developed,. *http://www. idi-ut.com/irs.html* - *size 7K - 21jan.97 - English*

NASA Landsat Pathfinder: Data Acguisition

NASA Landsat Pathfinder Data Acquisition. The project obtains digital Landsat MSS and TM data from three sources: (a) the U.S. national archives held at...

http,:/pathfinder-www.sr. unh. edu/pathfinder1 /information/overview/acquisition. html - *size 6K - 18.Jan.96 - English*

Glossary

LANDSAT (formerly ERTS) The Landsat program, first known as the Earth Resources Technology Satellite (ERTS) Program, is a development of the National...
http://edcwww.cr.usgs.gov/bin/glossearch/landsat - *size 1K - 24.May.97 - English*

Remote Sensing Links

Satellite Data. AVIRIS - Online Quicklooks. AIRSAR - Information about JPL's AIRSAR sensor. Alaska SAR Facility. Declassified Satellite Imagery. EOSAT
http://www.csr.utexas.edu/proiects/rs/links.html - *size 4K - 13.Mar.97 - English*

Annex 3 Earth Watch Incorporated

EarthWatch Incorporated (EarthWatch) offers images of the Earth's surface archived in the Digital Globe™ database, the world's first commercial, multipurpose collection of geographic data products including high-resolution satellite imagery, image maps, digital terrain models, and digital maps.

DIGITAL GLOBE
Your Planet On-Line™
Products Sign In Sign Up

Available now! Colorado Front Range high-resolution imagery. NEW

Interested in the design of the first U.S. commercial radar satellite? NEW

Launch a career in satellite imaging with EarthWatch.

Check
our job listings.

Check out our multimedia site - with animation and sound
(You'll need Shockwave and plenty of bandwidth!)

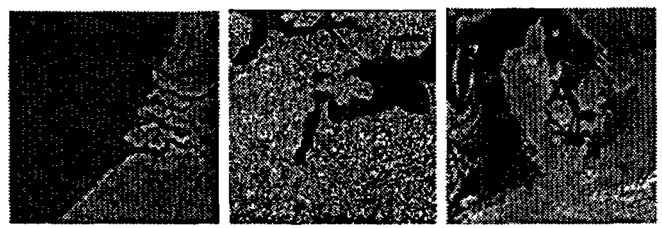
Contact EarthWatch

Please send your Web comments to webmaster@digitalglobe.com.

Annex 4 Ei Net WWW server
Quick Looks
Eurimage

The EiNet WWW server

- EiNet: a subscription service that allows users to access metadata and *Quick Look* images in the company's catalogues
- Standard World Wide Web + CGI extensions; Oracle 7 database
- 400,000 records, 265,000 Quick Looks; over 6 Gbytes



- Selection criteria: basic parameters (geographic location, acquisition period...) and mission-specific parameters
- Landsat Best Coverage tool recently added
- Planned developments: easier access to the catalogue, extended interactivity; possible use of Java technology currently under evaluation
- Network interfacing with other existing Earth Observation data sets under consideration

EiNet Service | Information | Demo | Best Of The U.S. | RESURS Browser

EiNet is an on-line subscription service that lets you access Eurimage's catalogues of Earth Observation satellite data, allowing you to browse thumbnails and metadata of the scenes covering your geographic area and time range of interest, and download Quick Looks.

It was conceived by Eurimage to be the European node of the global ImageNet service from Core Software Technology.

New prices for 1997

The Quick Looks are in JPEG format, and are accessible by any Web browser that supports inline viewing of JPEG images, such as the two shown here; click to download the latest version.

SPECIAL QUERY FEATURES

Search by city name
- **Define the geographic area by selecting a city name**

Landsat Best Coverage

- Choose the country of interest to obtain only the covering scenes

No output limit

- Results are returned in groups of 20 (previews) or 200 (text only)

What's Available

- **EiNet Service** - purchase a subscription to EiNet and gain access to our catalogue and Quick Looks browser of hundreds of thousands of scenes from LANDSAT TM, KVR-1000 and RESURS-O1 MSU-SK (see below for full details of what's available)
- **Information** - includes current prices for the EiNet service
- **EiNet Demo** - using a pre-defined area of interest and data set
- **Best Of The U.S.** - gives you access to catalogue of cloud-free, high quality Landsat TM images of the United States of America; access to the catalogue and downloading of the Quick Looks is *free of charge*
- **RESURS Browser** - gives you access to a catalogue of images from the RESURS-O1 satellite; you use simple criteria to search the catalogue and can then download the corresponding Quick Looks *free of charge*.

Current Data Sets: (details)

- Landsat TM (European Archive)
- Landsat TM (Worldwide Archive)
- KVR-1000
- RESURS-O1 MSU-SK (unlimited downloading of Quick Looks - *free of charge*).

Contact us

Ask for EiNet information and a registration form

Send your comments on EiNet

Up to Welcome Page.

How to contact Eurimage.

Last updated: 21 March 1997

How to Contact Eurimage

Sales Enquiries

Eurimage sells its products through National and Local Application Providers and Resellers, with a chain of more than 50 at present across Europe, Middle East and North Africa, with a growing presence in North America for certain missions.

Eurimage wants to make sure that you work with the Application Provider best adapted to serve your needs, and to that end you should contact the Area Business Manager who covers your country.

Match the colour code of your country with the appropriate Area Manager:

Countries				
Albania Lithuania Algeria Luxembourg Austria Malta Belgium Moldavia Bielorussia Morocco Bulgaria Netherlands Burkino Faso Norway Canada Poland Croatia Portugal	**Ms Roberta Rufo** **rufo@eurimage.it**	**+33-5 61 39 77 47**	**+33-5 61 00 64 94**	**OFF SHORE** **Centre d'Affaires** **Bat. Stratege** **Voie n. 1, B.P. 17** **F-31312** **Labege Innopole** **(Toulouse)** **FRANCE**
Czech Rep. Romania Denmark Russia Egypt Senegal Eire Serbia	**Ms Silvia Capurso** **capurso@eurimage.it**	**+39-06 40 69 42 26**	**+39-06 40 69 42 32**	**Via E d'Onofrio, 212** **Roma 00155** **Italy**
Estonia Slovak Rep. Finland Slovenia France Spain Fyrom Sweden	**Ms Donatella Giampaolo** **giampaolo@eurimage.it**	**+39-06 40 69 42 06**	**+39-06 40 69 42 32**	**Via E d'Onofrio, 212** **Roma 00155** **Italy**
Germany Switzerland Greece Syria Hungary Tunisia Iceland Turkey	**Mr Fabrizio Jemma** **jemma@eurimage.it**	**+39-06 40 69 42 12**	**+39-06 40 69 42 32**	**Via E d'Onofrio, 212** **Roma 00155** **Italy**
Israel UK Italy Ukraine Jordan USA Latvia	**Ms Luciana DiDomenico** **didomenico@eurimage.it**	**+39-06 94 18 07 51** **+39-06 40 69 42 24**	**+39-06 94 16 109** **+39-06 40 69 42 32**	**Via Galileo Galilei** **00044, Frascati (RM)** **Italy**
For countries not listed above, and for all other sales enquiries:	info@eurimage.it	+39-06-40 69 42 22	+39-06 40 69 42 32	Via E d'Onofrio, 212 Roma 00155 Italy

Other enquiries:				
ERS Help Desk Contact this office with technical enquiries about satellite data.	ers-help.desk@eurimage.it	+39-06 94 180 666	+39-06 94 180 652	Via Galileo Galilei 00044, Frascati (RM) Italy
On-Line Services Help Desk Contact this office for assistance if you have problems using the EiNet Service.	einet-help.desk@eurimage.it	+39-06-40 69 45 55	+39-06 40 69 42 32	Via E d'Onofrio, 212 Roma 00155 Italy
WWW Comments	Send an E-mail to our Webmaster if you have any comments about this WWW site.			

Up to Welcome Page.

Last updated: 03 September 1998

eiNet℠

General

EiNet is a subscription service, proposed in co-operation by Eurimage and Core Software Technology (CST), that allows users to search for metadata and browse Quick Look images from satellite missions such as Landsat, KVR 1000 and RESURS.

The system model is that of a Client / Server:

- **The Server software** is running on a dedicated workstation installed and operated by Eurimage at its main offices at Rome, 24 hours a day, 7 days a week

- **The Client software** can be any public domain World Wide Web (WWW) client available on Unix, PC or Macintosh system platforms. We recommend a client that shows JPEG images inline such as Netscape since all Quick Look images are stored and transmitted in JPEG format.

Catalogue (inventory)

The dataset for the vast majority of satellite scenes comprises three elements:

- Scene metadata (text)
- Quick Look preview (small image)
- Quick Look (image)

The exceptions are some earlier LANDSAT images, where no previews or Quick Looks are available.

How it works

When you connect to our the EiNet Service you will be asked for your user name and password. A graphical map interface allows you to zoom into your zone of interest and select either a single location or a rectangular area in which the data search is to be performed. Once you are satisfied with your area definition, an intuitive Query Form is displayed, from which you specify the other search parameters (date range, mission and mission dependent values). The server responds with the Metadata of the scenes that match your search parameters plus associated Quick Look previews. In this way you can immediately visualise the results of the query. You can click on a Preview to download the associated Quick Look, which can be either displayed by your WWW client's in-built image visualisation capability or by its launching a specific image viewing application.

EiNet Demo

If you would like to see what the EiNet service has to offer, select EiNet Demo to perform a search on a pre-defined geographic area and a small fixed dataset (the screens you see are copies of the real screens, but altering the parameters in the demo will not change the results).

Prices

New Prices for 1997

With effect from 1st January 1997 the price of EiNet will be reduced to:

ECU 100 / calendar year

This gives:

- access to EiNet from the date of subscription until the 31st of December of the subscription year

- an unlimited number of Quick Looks that can be downloaded within this period.

E-Mail Information Service

To obtain a faster response use the e-mail addresses indicated below.

Request	*E-mail Address*
Registration-Form - To request an EiNet Registration Form	einet-registration-form@eurimage.it
Registration - To send us your completed Registration Form	einet-register-me@eurimage.it
Technical problems - i.e. software problems, connectivity problems, etc.	einet-help.desk@eurimage.it
All other inquiries - When your request is not covered by the other items above.	einet-cust.services@eurimage.it

If you have any problems sending us an E-mail contact our Customer Services by phone or fax and they can provide you with the information you require.

Up to Welcome Page or back to the EiNet Welcome page.

How to contact Eurimage.

Last updated: 12 December 1996

Quick Looks

If you're new to the world of Remote Sensing you may be wondering what a Quick Look is. Well, let's take an example of an image from the most popular and reliable satellite in the history of Remote Sensing - LANDSAT. The Thematic Mapper (TM) instrument on this satellite measures the reflected solar light from its 185 km swath in an array of 7,020 sensors, each of which is measuring the reflectance of an area of the earth's surface about 26 metres square. The time interval between each successive capture is such that the satellite moves 26 metres along its track between each capture, thus neatly covering the surface of the earth without overlap - isn't technology wonderful!

5,760 of these rows of readings go to make a standard LANDSAT scene, giving a total of 40,435,200 readings (normally known as pixels). The LANDSAT TM sensor takes these readings simultaneously in seven separate bands in the visible and infrared parts of the spectrum, thus giving us a grand total of 283,046,400 pixels.

To create an image from these data we use just three of these bands, and so we have a mere 121,305,600 pixels to deal with. When you consider that each pixel is stored in one byte you can see that an image created from this data would be about 115.68 Mb (uncompressed) - not a very downloadable proposition on the Internet (1 Mb = 1024 x 1024 bytes).

Thus, we create a Quick Look by sub-sampling the data to give an image of **512 x 512 pixels per band**. An RGB colour image of these dimensions is normally about 768 Kb (1 Kb = 1024 bytes), but with JPEG compression we can get the size down to **9Kb - 31Kb** (depending on the image contents), without losing too much image quality.

The LANDSAT Quick Looks are RGB images, using bands **seven** (mid-infrared), **five** (near-infrared) and **two** (visible - green), as **RGB**, respectively, a combination which above all else helps users to distinguish between clouds and snow, because of their different reflectance in the infrared.

Finally, the images are contrast-stretched with a special algorithm to ensure that the range of reflectance values that was recorded by LANDSAT in each band (perhaps between 30 and 85) is stretched across the full range of potential values (0 to 255), thus giving a colourful image that makes it easy to distinguish major features.

For panchromatic sensors, such as the KVR-1000 camera on the COSMOS satellite, the Quick Looks are in black and white.

These Quick Looks are examined by potential users to check the estimates of cloud cover percentages that were made at the time of acquisition at the receiving station, as well as to decide which product would be most useful for their project.

To Receive Quick Looks

There are two ways to receive Quick Looks from Eurimage:

- Subscribe to EiNet, Eurimage´s catalogs and Quick Looks browser
- Subscribe to Eurimage´s Quick Looks CD-ROM

Up to Welcome Page or back to eiNet℠

How to contact Eurimage.

Last updated: 20 December 1996

Eurimage

Eurimage provides Earth Observation Products and Services in Europe, North Africa and the Middle East, offering remote sensing users a unique multi-mission service.

039723 - visitor count since 1st July 1995.

This site is best viewed with a browser that supports Tables and JPEG images, such as the two shown here; click to download the latest version.

On-line Services:

- **EiNet** Quick Looks and catalogue browsing system
- **Earth Watching** - Eurimage's monitoring service for natural disasters and special events, in conjunction with the European Space Agency.

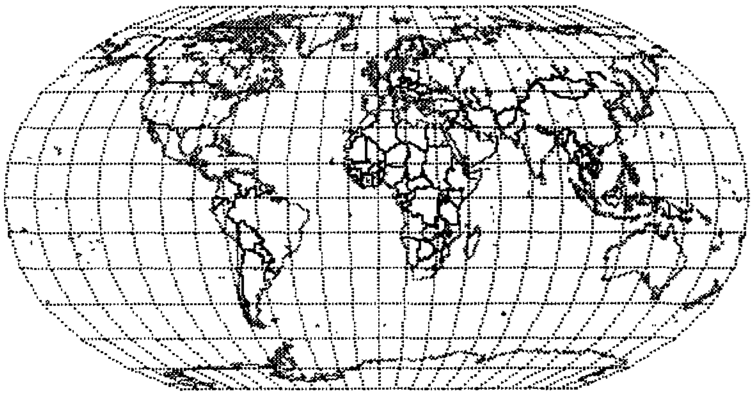
Information:

- **Products** and product-related services.
-

- **Applications** for a summary of the applications that use the different data sets offered by Eurimage.
- **What's New** for the latest information about data availability, special offers, technical updates, etc. and to read the Eurimage Newsletters.
- **Eurimage Summary** or **Background** - more about the Company.
- **Remote Sensing Links**
- **Contents Index**

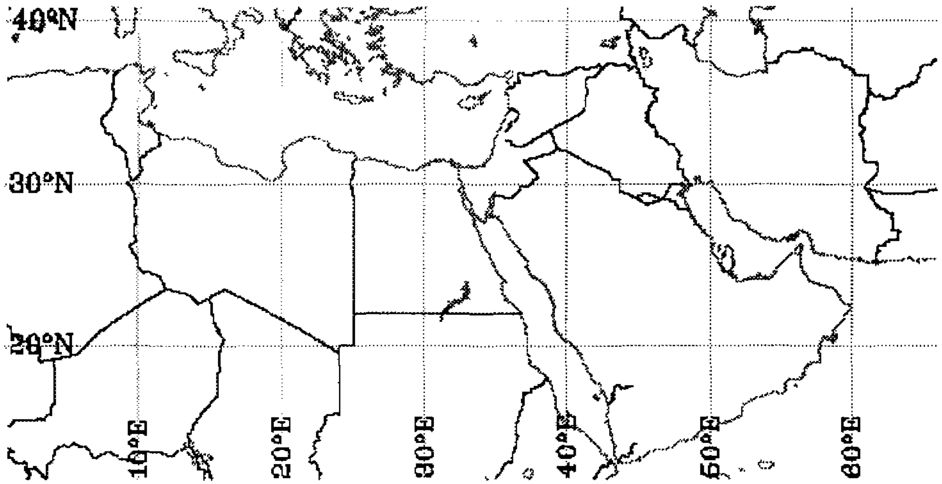
Situations Vacant	Eurimage addresses	What's new in these pages	E-Mail your comments about this site

Last updated: 12 June 1997

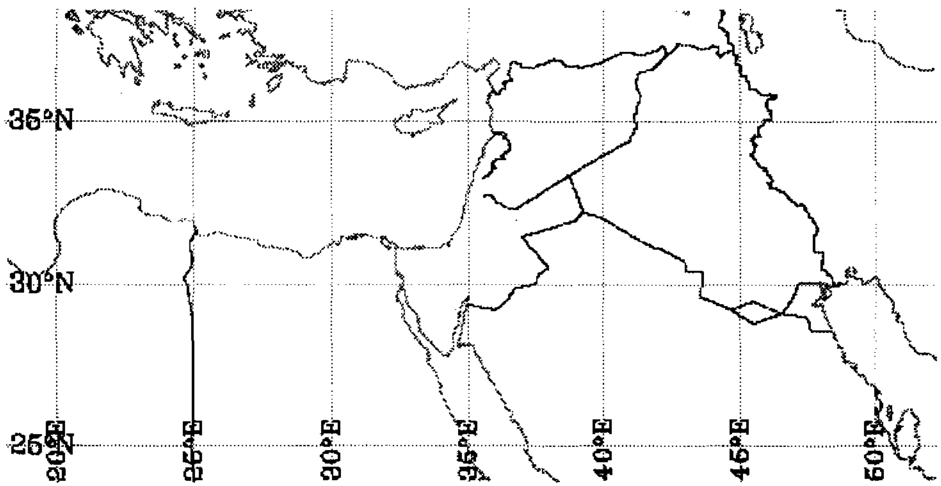


Click anywhere on the map to zoom in.

Note: This server uses JPEG images and requires a WWW Browser that displays inline JPEG images, such as Netscape (tm) from Netscape Communications, Inc.



Click anywhere on the map to zoom in. When you are ready to search, press the button below.



You may search for any images that include just a location, or for images that contain a minimum area by indicating your choice in the boxes below, and then selecting a location on the map above

Point Area

This form is for DEMO purposes only.

The search will be performed on a fixed data set regardless of the search parameters entered.

Only the `Display Output Format` may be changed.

Location:

`P1 Latitude : D ' " N S Longitude : D ' " E W`

`P2 Latitude : D ' " N S Longitude : D ' " E W`

Date: From: To:

Year: From: To: Yearly

Max. Average Cloud Cover (not applicable to RESURS) :

Scenes with corresponding Quick Looks **only**

Output Format:

Display Output Format : All Icons Text Full Text Brief

Order Scenes by :

Current Data Sets: (details)

Landsat TM (European Archive)

Landsat TM (Worldwide Archive)

KVR-1000

RESURS-O1

Landsat TM (European and Worldwide Archives)

Spacecraft : Landsat4 Landsat5

Override default Lat./Lon. Location

```
From:                          To:
Path :      Row :  Path :      Row :
```

Override Average Cloud Cover :

Upper Left : Upper Right :

Lower Left : Lower Right :

Minimum Data Quality : (Worldwide Archive ONLY)

Complete Frames Only

KVR-1000

Spectral Mode : Black & White Color

Override the default Lon./Lat. Location

Continent :

Max. Overall % Haze :

Min. Image Quality :

Database Statistics

Landsat TM European Archive

Year	No. Records	No. QL	Min Date	Max Date
1994	35975	29561	18/02/94	31/12/94
1995	50921	50467	01/01/95	31/12/95
1996	48437	47542	01/01/96	31/12/96
1997	17474	16701	01/01/97	31/05/97
Total	**152807**	**144271**	**18/02/94**	**31/05/97**

Landsat TM Worldwide Archive

Year	No. Records	No. QL	Min Date	Max Date
1982	740	0	23/08/82	31/12/82
1983	719	33	01/01/83	18/11/83
1984	18976	1482	15/03/84	31/12/84
1985	16301	736	01/01/85	11/12/85
1986	42588	5902	03/01/86	31/12/86
1987	39184	7266	01/01/87	31/12/87
1988	28730	16169	01/01/88	31/12/88
1989	30440	24303	01/01/89	31/12/89
1990	23873	23297	01/01/90	31/12/90
1991	22799	21342	01/01/91	31/12/91
1992	22373	21927	01/01/92	31/12/92
1993	22989	22495	01/01/93	30/12/93
1994	16981	16981	01/01/94	31/12/94

1995	13518	13518	01/01/95	21/09/95
Total	**300211**	**175451**	**23/08/82**	**21/09/95**

KVR-1000 Archive

Year	No. Records	No. QL	Min Date	Max Date
1990	1585	1579	18/05/90	27/06/90
1991	105	69	23/02/91	22/12/91
1992	942	826	01/01/92	30/12/92
Total	**2632**	**2474**	**18/05/90**	**30/12/92**

RESURS-O1 First Available Images

Year	No. Records	No. QL	Min Date	Max Date
1995	71	71	29/05/95	27/11/95
1996	297	296	18/01/96	19/12/96
1997	88	88	04/01/97	17/05/97
Total	**456**	**455**	**29/05/95**	**17/05/97**

To receive information and a registration form for EiNet, complete the following and press Send Mail

Name :

Company :

e-mail address :

Annex 5 Australian Centre for Remote Sensing (ACRES)

About Remote Sensing

Remote Sensing Products and Services

ACRES Products and Services Index

ACRES Landsat TM Price List

ACRES SPOT Price List

Satellite - ERS

ACRES ERS SAR Price List

Satellite - JERS

EOSAT JERS Price List

Satellites - Indian Remote Sensing Satellite (IRS)

EOSAT IRS Price List

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AUSTRALIAN CENTRE FOR REMOTE SENSING

About Remote Sensing

What is Remote Sensing?

Remote sensing is the observation of an object from a distance. Examples are Aerial Photography and the use of satellites to observe the Earth.

Satellite remote sensing involves gathering information about features on the Earth's surface from orbiting satellites. These satellites carry two types of sensor systems known as "active" and "passive". A "passive" system generally consists of an array of small sensors or detectors which record (as digital numbers) the amount of electro-magnetic radiation reflected and/or emitted from the Earth's surface. A multispectral scanner is an example of a passive system. An "active" system propagates its own electro-magnetic radiation and measures (as digital numbers) the intensity of the return signal. Synthetic Aperture Radar (SAR) is an example of an active system.

The digital data acquired by the satellites are transmitted to ground stations and can be used to reconstitute an image of the Earth's surface not too dissimilar to an aerial photograph.

Benefits of Remotely Sensed Data from Earth Observation Satellites.

Remotely sensed data acquired by the Earth observation satellites provide a number of benefits for studying the Earth's surface, including:

- continuous acquisition of data
- regular revisit capabilities (resulting in up-to-date information)
- *broad regional coverage*
- good spectral resolution (including infra-red bands)
- good spatial resolution

- ability to manipulate/enhance digital data
- ability to combine satellite digital data with other digital data
- cost effective data
- map-accurate data
- possibility of stereo viewing
- large archive of historical data

How are data provided to the end-user?

Data are provided as hard copy photographic data products, or as digital data products which can be viewed and manipulated on a variety of software systems.

Further information is available on ACRES Products and Services.

How are data used?

Satellite data are used to provide timely and detailed information about the Earth's surface, especially in relation to the management of our renewable and non-renewable resources.

Some examples of uses of satellite data are:

- assessment and monitoring of vegetation types and their status
- soil surveys
- mineral exploration
- map making and revision
- production of thematic maps
- water resources planning and monitoring
- urban planning
- agricultural property management planning
- crop yield assessment
- natural disaster assessment

Some Common Earth Observation Satellites

Common Earth observation satellites include Landsat, SPOT, ERS and JERS.

See ACRES Satellite Facts Page for more information.

More information about Remote Sensing can be obtained by connecting to the WWW pages of the Nottingham University in the United Kingdom.

ACRES Products and Services

About ACRES

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Remote Sensing Products and Services

Last Updated - July 1996

The **Australian Centre for Remote Sensing (ACRES)** is the business unit of AUSLIG responsible for its national remote sensing program. ACRES acquires, archives and processes data from some of the major polar orbiting earth resource satellites. In addition, ACRES provides satellite data imported from overseas suppliers (ie acquired from other ground stations). Products may be purchased either through one of ACRES specially appointed Distributors around Australia (Landsat, SPOT, RADARSAT, ERS and JERS), New Zealand (RADARSAT only), Indonesia (Landsat only) and USA (Landsat only), or directly from the ACRES office in Canberra.

ACRES has a range of products and services to suit various data analysis applications. Detailed information can be obtained via the **ACRES Products and Services Index**.

Following is a brief summary of the various satellite sensors from which ACRES directly receives data:

Satellite	Sensor	Scene Size (km)	Resolution (metres)	No. of Bands	ACRES Archive begins
Landsat	Multispectral Scanner (MSS)	184 x 172	80	4	Nov 1979
	Thematic Mapper (TM)	184 x 172	30 (120m band 6)	7	Sep 1987
SPOT	Multispectral (XS)	60 x 60	20	3	Jan 1990
	Panchromatic (Pan)	60 x 60	10	1	Jan 1990
European Resource Satellite (ERS)	Synthetic Aperture Radar (SAR)	100 x 100	20	1	Sep 1991

ACRES and our Distributors can advise customers on image acquisition dates and any associated cloud cover. This information is also available from the ACRES on-line **Digital Catalogue**, for data acquired in Australia.

Satellite imagery is available in a range of processing levels, which refer to the degree of corrections applied to the raw satellite data. Imagery is supplied on photographic and/or digital media.

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ACRES Products and Services Index

Check out What's New at ACRES

Satellite and Sensor Characteristics

- Satellites - Landsat: Sensor Characteristics
- Satellites - SPOT: Sensor Characteristics
- Satellites - ERS: Sensor Characteristics
- ACRES Landsat Variable Window Product Characteristics
- ACRES SPOT Variable Window Product Characteristics
- Satellites - RADARSAT: Sensor Characteristics
- Satellites - IRS: Sensor Characteristics
- Satellites - JERS: Sensor Characteristics

Satellite Data Price Lists

ACRES Products

- ACRES Landsat Thematic Mapper (TM) Data
- ACRES Landsat Multispectral Scanner (MSS) Data
- ACRES SPOT Multispectral and Panchromatic Data
- ACRES ERS Synthetic Aperture Radar (SAR) Data

Imported Products

- RADARSAT SAR Products
- EOSAT Landsat TM Products
- NRCT (Thailand) Landsat TM Products
- EROS Landsat MSS Products
- EOSAT IRS Products
- EOSAT JERS Products
- SSC Satellitbild RESURS Products

ACRES Services

- Image Writing Service
- Image Writing Service Prices
- Imported Satellite Data from Overseas Suppliers
- Satellite Programming Service
- ACRES Future Acquisitions for SPOT Imagery - Fee Structure and Details

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ACRES Speciality Products

- Customised Sample Product

ACRES Satellite Data Processing Levels

- Landsat and SPOT data - Levels 0 - 10
- ERS SAR Data

Additional Information

- ACRES Conditions of Sale
- ACRES Data Enhancement Definitions
- ACRES Customer Service Guarantee
- Confirmation of Orders
- ACRES Data Warranty
- ACRES Cloud Cover Policy
- ACRES Photographic Products
- EOSAT Photographic products - Copyright
- Freight

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ACRES Landsat TM Price List

Last Updated - August 1994

DIGITAL DATA

ACRES digital data products are available in a range of Processing Levels

Path Oriented, System Corrected - Level 4/5

No. of Bands	*Coverage*	*Price*	*Coverage*	*Price*
4	Full Scene	$2950	Quarter Scene	$1070
7	Full Scene	$5250	Quarter Scene	$1950

Path Oriented, Precision Corrected - Level 6

No. of Bands	*Coverage*	*Price*	*Coverage*	*Price*
4	Full Scene	$3350	Quarter Scene	$1470
7	Full Scene	$5650	Quarter Scene	$2350

Map Oriented, System Corrected, Variable Window - Level 8

(Pixels resampled to 25 metres)

No. of Bands	Up to 60000 sq Km	* Up to 40500 sq Km	Up to 17000 sq Km
4	$3720	$3100	$2080
7	$6480	$5400	$3510
No. of Bands	*Up to 8100 sq Km*	*Up to 3600 sq Km*	*Up to 2025 sq Km*
4	$1220	$990	$780
7	$2100	$1550	$1150

Map Oriented, Precision Corrected, Variable Window - Level 9
(Pixels resampled to 25 metres)

No. of Bands	Up to 60000 sq Km	* Up to 40500 sq Km	Up to 17000 sq Km
4	$4020	$3350	$2330
7	$6780	$5650	$3760
No. of Bands	*Up to 8100 sq Km*	*Up to 3600 sq Km*	*Up to 2025 sq Km*
4	$1470	$1350	$1030
7	$2350	$1910	$1400

Note: Variable Window Products may contain blank pixels, depending on location within satellite path. Please refer to separate Data Sheet - Landsat Variable Window Product Characteristics.

* **Note:** A window of 225 km E-W and 180 km N-S will cover an area which approximates a path oriented full scene.

Floppy Disk Subsets - Map Oriented, System Corrected - 25m Pixels

4 bands	1024 pixels x 1024 lines	Approx 25 x 25 km	$570
7 bands	1024 pixels x 1024 lines	Approx 25 x 25 km	$750

Media

Data is available on 6250 bpi and 1600 bpi Computer Compatible Tape, 2.3 GByte Exabyte Tape, 1.3 GByte DAT or 3.5" (1.44 MByte) PC compatible floppy disks. Additional copies of digital data sets are available for $65 when ordered with the original data set.

PHOTOGRAPHIC PRINTS

ACRES photographic data products are available in a range of Processing Levels

Path Oriented, System Corrected - Level 5

Coverage	*Small (1:1)*	*Large(>1:1)*
Full Scene	$750	$945
Quarter Scene	$360	$555

Path Oriented, Precision Corrected - Level 6

Coverage	*Small (1:1)*	*Large(>1:1)*
Full Scene	$1150	$1345
Quarter Scene	$760	$955

*Map Oriented, System Corrected, Variable Window - Level 8**

Coverage	Small (1:1)	Large(>1:1)
Up to 200 km E-W and 180 km N-S	$750	$945
Up to 9000 sq km, eg: 100 km E-W and 90 km N-S	$360	$555

*Map Oriented, Precision Corrected, Variable Window - Level 9**

Coverage	Small (1:1)	Large(>1:1)
Up to 200 km E-W and 180 km N-S	$1150	$1345
Up to 9000 sq km, eg: 100 km E-W and 90 km N-S	$760	$955

* See separate Data Sheet - ACRES Landsat Variable Window Product Characteristics

STANDARD ENLARGEMENTS

Path Oriented

Scale	*Enlargement Factor*	*Product*	*Approx Size (mm)*
1:1 000 000	1:1	Full Scene Contact	238 x 219
1: 500 000	1:1	Quarter Scene Contact	238 x 219
1: 500 000	2:1	Full Scene Enlargement	476 x 438
1: 250 000	2:1	Quarter Scene Enlargement	476 x 438
1: 250 000	4:1	Full Scene Enlargement	952 x 876
1: 100 000	5:1	Quarter Scene Enlargement	1190 x 1095

Media

Photographic products are available as transparencies or paper prints. Additional copies of products are available for $80 when ordered with the original print.

Enquiries and Orders for Landsat TM Data

To enquire about data availability or to order your Landsat TM data, please contact ACRES or your ACRES Distributor.

Trading Conditions

Special copyright conditions apply to the sale of satellite data. To acknowledge these copyright conditions, customers are required to sign a Satellite Data Licence Conditions (Schedule G) prior to the purchase of any data.

Priority Orders

Priority processing of orders is available with an average turnaround of less than 5 days, charged at 2 times the quoted price. *Actual turnaround times* *should be discussed with ACRES at time of order.*

Delivery Details

ACRES products are dispatched by air freight. The price of data includes freight charges, except for international deliveries. To facilitate delivery of your products, please provide both your postal and street address.

All prices are subject to variation without notice and are quoted in Australian Dollars.

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ACRES SPOT Price List

Last Updated - January 1996

Note - Future Acquisitions

All SPOT prices listed here are for archived data. Requests for Future Acquisitions will incur an additional fee as described in SPOT Future Acquisitions - Fee Policy.

DIGITAL DATA

ACRES digital data is available in a range of Processing Levels.

Path Oriented, System Corrected - Level 4/5

Sensor	*Coverage*	*Price*
Panchromatic	Full Scene	$1740
Multispectral	Full Scene	$1540

Path Oriented, Precision Corrected - Level 6

Sensor	*Coverage*	*Price*
Panchromatic	Full Scene	$2290
Multispectral	Full Scene	$2090

Map Oriented, System Corrected, Variable Window - Level 8

Sensor	*Up to 10000 sq Km*	** Up to 4800 sq Km*	*Up to 1800 sq Km*	*Up to 900 sq Km*
PAN	$3050	$1900	$1390	$890
XS	$2730	$1700	$1300	$860

Map Oriented, Precision Corrected, Variable Window - Level 9

Sensor	*Up to 10000 sq Km*	** Up to 4800 sq Km*	*Up to 1800 sq Km*	*Up to 900 sq Km*
PAN	$3660	$2290	$1720	$1290
XS	$3350	$2090	$1600	$1250

Note: Variable Window Products may contain blank pixels, depending on location within satellite path. Please refer to Data Sheet - ACRES SPOT Variable Window Product Characteristics.

* **Note:** A window of 80 Km E-W and 60 Km N-S will cover an area which approximates a vertical path oriented full scene.

Floppy Disk Subsets - Map Oriented, System Corrected

Panchromatic	10 m pixels	1024 pixels x 1024 lines	Approx 10 x 10 km	$715
Multispectral	20 m pixels	1024 pixels x 1024 lines	Approx 20 x 20 km	$660

Media

Data is available on 6250 bpi and 1600 bpi Computer Compatible Tape, 2.3 GByte EXABYTE© Tape, 1.3 GByte DAT and 3.5" (1.44 MByte) PC compatible floppy disks. Additional copies of digital data sets are available for $65 when ordered with the original data set.

PHOTOGRAPHIC PRINTS

ACRES photographic prints are available in a range of Processing Levels.

Path Oriented, System Corrected - Level 4/5

Sensor	*Coverage*	*Small (1:1)*	*Large (> 1:1)*
Panchromatic	Full Scene	$840	$1080
Multispectral	Full Scene	$645	$860

Path Oriented, Precision Corrected - Level 6

Sensor	*Coverage*	*Small (1:1)*	*Large (> 1:1)*
Panchromatic	Full Scene	$1110	$1350
Multispectral	Full Scene	$920	$1130

Map Oriented, System Corrected, Variable Window - Level 8 *

Sensor	*Coverage*	*Small (1:1)*	*Large (> 1:1)*
Panchromatic	Up to 80 Km E-W and 60 Km N-S	$840	$1080
	Up to 900 sq Km	$495	$740
Multispectral	Up to 80 Km E-W and 60 Km N-S	$645	$860
	Up to 900 sq Km	$410	$630

Map Oriented, Precision Corrected, Variable Window - Level 9 *

Sensor	*Coverage*	*Small (1:1)*	*Large (> 1:1)*
Panchromatic	Up to 80 Km E-W and 60 Km N-S	$1110	$1350
	Up to 900 sq Km	$890	$1130
Multispectral	Up to 80 Km E-W and 60 Km N-S	$920	$1130
	Up to 900 sq Km	$810	$1020

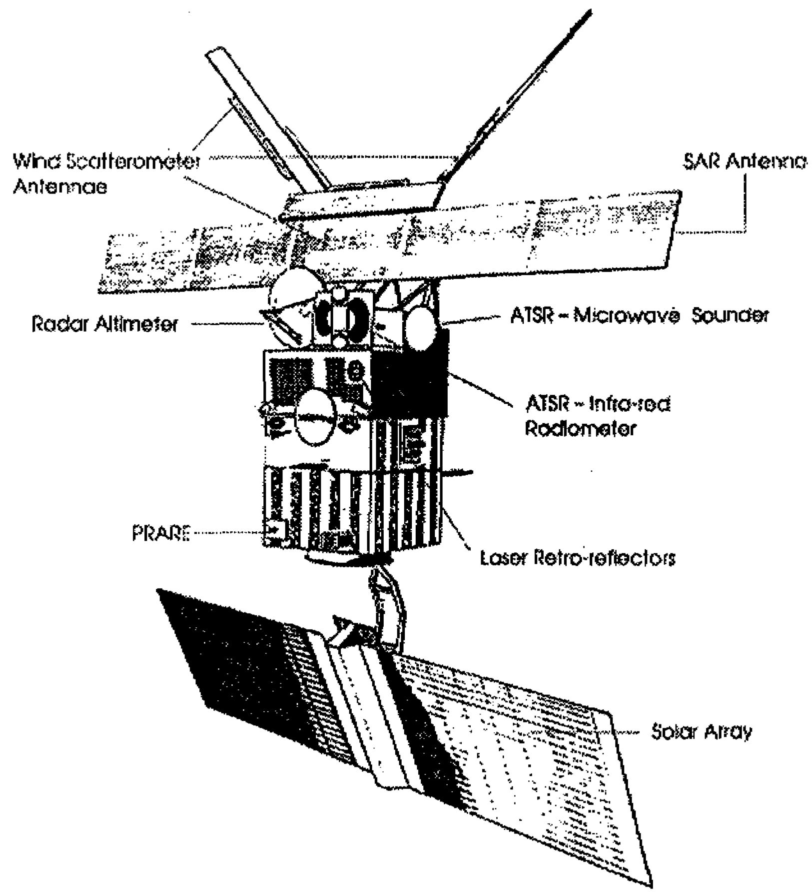
* See Data Sheet - ACRES SPOT Variable Window Product Characteristics.

STANDARD ENLARGEMENTS

Path Oriented

Scale	*Enlargement Factor*	*Product*	*Approx Product Size (mm)*
1:400 000	1:1	Full Scene Contact	238 x 219
1:200 000	2:1	Full Scene Enlargement	476 x 438
1:100 000	4:1	Full Scene Enlargement	952 x 876

Media



ACRES acquires data from one of the instruments on board, the Synthetic Aperture Radar (SAR), which operates in C band from the microwave region of the electromagnetic spectrum.

In addition to the Synthetic Aperture Radar, ERS-1 and ERS-2 carry other instruments:

- The Radar Altimeter
- The Along-Track Scanning Radiometer and Microwave Sounder
- The Precise Range and Range Rate Equipment (functional only on ERS-2)
- The Wind Scatterometer
- The Laser Retro-reflector

SATELLITE DETAILS

SENSOR PARAMETERS - Synthetic Aperture Radar (SAR)

The SAR is an active microwave sensor capable of imaging earth resource targets regardless of time of day, cloud, haze or smoke cover of an area. The instrument is classified "active" as it emits the energy necessary to image the earth's surface. In contrast, "passive" or "optical" sensors rely on the sun's reflected energy to image the earth. More general information on SAR is available through NASA's Jet Propulsion Laboratory: What is Imaging Radar.

ERS SAR Characteristics

Photographic products are available as paper prints. Additional copies of products are available for $80 when ordered with the original print.

ENQUIRIES AND ORDERS FOR SPOT DATA

Enquiries and orders for SPOT data should be submitted to SPOT Imaging Services. Advance programming of the SPOT satellite is available - please contact SPOT Imaging Services for details.

Trading Conditions

Special copyright conditions apply to the sale of satellite data. To acknowledge these copyright conditions, customers are required to sign a Satellite Data Licence Conditions (Schedule G) prior to the purchase of any data.

Priority Orders

Priority processing of orders is available with an average turnaround of less than 5 days, charged at 2 times the quoted price. *Actual turnaround times should be discussed with ACRES at time of order.*

Delivery Details

ACRES products are dispatched by air freight. The price of data includes freight charges except for international deliveries. To facilitate delivery of your products, please provide both your postal and street address.

All prices are subject to variation without notice and are quoted in Australian Dollars.

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Satellites - ERS

Last Updated - May 1997

The following is a brief description of the European Space Agency's (ESA) Earth Resource Satellite (ERS). The first satellite in this series, ERS-1 was launched on 17 July 1991 and ERS-2 on 20 April 1995. These satellites are designed to gather information about the earth's ocean, ice and land resources using a variety of sensors.

Below is a diagram of the ERS spacecraft.

Frequency	5.3 GHz
Bandwidth	15.55 MHz
Band Name	C Band
Wavelength	56mm
Incidence Angle	23 deg (mid swath)
Polarisation	VV*

*V=vertical

GENERALISED APPLICATIONS

Meteorology	Interrelationship between oceanographic and climatic phenomena and their influence on global climatic change
Geology	Structural mapping, volcanism studies, coastal erosion studies
Vegetation Monitoring	Vegetation change, crop monitoring
Hydrology	Soil moisture studies, surface water body morphology, snow extent and condition
Land Use	Mapping, change assessment
Oceanography and Glaciology	Monitoring of polar ice sheets and sea ice; monitoring ocean circulation, currents and tides

ENQUIRIES AND ORDERS FOR ERS SAR DATA

To enquire about data availability or to order your ACRES ERS SAR data, please contact your prefered ACRES Distributor or our Satellite Operations Section on (tel) 06 201 4109 or (fax) 06 251 6326. Prices for ACRES ERS SAR data can be found in the ERS SAR Price List.

COPYRIGHT

ERS SAR data is subject to ACRES Terms and Conditions of Sale covering the use of ERS data.

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FOR REMOTE SENSING

ACRES ERS SAR Price List

Last Updated - December 1996

DIGITAL DATA

SINGLE SCENE PRODUCTS

Digital Products, Full Scene Only. (~100 km x 100 km)			
Processing Level (and code)	**Customer selected area**	**Processed Data Archive (list available on request)**	**Sample Images (list available on request)**
Annotated Raw Data (RAW)	$1,800	N/A	$170
Single Look Complex (SLC)	$2,200	$1,100	$170
Bulk Path Image (PRI)	$2,200	$1,100	$170

Copies

Copy of any product listed above, ordered at the same time as the original product	$180
Any one photographic product ordered together with the digital version.	$400

Volume Discount

A 10% discount applies to the above products for any order of $18,000 or greater.

Research & Demonstration Usage

Digital single scene products purchased for non-commercial or demonstration purposes are available, at ACRES discretion, at reduced prices. Specific criteria and conditions apply. A project form must be completed outlining the project and data requirements. This will be assessed by ACRES to determine suitability. Please refer to ACRES Data Sheet EO3 - ERS Research & Demonstration Purchasing Category.

MULTI-SCENE PRODUCTS

Multi-Temporal Set

Three or more digital products of the same scene acquired on different dates, and ordered at the same time. At least one scene must have already been acquired by an ACRES groundstation:

Bulk Path Image (PRI)	3 scenes	$4400
	Additional scenes (price per scene)	$1100

Interferometry Set

Three or more digital products of the same scene acquired on different dates:

Annotated Raw (RAW)	3 scenes	$3600
	Additional scenes (price per scene)	$900
Single Look Complex (SLC)	3 scenes	$4400
	Additional scenes (price per scene)	$1100

Media

Digital data is available on 6250 bpi Computer Compatible Tape, 2.3 Gbyte EXABYTE Tape and 1.3 Gbyte DAT.

PHOTOGRAPHIC PRODUCTS

Photographic Prints and Small (1:1) Transparencies*. Full Scenes Only						
Processing Level and code	**Customer selected area**		**Processed Data Archive (list available on request)**		**Sample Images (list available on request)**	
	Small (1:1)	Large (>1:1)	Small (1:1)	Large (>1:1)	Small (1:1)	Large (>1:1)
Bulk Path Image (PRI)	$2,200	$2,350	$1,100	$1,250	$270	$270

*Transparencies are only available in small (1:1) size.

Standard Enlargements			
Scale	**Enlargement Factor**	**Product**	**Size (mm)**
1: 500 000	1:1	Full Scene	~200 x 200
1: 250 000	2:1	Full Scene	~400 x 400
1: 100 000	5:1	Full Scene	~1000 x 1000

Copies

Copy of any photographic product, ordered at the same time as the original product	$180
Any one photographic product ordered together with the digital version.	$400

Volume Discount

A 10% discount applies to the above products for any order of $18,000 or greater.

Media

Photographic products are available as black & white paper prints and small contact transparencies.

Priority Orders

Priority processing of orders ***may*** be available within an average turnaround of less than 5 days, and charged at 2 times the quoted price. Availability of this service and actual turnaround times should be discussed with ACRES at time of order.

Trading Conditions

Special licence conditions apply to the sale of satellite data. To acknowledge these conditions, customers are required to sign a satellite data Licence Conditions agreement prior to the purchase of any data.

Delivery Details

ACRES products are dispatched by air freight. The price of data includes freight within Australia. To facilitate delivery of your products, please provide both your postal and street address.

All prices are subject to change without notice and are quoted in Australian dollars.

Enquiries and Orders for ERS SAR Data

To enquire about data availability or to order your ERS SAR data, please contact ACRES or your ACRES Distributor.

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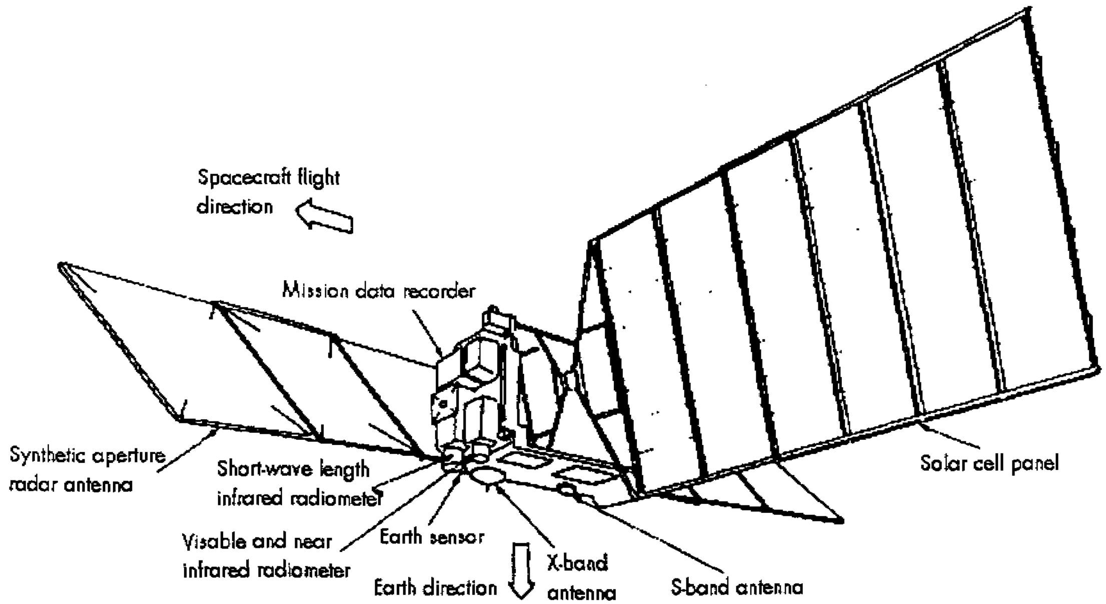
Satellites - JERS

The Japanese Earth Resources Satellite-1 (JERS-1) is a joint project between the National Space Development Agency of Japan (NASDA) and the Ministry of International Trade and Industry (MITI). NASDA is in charge of the satellite while MITI is responsible for the observation equipment. JERS-1 was launched in February 1992 and observes the Earth's surface using optical sensors and a synthetic aperture radar (SAR) sensor. The optical sensors collect information from eight spectral bands, while the SAR sensor operates in the L-band of the microwave wavelengths.



ACRES has been acquiring JERS-1 optical and SAR data at the Alice Springs ground station for some time, but this has only been available to Principle Investigators. More recently, worldwide data (including data over Australia) has been available from ACRES through a distribution agreement with EOSAT in the USA.

SATELLITE DETAILS

Geology	Geological structural mapping
Forestry	Tree density; Forest-type mapping
Soils	Soil moisture studies
Agriculture	Crop type discrimination
Land Use	Surface feature discrimination

ENQUIRIES AND ORDERS FOR JERS-1 DATA

To enquire about data availability (Optical or SAR) and to order you JERS-1 product, please contact ACRES or your ACRES Distributor. Prices are shown in the JERS-1 Price List.

COPYRIGHT

JERS data is subject to copyright. The purchaser agrees to use JERS data for their own internal purpose, and not to copy, reproduce and/or permit reproduction or dissemination of JERS data. A limit of one copy is permitted for backup purposes.

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ACRES **AUSTRALIAN CENTRE FOR REMOTE SENSING**

EOSAT JERS Price List

Last Updated - September 1996

ACRES is an EOSAT Representative for sales of (Japanese) JERS data in Australia. To assist our customers we have appointed some of our **Distributors** as Sub-Representatives for the purpose of taking EOSAT JERS data orders.

Archive and Coverage

JERS-1 data is available from 1992 onwards and the archive covers most parts of the world. Data is available for each of three on board sensors, a synthetic aperture radar (SAR), an optical visible-near infrared (VNIR) and an optical shortwave infrared (SWIR) instrument.

Digital Data

Media: CCT (6250 BPI) at standard digital price or on CD ROM or Exabyte for US $150.00 extra.

Currency: Prices shown are in **US Dollars**

SENSOR PARAMETERS

OPTICAL DATA

Visible and Near Infrared (VNIR)

Band No.	Spectral Range (um)	EM Region	Generalised Application Details
1	0.52 - 0.60	visible green	vegetation surveys; land use; water monitoring
2	0.63 - 0.69	visible red	chlorophyll absorbtion for vegetation differentiation
3	0.76 - 0.86	near infrared	Biomass surveys (nadir viewing)
4	0.76 - 0.86	near infrared	Biomass surveys (forward looking, at 15.3 degrees, to give stereo coverage with band 3)

Short Wave Infrared (SWIR)

Band No.	Spectral Range (um)	EM Region	Generalised Application Details
5	1.60 - 1.71	middle infrared	vegetation moisture
6	2.01 - 2.12	middle infrared	Hydrothermal mapping (eg. soils; geology)
7	2.13 - 2.25	middle infrared	Hydrothermal mapping (eg. soils; geology)
8	2.27 - 2.40	middle infrared	Hydrothermal mapping (eg. soils; geology)

Optical Data Characteristics (VNIR and SWIR)

Product Pixel Size	18 meters
Scene Size	75 km x 75 km
Data quantisation	6 bits

SYNTHETIC APERTURE RADAR DATA (SAR)

The SAR sensor is an active microwave sensor capable of imaging the Earth regardless of time of day, cloud, haze or smoke over an area. The instrument is classified as "active" as it emits the microwave energy necessary to image the Earth's surface. In contrast, "passive" or "optical" sensors rely on the sun's reflected energy to image the Earth.

An important difference between ERS SAR, RADARSAT and JERS SAR is that the latter operates in L-band, while the former two operate in the C-band part of the spectrum.

JERS SAR Characteristics

Frequency	1.3 GHz
Band Width	15 MHz
Band Name	L-Band
Wavelength	235 mm
Off Nadir Angle	35 degrees
Ground Resolution	18 meters
Swath Width	75 km
Polarisation	HH*

*H=horizontal

	Processing level	Tape format	*Price $US
Optical VNIR	System corrected (bands 1-3)	BSQ or BIL	$ 1250
	Stereo image product (bands 3 & 4)	BSQ	$ 1650
Optical SWIR	System corrected	BSQ or BIL	$ 1250
SAR	Standard georeferenced	BSQ	$ 1250

*Prices shown are approximate, based on a conversion rate of 100Yen = $US1. Actual rate determined at time of order with EOSAT.

PHOTOGRAPHIC DATA

Photographic data is available as film products, or as paper products in a variety of scales. The following table gives a brief guide to the approximate prices in $US. Further prices and scales are available on application.

Sensor	Product characteristics	Price for film only $US	Scale of largest paper product	*Price for largest paper product $US
VNIR	Black & white (System corrected)	$ 307	1: 100 000	$ 387
	Black & white (Stereo image)	$ 807	1: 500 000	$ 267
	Bands 1,2,3 as BGR (False colour)	$ 1207 (positive film only)	1: 100 000	$ 937
	Bands 1,3,2 as BGR (Natural colour)	$ 1207 (positive film only)	1: 100 000	$ 937
SWIR	Black & white	$ 307	1: 100 000	$ 387
SAR	Black & white	$ 1207	1: 100 000	$ 387

*Prices shown are approximate, based on a conversion rate of 100Yen = $US1. Actual rate determined at time of order with EOSAT.

FREIGHT

The cost of freight is extra and will be advised at the time of ordering.

TRADING CONDITIONS

JERS data is subject to copyright. The purchaser agrees to use JERS data for their own internal purpose, and not to copy, reproduce and/or permit reproduction or dissemination of JERS data.

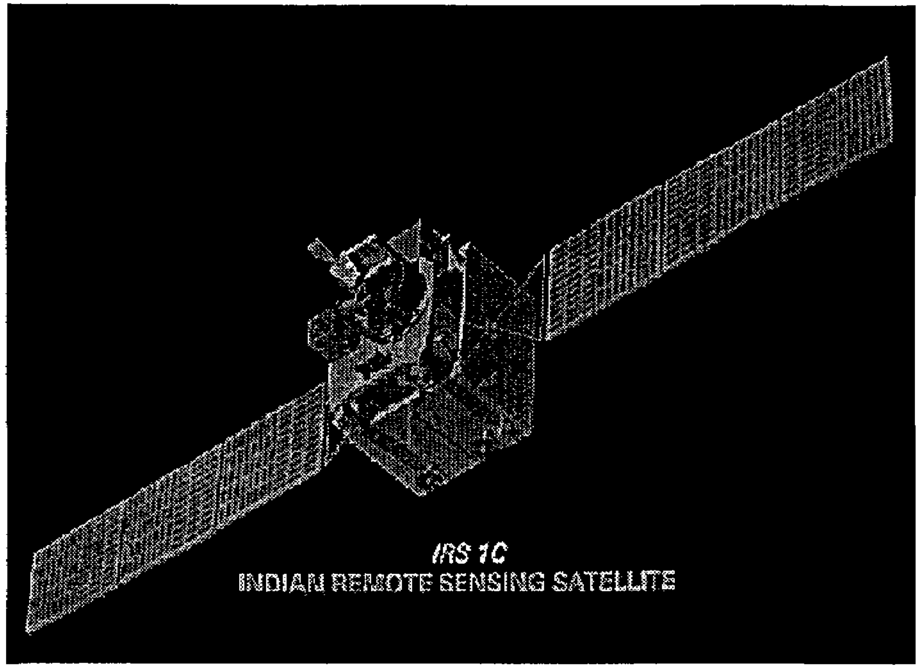
AUSTRALIAN SURVEYING & LAND INFORMATION GROUP
Scrivener Building, Dunlop Court, Fern Hill Park, Bruce ACT 2617
PO Box 2 Belconnen ACT 2616 Phone: +61 6 201 4201 Fax: +61 6 201 4366

AUSLIG

ACRES AUSTRALIAN CENTRE FOR REMOTE SENSING

Satellites - Indian Remote Sensing Satellite (IRS)

The Indian Space Research Organisation (ISRO) has been responsible for the development and management of the IRS (Indian Remote Sensing) series of satellites. These satellites carry a variety of optical sensors to provide both multispectral and panchromatic earth resource information to users.



ACRES does not directly downlink IRS data at this stage, but can supply data via EOSAT in the USA. EOSAT are the exclusive worldwide IRS data distributor outside India. IRS-1C is the primary satellite currently used from the IRS series. Data availability from this satellite is currently limited to the acquisition circles of USA, Germany and India, from a data archive commencing in early 1996.

The IRS-1C satellite supports three onboard sensors:

Linear Imaging Self Scanning Sensor (LISS-3)
Wide Field Sensor (WiFS)
Panchromatic Sensor (Pan)

IRS-1C SENSOR PARAMETERS

LISS-3

Band No.	Quantisation (bits)	Spectral Range (um)	EM Region	Product Resolution (m)	Approx Product Scene size (km)
B2	7	0.52 - 0.59	Green	25	141 x 141
B3	7	0.62 - 0.68	Red	25	141 x 141
B4	7	0.77 - 0.86	Near Infrared	25	141 x 141
B5	7	1.55 - 1.70	SW Infrared	70	141 x 141

WiFS

Band No.	Quantisation (bits)	Spectral Range (um)	EM Region	Product Resolution (m)	Approx Product Scene size (km)
B3	7	0.62 - 0.68	Red	180	774 x 774
B4	7	0.77 - 0.86	Near Infrared	180	774 x 774

Panchromatic

Band No.	Quantisation (bits)	Spectral Range (um)	EM Region	Product Resolution (m)	Approx Product Scene size (km)
"Pan"	6	0.5 - 0.75	Green/Red	5	70 x 70

Off Nadir Viewing Capabilities

The Panchromatic instrument has the ability to image from vertical viewing, up to plus or minus 26 degrees across track. At large angles, this results in the scene size and pixel size being slightly larger than that quoted above.

Stereoscopy

Stereo pairs can be obtained from Panchromatic imagery by combining two images of the same area, but recorded during different orbits and at different viewing angles

Revisit Capability (days at equator)

LISS-3	WiFS	Pan - Vertical	Pan - maximum angle (from vertical)
24	5	24	5 (approx)

ENQUIRIES AND ORDERS FOR IRS DATA

To enquire about data availability and to order you IRS product, please contact ACRES or your ACRES Distributor. Prices are shown in the EOSAT IRS Price List.

COPYRIGHT

IRS data is subject to copyright. The purchaser agrees to use IRS data for their own internal purpose, and not to copy, reproduce and/or permit reproduction or dissemination of IRS data.

AUSTRALIAN SURVEYING & LAND INFORMATION GROUP
Scrivener Building, Dunlop Court, Fern Hill Park, Bruce ACT 2617
PO Box 2 Belconnen ACT 2616 Phone: +61 6 201 4201 Fax: +61 6 201 4366

AUSLIG

AUSTRALIAN CENTRE
FOR REMOTE SENSING

EOSAT IRS Price List

Last Updated - April 1996

IRS PRODUCTS

ACRES is an EOSAT Representative for sales of IRS data in Australia. To assist our customers we have appointed some of our **Distributors** as Sub-Representatives for the purpose of taking EOSAT IRS data orders.

ARCHIVE AND COVERAGE

IRS-1C data is available from early 1996 onwards. The data covers the acquisition circles of USA, Germany and India. Data over Australia is currently unavailable.

DIGITAL DATA

Media: CD-ROM, Exabyte or CCT (6250 BPI)

Data Format: Fast Format

Copies: Available for US$250 when ordered with the original product.

Currency: Prices shown are in **US Dollars**.

IRS-1C - LISS-3

Processing Level		Super Scene (141 x 141 km)	Scene (70.5 x 70.5 km)
Path Oriented	System Corrected	$ 2970	$ 2070
Map Oriented	System Corrected	$ 2970	N/A

IRS-1C - WiFS

Processing Level		Full Scene (774 x 774 km)
Path Oriented	System Corrected	$ 600

IRS-1C - Panchromatic

Processing Level		Pan Scene (70 x 70 km)	Pan Junior (23 x 23 km)
Path Oriented	System Corrected	$ 2500	$ 900
Map Oriented	System Corrected	$ 2500	$ 900

Freight: $US42 for first tape plus US$10 for each subsequent tape

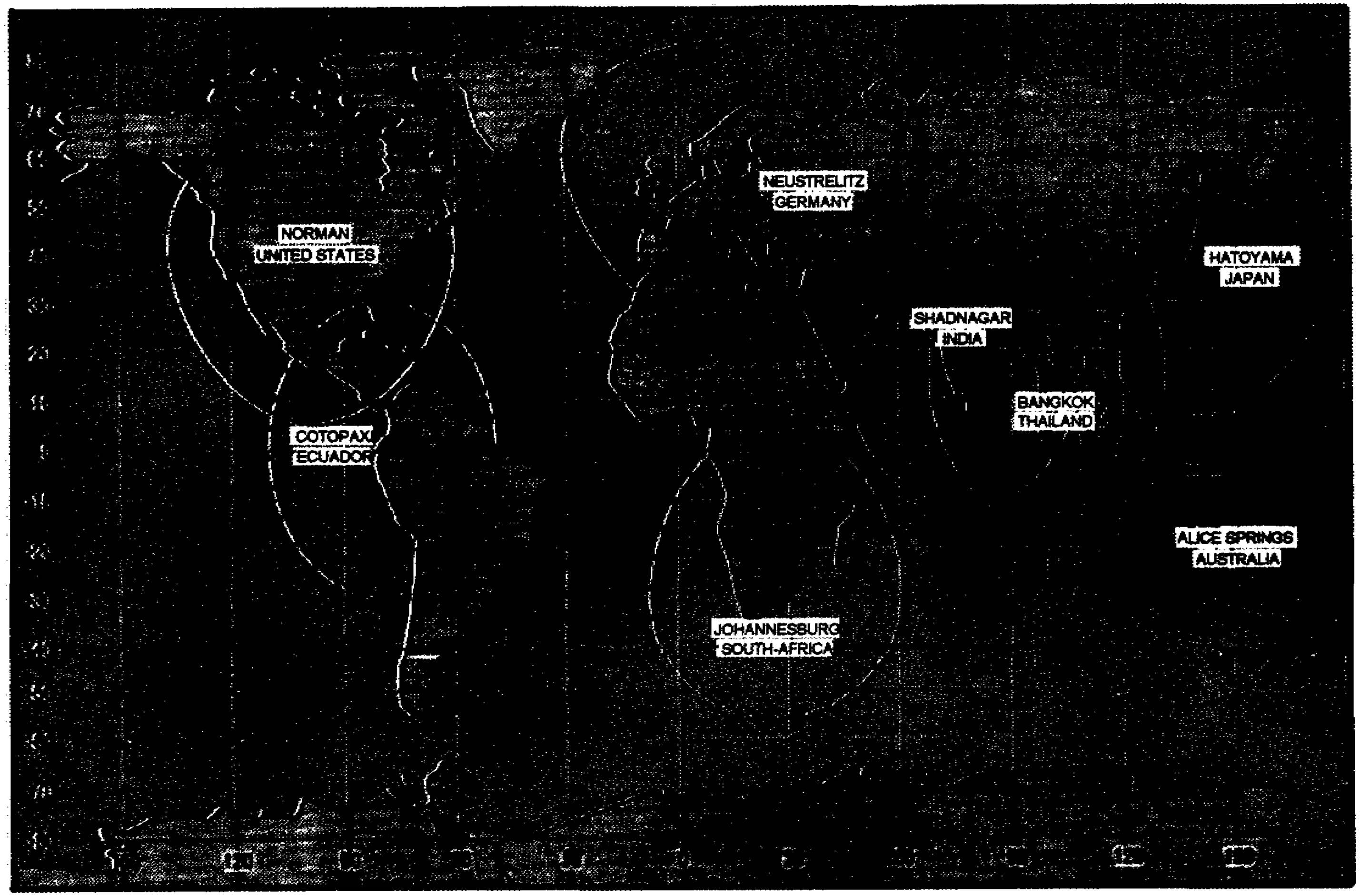
PHOTOGRAPHIC DATA

Not available

TRADING CONDITIONS

IRS data is subject to copyright. The purchaser agrees to use IRS data for their own internal purpose, and not to copy, reproduce and/or permit reproduction or dissemination of IRS data.

IRS-1C Network of International Ground Stations



Indian Remote Sensing Satellite (IRS) Coverage:

Contact Space Imaging EOSAT for actual assessment and availability of data.

Annex 6 Commercial Network Organisation SPOT IMAGE
System Exploitation - Receiving Stations
Local Distributors (ESCWA-Region)

Commercial Network Organisation

SPOT IMAGE

Spot Image was set up in 1982 by the CNES to distribute worldwide, satellite imagery returned by the SPOT earth observation satellite. It has become an unrivalled source of geographic information.

Since 1986, five million images have been acquired and catalogued, building up a unique record of our planet.

To provide easy access for new and existing users, Spot Image has set up a worldwide network of 80 distributors and three subsidiaries: Spot Image Corporation (USA), Spot Imaging Services (Australia), Spot Asia (Singapore).

We also operate:
twenty one direct receiving stations around the world, two main stations in Toulouse (France) and Kiruna (Sweden) which receive the images stored by the satellites' onboard recorders.

The 190-strong Spot Image group generated consolidated revenues of FFr M 215 in 1996. Within just a few years it has become world leader in the supply of geographic information derived from satellite imagery.

> Today, more than ever, Spot Image aims to give everyone access to a living vision of the earth.

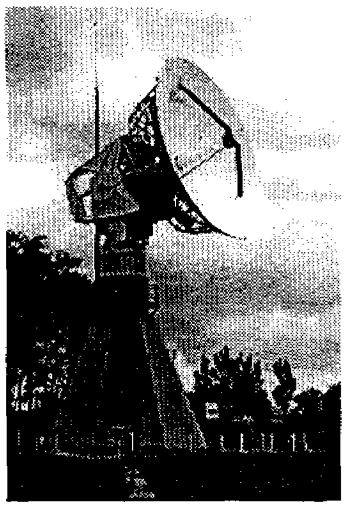
Spot Image and its subsidiaries receiving stations local distributors alphabetical search geographical search

1 - Spot Image	5, rue des Satellites BP 4359 F 31030 Toulouse cedex 4 France	+33 (0)5 62 19 40 40 +33 (0)5 62 19 40 11
2 - Spot Image Corporation	1897 Preston White Drive Reston, VA 20191-4368 USA	(+1-703) 715 3100 (+1-703) 648 1813
3 - Spot Imaging Services	156 Pacific Highway St Leonards - NSW 2065 Australia	(+61-2) 9906 1733 (+61-2) 9906 5109
4 - Spot Asia	73 Amoy Street Singapore 069892	(+65) 227 55 82 (+65) 227 62 31

SYSTEM EXPLOITATION

Receiving stations

SPOT
IMAGE



SPOT receiving stations operate on 8 GHz (X-band). This networks comprises two types of stations:

- two main stations at Toulouse and Kiruna. These stations are capable of receiving the telemetry previously recorded on the on-board recorders or directly within their visibility circle of approximatively 2500 km radius centred on the stations. Hence, they have access to imagery of any part of the globe.

- 21 direct receiving stations (DRS) which can only receive telemetry within their visibility circle. each DRS effectively manages its own visibility aone according to the satellite resources allocated by Spot Image. For each allocated pass, the station operator specifies the imaging conditions through a dialogue with a front end computer (FCMS) situated in the Mission Control Centre.

Coverage of Spot receiving stations

Local Distributors

The icon means that the distributor also operates a receiving station.

Spot Image and its subsidiaries are marked with the following icon:

Algeria

INC - National Institute of Cartography
123 rue de Tripoli
BP 430
Hussein Dey, Alger
Algeria

(+213) 223 4376
(+213) 223 4381

Benin

Centre National de Télédétection et de Surveillance du Couvert Forestier (CE.NA.TEL)
B.P. 06-711
Cotonou
Benin

(+229) 33 03 80
(+229) 33 19 56

Jordan	**Research & Consulting Services Co. Ltd.** P.O. Box 5013 Amman Hashemite Kingdom of Jordan	☎ (+962-6) 603 255 FAX (+962-6) 603 420
Kenya	**Andrews Aeronautical & Allied Equipment Ltd.** Kasuku Road, Kilimani P.O. Box 41152 Nairobi Kenya	☎ (+254-2) 72 14 33 FAX (+254-2) 72 16 40
Kuwait	**COMET International Co.** P.O. Box 29606 Safat, Code 13157 Kuwait	☎ (+965) 244 41 41 FAX (+965) 244 41 40
Libya	**Libyan Center for Remote Sensing and Space Science** P/o Box 397 Tripoli Libya	☎ / FAX (+218 21) 607 015
Morocco	**Centre Royal de Télédétection Spatiale**	☎

Morocco

Centre Royal de Télédétection Spatiale
16 bis, avenue de France
Agdal Rabat
Morocco

(+212-7) 776305 or 06
(+212-7) 776300

Mozambique

CENACARTA
537 Josina Machel Av.
P.O. Box 83
Maputo
Mozambique

(+258-1) 424 789
(+258-1) 421 959

Nigeria

Information Research Ltd.
3, Gerrard Road, Ikoyi
P.O. Box 53386
Ikoyi, Lagos
Nigeria

(+234-1) 269 34 21
(+234-1) 269 34 19

Oman

INTERTEC SYSTEMS L.L.C.
P.O. Box 345
Postal Code 118
Sultanate of Oman

(+968) 595 417 or 418
(+968) 595 419

Saudi Arabia

King Abdulaziz City for Science and Technology (KACST)
P.O. Box 6086
Riyadh 11442

(+966-1) 488 3444
(+966-1) 481 1154

Kingdom of Saudi Arabia

South Africa

CSIR
Satellite Applications Center
P.O. Box 395
Pretoria 0001
South Africa

(27-11) 642 46 92
(27-11) 642 24 46

Tunisia

Centre National de Télédétection
Route de la Marsa
B.P. 200
1080 Tunis Cedex
Tunisia

(216-1) 761 333
(216-1) 760 890

Yemen

M.A.M. International Corporation
P/O Box 525
SANA'A
Republic of Yemen

(967-1) 272 401
(967-1) 274 141

Annex 7 Information Catalog: **Eurimage**

Eurimage Newsletter December, 1996

Eurimage Newsletter December, 1996- Dear Colleague, Upcoming ERS-2 products! ESRIN has further improved the ERS SAR data products. The latest improvements.
http://www.eurimage.it/Latest_News/NewsLetters/dec96.html - size 6K - 21.May.97 - English

WWW Access to Earth Observation Data - Eurimage

Eurimage profile. Founded in 1989 by four leading companies in EO. Mission: distribution of world-wide satellite imagery to a wide range of users. In...
http://www.eurimage.it/info/www5/slide1.html - size 914 byres - 21.May.97 - English

Eurimage Newsletter November, 1995

Eurimage Newsletter November, 1995. 8th November, 1995. Dear Colleague, Best of Europe series! In the last issue we gave you a foretaste of this new...
http://www.eurimage.it/Latest_News/NewsLetters/Nov95.html - size 7K - 21.May.97 - English

WWW Access to Earth Observation Data - Eurimage

Www Access to Earth Observation Data. Eurimage Position Paper. Fifth International World Wide Web Conferencc. Tile EiNet WWW server. EiNet is a...
http://www.eurimage.it/info/www5/einet.html - size 5K - 21.May97 - English

WWW Access to Earth Observation Data - Eurimage

Interoperability. Eurimage has closely followed the ongoing activities for an EO catalogue interoperability protocol definition. An IMS gateway was~.~
http://www.eurimage.it/info/www5/slide3.html - size 1K - 2J.May.97 - English

Eurimage Prices

Eurimage Prices. Eurimage sells its Products and Services through a large network of expert distributors across Europe, North Africa and the Middle East...
http://www.eurimage.it/Common/Price_List.html - size 1K - 21 .May.97 - English

WWW Access to Earth Observation Data - Eurimage

The EiNet WWW server. EiNet: a subscription service that allows users to access metadata and Quick Look images in the company's catalogues. Standard World.
http://www.eurimage.it/info/www5/slide2.htmI - size 1K - 22.May.97 - English

Eurimage Newsletter December, 1995

Eurimage Newsletter December, 1995. 22nd December, 1995. Dear Colleague, The first images from this satellite are now available; Quick Looks can be...
http://www.eurimage.it/Latest_News/NewsLetters/Dec95.htmI - size 3K - 22.May.97 - English

How to Contact Eurimage

How to Contact Eurimage. Head Office. Contact this office for general enquiries or enquiries about invoices. Via E d'Onofrio, 212 Roma 00155 Italy..
http://www.eurimage.it/Common/Addresses.html - size 5K - 22.May.97 - English

Eurimage Newsletter May, 1996

Eurimage Newsletter May, 1996. Dear Colleague, New ERS- 1/2 Products. A series of new products is being offered for those customers interested in...
http://www.eurimage.it/Latest_News/NewsLetters/may96.html - size 5K - 22.May.97 - English

Annex 8 Information Catalog: **JERS**

Classification map using multidate JERS-1/SAR data

Rikubetsu. Classification map using multidate JERS-1/SAR data. (180kB) FTP. Data. SAR_classification-2(Hokkaido)/classify.tiff. Date: 1992.10.10,...
http:// mentor.eorc.nasda.go.jp./Gallery/Japan/Hokkaido/rikubetsu_01.html-size 1K-6.Jun,96-English

DEM data from JERS-1/OPS stereo pair images

Kiso. DEM data from JERS-l/OPS stereo pair images. Data theme: Bird's eye view image DEM data. (2l5kB) FTP. Readme. readme ops_dem/readme.Data....
http://mentor.eorc.nasda.go.jp/Gallery/Japan/Chubu/kiso_01.html - size 2K - 6.Jun.96 - English

JERS-1 COVERAGE

JERS-l observation condition (as of November *1995)* Japanese coverage... 42931 Bytes. World coverage... 46226 Bytes. This image is a distribution map which is....
http://hdsn.eoc.nasda.go.jp/guide/guide/satellite/j1_coverage_e.html - size 1014 bytes - 23.Aug.96 - English

ASF's JERS-1 SAR Computer Compatible Signal Data

JERS-1 SAR Computer Compatible Signal Data. Summary: One way that NASDA's JERS-1 (the National Aeronautics and Space Development Agency's first Japanese...
http://www.asf.alaska.edu/dataset_documents/jers1_sar_signal_data.html - size 60K - 8.May.97 - English

JERS-1 - Platforms/satellites

JERS-1 - Platforms/satellites. Launch Date Sensors Status JERS-1 11/2/92 OPS, SAR mission duration: 2 years. Orbital characteristics. - altitude: *568* km..
http://www.belspo.be/telsat/jers/jepl_001.htm-size 970 bytes - 15.Mar.96 - English

ERS-1 vs. JERS-I, White Mauntains

ERS-1 vs. JERS-1 White Mountains. Copyright 1992, ESA. Comparison: These image samples demonstrate the increased foreshortening and layover distortions...
http://www.asf.alaska.edu/user_serv/mountains.html - size 4K - 11.Oct.96 - English

JERS-1 - Services & Distributors

JERS- 1 - Services & Distributors. Contact addresses. Catalogues. Prices. Products, in both digital and photographic formats, are available through...
http://www.belspo.be/telsat/jers/jesd_001.htm - size *650 bytes - 15.Mar.96 - English*

JERS-1 Data

JERS-1 Data. SUMMARY_DESCRIPTION. Digital data from the Japanese Space Agency's Earth Resource Satellite JERS-1.
TIME_COVERAGE. 0000-00-00, 0000-00-00....
http://www.ccrs.emr.ca/linc/ps/digital/remote/djersle.html - size 7K- 1.Oct.96 - English

Annex 9 Information Catalog: **NOAA** and **NOAA-AVHRR**

USDOC/NOAA/NESDIS/National Geophysical Data Center

The National Geophysical Data Center (NGDC) manages environmental data in the fields of marine geology and geophysics, paleoclimatology, solar-terrestnal.
http://julius.ngdc.noaa.gov/ - size 8K - 2.May.97 - English

NOAA AVHRR: Methodology

NOAA AVHRR: Methodology. GIS Methodology. Integrity of the Remotely Sensed Data. when utilising a temporal series of AVHRR data it is important to...
http://www.dwe.csiro.au/local/forest/bbproj/avhnneth.hnn - size 15K - 11.Feb.96 - English

NOAA AVHRR Data User's Guide

NOAA AVHRR Data User's Guide. (Version 1.1, December 1995) Introduction. Spatial and Temporal Extent of CCRS AVHRR Archive. AVHRR Sensor Characteristics..
http://www.ccrs.nrcan.gc.ca/gcnet/guides/avhrr/avhrr.html - size 3K - 21.Dec.95- English

Search for NOAA AVHRR Quicklook Images

Search for NOAA AVHRR Quicklook Images. Search by Button. Search by Data and Time. nemoto@tkl.iis.u-tokyo.ac.jp.
http://www.tkl.iis.u-tokyo.ac.jp/SatIAN/Search/search.html - size 492 bytes - 2.Aug.96 -English

NOAA AVHRR Quicklook

NOAA AVHRR Quicklook. Quicklooks stored after December 7th 1994 are showing a combination of AVHRR channels 1-2-4 (r-g-b) for daytime data (minimum sun zenith.
http://129.247.162.47/PRODUCTS/D-QL.html - size 2K - 7 JuL95 English

Annex 10 **AVHRR-data collection:**
Summary
Attributes
Data Center
Personnel
Reference

DIF Display

If you have further questions or noticed a need for an update, please contact the GCMD staff scientists!.

EDC-Held AVHRR Data

Data Set Citation

Originator(s): U.S. Geological Survey
Title: EDC-Held AVHRR Data
Publication Date: 1980
Publication Place: Sioux Falls, South Dakota
Publisher: U.S. Geological Survey
Data Presentation Form: Remote Sensing Image

Summary

Last Updated: 1997-06-11

The Advanced Very High Resolution Radiometer (AVHRR) data set is comprised of data collected by the AVHRR sensor and held in the archives of the U.S. Geological Survey's EROS Data Center. Carried aboard the National Oceanic and Atmospheric Administration's Polar Orbiting Environmental Satellite series, the AVHRR sensor is a broad-band, 4- or 5-channel scanning radiometer, sensing in the visible, near-infrared, and thermal infrared portions of the electromagnetic spectrum.

The EROS Data Center houses AVHRR High Resolution Picture Transmission (HRPT) data and Local Area Coverage (LAC) data. The HRPT data are full resolution image data transmitted to a ground station as they are collected, while LAC data (also full resolution data) are recorded with an onboard tape recorder for subsequent transmission during a station overpass.

The objective of the AVHRR instrument is to provide radiance data for investigation of clouds, land-water boundaries, snow and ice extent, ice or snow melt inception, day and night cloud distribution, temperatures of radiating surfaces, and sea surface temperature. The AVHRR data collection effort also provides opportunities for studying and monitoring vegetation conditions in ecosystems, including forests, tundra, and grasslands with applications that include agricultural assessment, land cover mapping, production of large-area image maps (e.g., country maps, continental maps, world maps), and evaluation of regional and continental snow cover.

The Global Land Information System (GLIS) and the EOSDIS Information Management System (IMS) are interactive query systems providing information on this data set and on a variety of other data sets. These systems also support data visualization and ordering services.

For more information about these systems, see the following home pages:

GLIS Home Page: http://edcwww.cr.usgs.gov/glis/glis.html

EDC DAAC Home Page: http://edcwww.cr.usgs.gov/landdaac/landdaac.html

Attributes

Entry_ID:AVHRR
Originating Center:EDC

Temporal Coverage
From: 1980-02-10

Geographic Coverage

SouthWest Extent: 90S,180W NorthEast Extent: 90N,180E

Sources:
NOAA POES > NOAA Polar Orbiting Environmental Satellites
NOAA-10 > National Oceanic & Atmospheric Administration-10
NOAA-11 > National Oceanic & Atmospheric Administration-11
NOAA-12 > National Oceanic & Atmospheric Administration-12
NOAA-14 > National Oceanic & Atmospheric Administration-14
NOAA-6 > National Oceanic & Atmospheric Administration-6
NOAA-7 > National Oceanic & Atmospheric Administration-7
NOAA-8 > National Oceanic & Atmospheric Administration-8
NOAA-9 > National Oceanic & Atmospheric Administration-9

Sensors:
AVHRR > Advanced Very High Resolution Radiometer

Distribution Media:

Distribution Media:Tape
Size:2 gigabyte maximum per image
Format:3480 bpi, 8 mm, ASCII unlabeled
Fees: Level 1b, $50; Georegistered, $190

Storage Media: Magnetic Tape

Parameters: Category > Topic > Term > Variable:
EARTH SCIENCE > RADIANCE OR IMAGERY > INFRARED WAVELENGTHS > INFRARED IM

EARTH SCIENCE > RADIANCE OR IMAGERY > VISIBLE WAVELENGTHS > VISIBLE IMAG

Discipline > Subdiscipline:
EARTH SCIENCE

Location Keywords:
GLOBAL

General Keywords:
AVHRR
DAAC
EDC
EOSDIS
EROS
HRPT
IMAGERY
LAC
LEVEL 1B
RADIANCE
RASTER
SATELLITE
USGS

Access Constraints:
None

Use Constraints:
None

Revision Date: 1997-06-11

Data Center

Data Center:EDC_DAAC > EROS Data Center Distributed Active Archive Center
Data Center URL:http://edcwww.cr.usgs.gov/landdaac/landdaac.html
Data Center Contact:EDC_DAAC_USER_SERVICES,PLEASE_CONTACT

Phone: 605-594-6116
Phone: FAX 605-594-6963
Email: INTERNET > EDC@EOS.NASA.GOV

EDC DAAC User Services
U.S. Geological Survey
EROS Data Center
Sioux Falls, SD 57198
USA

Data Center:EROS > Earth Resources Observation Systems Data Center
Data Center URL:http://edcwww.cr.usgs.gov/eros-home.html
Data Center Contact:CUSTOMER_SERVICES,PLEASE_CONTACT

Phone: 605-594-6151
Phone: FAX 605-594-6589
Email: INTERNET > CUSTSERV@EDCMAIL.CR.USGS.GOV

Customer Services
U.S. Geological Survey
EROS Data Center

```
Sioux Falls, SD  57198
USA
```

Personnel

```
Tech Contact: CUSTOMER_SERVICES,PLEASE_CONTACT
              Phone:605-594-6151

              Phone:FAX 605-594-6589
              Email:INTERNET > CUSTSERV@EDCMAIL.CR.USGS.GOV

              Customer Services
              U.S. Geological Survey
              EROS Data Center
              Sioux Falls, SD  57198
              USA
DIF Entry Author: INFORMATION_SYSTEMS_MANAGEMENT,PLEASE_CONTACT
              Phone:605-594-6594

              Phone:FAX 605-594-6589
              Email:INTERNET > CUSTSERV@EDCMAIL.CR.USGS.GOV

              Information Systems Management
              U.S. Geological Survey
              EROS Data Center
              Sioux Falls, SD  57198
              USA
```

Reference

Kidwell, K.B., 1995, NOAA polar orbiter data user's guide: Washington, D.C., National Oceanic and Atmospheric Administration [variously paged].

Supplementary Information Menu

Data Center: EDC_DAAC > EROS Data Center Distributed Active Archive Center

Data Center: EROS > Earth Resources Observation Systems Data Center

Source: NOAA POES > NOAA Polar Orbiting Environmental Satellites

Source: NOAA-10 > National Oceanic & Atmospheric Administration-10

Source: NOAA-11 > National Oceanic & Atmospheric Administration-11

Source: NOAA-12 > National Oceanic & Atmospheric Administration-12

Source: NOAA-6 > National Oceanic & Atmospheric Administration-6

Source: NOAA-7 > National Oceanic & Atmospheric Administration-7

Source: NOAA-8 > National Oceanic & Atmospheric Administration-8

Source: NOAA-9 > National Oceanic & Atmospheric Administration-9

Sensor: AVHRR > Advanced Very High Resolution Radiometer

Annex 10-1 Advanced Very High Resolution Radiometer (AVHRR)

Background
Extent of Coverage
Acquisition
    Processing Steps
Data Characteristics
    Spatial Resolution
    Temporal Coverage
    Spectral Range
Data Organization
Data Availability
    Procedures for Obtaining Data
    Products and Services
Applications and Related Data Sets
References
Appendix -data types and selection parameters-

Advanced Very High Resolution Radiometer

Table of Contents

Background

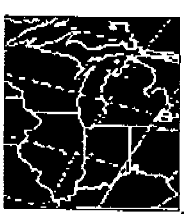
The Advanced Very High Resolution Radiometer (AVHRR) is a broad-band, four or five channel (depending on the model) scanner, sensing in the visible, near-infrared, and thermal infrared portions of the electromagnetic spectrum. This sensor is carried on NOAA's Polar Orbiting Environmental Satellites (POES), beginning with TIROS-N in 1978.

AVHRR data are acquired in three formats:
  High Resolution Picture Transmission (HRPT)
  Local Area Coverage (LAC)
  Global Area Coverage (GAC)

HRPT data are full resolution image data transmitted to a ground station as they are collected. LAC are also full resolution data, but recorded with an on-board tape recorder for subsequent transmission during a station overpass. GAC data provide daily subsampled global coverage recorded on the tape recorders and then transmitted to a ground station.

Extent of Coverage

The AVHRR sensor provides for global (pole to pole) on board collection of data from all spectral channels. Each pass of the satellite provides a 2399 km (1491 mi) wide swath. The satellite orbits the Earth 14 times each day from 833 km (517 mi) above its surface.


Example swath

Acquisition

AVHRR data are both broadcast continually in direct readout mode and recorded on board the satellite for later playback. The EROS Data Center (EDC) AVHRR Data Acquisition and Processing System (ADAPS), which began operation in May 1987, receives approximately six daytime passes per day of HRPT data over the conterminous United States. Night acquisitions are acquired upon request only. As of March 1990, all data received at EDC are permanently archived. Prior to March 1990, approximately 40 percent of the data received were archived.

The EROS Data Center AVHRR Data Acquisition and Processing System was expanded on June 15, 1990, to acquire LAC and GAC data via a communications satellite for areas recorded throughout the entire globe. Priority is given to LAC acquisitions of the North American continent not covered by EDC's direct reception capabilities and other project specific areas.

NOAA/NESDIS receives both world-wide recorded and direct readout AVHRR data from the Wallops Island, Virginia, and Gilmore Creek, Alaska, stations. Those stations then redirect the data via a satellite relay to NOAA/NESDIS in Suitland, Maryland, where the data are processed, archived, and reproduced.

Processing Steps

EDC's ADAPS flow for acquisitions and archiving begins with either direct HRPT reception or re-broadcast DOMSAT LAC/GAC reception. Initial ingest of the data reformatting includes archiving, and creation of browse quick looks, 9-track tapes, and 3480 cartridge tapes.

The NOAA AVHRR processing flow begins with sensor data receipt by the Command and Data Acquisition (CDA) stations (Wallops Island, Virginia and Gilmore Creek, Alaska) where the data are re-broadcast via communications satellites, to NOAA/NESDIS in Suitland, Maryland. The ephemeris data are accessed through the Gridded Earth Location and Determination System (GELDS) software on NAS computers for Level 1b production.

The EROS ADAPS systematic georegistration process references AVHRR data to the Earth's surface. Through modeling the position and attitude of the TIROS satellite platforms and the scanning geometry of the AVHRR sensor, geometric distortions can be minimized. The position of the satellite is determined by an orbital model updated by ephemeris data received daily from NAVY Space Surveillance. The AVHRR sensor model characterizes the non-linear scanning of the sensor mirror. A refinement to the sensor model accounts for the displacement in longitude due to the rotation of the Earth under the satellite. All modeling is referenced to the time of acquisition. As the satellite clock time drifts, a delta time adjustment is applied. Collectively, these models comprise the geometric correction model in ADAPS. The positional accuracy of a systematic georegistration is approximately 5000 m, RMSE.

Precise georegistration positional accuracy of 1000 m RMSE, requires correlation of image features with accurately registered cartographic or image-based maps. A common practice is to use cartographic sources such as Digital Chart of the World (DCW) or hydrography data to extract easily identifiable features such as coastlines, water bodies, and rivers and to correlate them with the matching raw image locations using various techniques. The correlation process determines specific adjustments to be applied to the time, roll, and yaw parameters of the orbital model. The EDC ADAPS uses a variety of techniques depending upon the geographic location of the imagery and the volume of data to be processed.

Data Characteristics

Spatial Resolution

The average instantaneous field-of-view (IFOV) of 1.4 milliradians yields a LAC/HRPT ground resolution of approximately 1.1 km at the satellite nadir from the nominal orbit altitude of 833 km (517 mi). The GAC data are derived from an on board sample averaging of the full resolution AVHRR data. Four out of every five samples along the scan line are used to compute one average value and the data from only every third scan line are processed, yielding 1.1-km by 4-km resolution at nadir.

Temporal Coverage

AVHRR

Satellite Number	Launch Date	Ascending Node	Descending Node	Service Dates
TIROS-N	10/13/78	1500	0300	10/19/78 - 01/30/80
NOAA-6	06/27/79	1930	0730	06/27/79 - 11/16/86
NOAA-7	06/23/81	1430	0230	08/24/81 - 06/07/86
NOAA-8	03/28/83	1930	0730	05/03/83 - 10/31/85
NOAA-9	12/12/84	1420	0220	02/25/85 - Present
NOAA-10	09/17/86	1930	0730	11/17/86 - Present
NOAA-11	09/24/88	1340	0140	11/08/88 - 09/13/94
NOAA-12	05/14/91	1930	0730	05/14/91 - Present
NOAA-14	12/30/94	1340	0140	12/30/94 - Present

NOAA-B launched May 29, 1980, failed to achieve orbit. NOAA-13 launched August 9, 1993, failed due to an electrical short circuit in the solar array.

Spectral Range

Band #	Satellites: NOAA-6,8,10	Satellites: NOAA-7,9,11,12,14	IFOV
1	0.58 - 0.68	0.58 - 0.68	1.39
2	0.725 - 1.10	0.725 - 1.10	1.41
3	3.55 - 3.93	3.55 - 3.93	1.51
4	10.50 - 11.50	10.3 - 11.3	1.41
5	band 4 repeated	11.5 - 12.5	1.30
	(micrometers)	(micrometers)	(milliradians)

Data Organization

The record structure of LAC/HRPT Level 1b data sets for each file follows the pattern:

```
Record 1  TBM (Terabit memory)Header record (122 bytes)
Record 2  Data Set Header record (7400 bytes)
Record 3  Dummy (7400 bytes)
Records 4-n  Data records (7400 bytes)
```

The record structure of GAC data sets for each file follows the pattern:

```
Record  1 .... TBM (Terabit memory) Header record (122 bytes)
Record  2 .... Data Set Header record
Record  3-n .. Data records
```

Data Availability

Procedures for Obtaining Data

To place orders and to obtain additional information regarding technical details, ancillary products, and pricing schedules, contact:
Customer Services, Eros Data Center
OR
NOAA/SAA User Assistance

The GLIS INVENTORY and ORDER screens may also be used for further information on ordering AVHRR data. NOAA/SAA may also be contacted through the GLIS Remote Link.

Products and Services

The EROS Data Center provides standard AVHRR digital Level 1b and georegistered products on 9-track tapes 6250 bpi, 3480 cartridge, 8 mm cassette, and via network access.

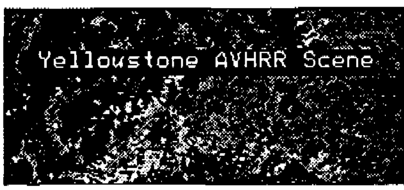
Applications and Related Data Sets

AVHRR

AVHRR data provide opportunities for studying and monitoring vegetation conditions in ecosystems including forests, tundra, and grasslands. Applications include agricultural assessment, land cover mapping, producing image maps of large areas such as countries or continents and tracking regional and continental snow cover. AVHRR data are also used to retrieve various geophysical parameters such as sea surface temperatures and energy budget data.

Additional data sets include the Alaska twice-monthly AVHRR and the U.S. Conterminous bi-weekly composites. These comprehensive time series data sets are calibrated, georegistered daily observations and twice-monthly maximum NDVI composites for each annual growing season.

Global Experimental Bi-Weekly Normalized Difference data, computed from Global Vegetation Index (GVI) data, are analyzed to monitor global vegetation as a potential tool in global climatic studies.



Example scene

References

Kidwell, Katherine B., comp. and ed., 1991, NOAA polar orbiter data (TIROS-N, NOAA-6, NOAA-7, NOAA-8, NOAA-9, NOAA-10, NOAA-11, and NOAA-12) users guide: Washington, D.C., NOAA/NESDIS.

Kidwell, Katherine B., comp. and ed., May 1990, Global Vegetation Index user's guide: Washington, D.C., NOAA/NESDIS.

Ohring, George, Gallo, K.P., Gruber, Arnold, Planet, Walter, Stowe, Larry, Tarpley, J.D., 1989, Climate and global change: Eos, American Geophysical Union, v. 70, no. 41, October 10, 1989, p. 889, 891, 894, 901.

Earth Observation Satellite Company, 1994, Landsat system status report--September 1994: Lanham, Md., Earth Observation Satellite Company, p. 1-11.

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National Oceanic and Atmospheric Administration, 1985, Hydrologic and land sciences applications of the National Oceanic and Atmospheric Administration polar-orbiting satellite data: Washington, D.C., NOAA/NESDIS.

National Oceanic and Atmospheric Administration, March 1994, National Oceanic and Atmospheric Administration Retrospective satellite data price list, satellite products list and ordering procedures: Washington, D.C., NOAA/NESDIS.

Appendix

TBM Header The TBM Header contains data type and selection parameters. All fields are ASCII except the Channels Selected field which is binary. The overall format follows:

BYTE #	# OF BYTES IN FIELD	CONTENT
31-74	44	Data Set Name**
75	1	Total/Selective Copy ("T" or "S")
76-78	3	Beginning Latitude
79-81	3	Ending Latitude
82-85	4	Beginning Longitude
86-89	4	Ending Longitude
90-91	2	Start Hour
92-93	2	Start Minute
94-96	3	Number of Minutes
97	1	Appended Data Selection ("Y" or "N")
98-117	20	Channels Selected (in binary)

** The complete data set name with qualifiers follows the pattern:

NSS.Data-type.Spacecraft-Unique-ID.Year-day.Start-time.
Stop-time.
Processing-block-ID.Source. The following screens detail this scheme.

Qualifier	Valid Entry
Data-Type	HRPT = HRPT GHRR = GAC (recorded) LHRR = LAC (recorded HRPT)
Spacecraft-Unique ID	TIROS-N = TN NOAA-A = NA = NOAA-6 NOAA-B = NB NOAA-C = NC = NOAA-7 NOAA-E = NE = NOAA-8 NOAA-F = NF = NOAA-9 NOAA-G = NG = NOAA-10 NOAA-H = NH = NOAA-11 NOAA-D = ND = NOAA-12 NOAA-I = NI = NOAA-13 NOAA-J = NJ = NOAA-14
Year-day	D78141, where "D" identifies this section as a Julian day delimiter. The "78" identifies the year the spacecraft began recording data, and the "141" indicates the Julian day the satellite began recording.
Start-time	S1422, where "S" identifies this group as a start time delimiter. The "1422" indicates 14 hours and 22 minutes GMT to the nearest minute to when the spacecraft recording began.
Stop-time	E1555, where "E" identifies this group as a end time delimiter. The "1555" indicates 15 hours and 55 minutes GMT to the nearest minute of the spacecraft recording of the last usable data.
Processing-Block-ID	B0017499, where "B" indicates this group is a processing block ID delimiter. The "0017499" is

	a seven digit number identifying the spacecraft revolution number in which data recording began and the revolution in which the recording ended. The first five digits identify the beginning revolution and the last two being the least significant numbers of the ending revolution. The revolution number may be off by one or two digits.
Source	Gilmore Creek, Alaska = GC Western Europe CDA = WE SOCC (Satellite Operations Control Center) = SO Wallops Island, Virginia = WI EDC, Sioux Falls, SD = SD

Header Record Formats

The pre-September 1992 binary Data Set Header record format follows:

BYTE #	# OF BYTES IN FIELD	CONTENT
1	1	Spacecraft ID
2	1	Data Type
3-8	6	Start Time - time code from first data frame
9-10	2	Number of Scans
11-16	6	End Time - time code form last data frame
17-23	7	Processing Block ID (ASCII)
24	1	Ramp/Auto Calibration
25-26	2	Number of Data Gaps
27-32	6	DACS Quality
33-34	2	Calibration Parameter ID
35	1	DACS Status
36-40	5	Zero-filled - spare
41-84	44	44 Character data set (EBCDIC)
85-end	variable	Spares - Zero-filled to size of data record (3220 or 14800)

The post-September 1992 binary Data Set Header record format follows:

BYTE #	# OF BYTES IN FIELD	CONTENT
1-84	84	Remain unchanged
85-86	2	Year of Epoch for orbit vector(xx)
87-88	2	Julian Day of Epoch (xxx)
89-92	4	Millisecond GMT Epoch time of day (xxxxxxxx)
	Keplerian Orbital Elements	
93-100	8	Semi-major axis in kilometers (xxxxx .xxx)
101-108	8	Eccentricity (.xxxxxxxx)
109-116	8	Inclination in degrees (xxx.xxxxx)
117-124	8	Argument of Perigee in degrees (xxx .xxxxx)
125-132	8	Right Ascension of the Ascending Node in degrees (xxx.xxxxx)
133-140	8	Mean Anomaly in degrees (xxx.xxxxx)

The September 7, 1994 binary Data Set Header record enhancement format follows:

BYTE #	# OF BYTES IN BYTES	CONTENT
1-35	35	Remain unchanged
36	1	Reserved for Mounting and Fixed

		attitude correction indicator 0 = no corrections applied 1 = corrections applied
37	1	NADIR EL tolerance - integer scaled to 0.1 km, values range from 0.1 to 25.5 km
38-40	3	Zero-filled - spare
41-92	52	Remain unchanged

Keplerian Orbital Elements

93-96	4	Semi-major axis in kilometers times 10E+3
97-100	4	Eccentricity times 10E+8
101-104	4	Inclination in degrees times 10E+5
105-108	4	Argument of Perigee in degrees times 10E+5
109-112	4	Ascending Node in degrees times 10E+5
113-116	4	Mean Anomaly in degrees times 10E+5
117-120	4	X Position Vector in kilometers times 10E+4
121-124	4	Y Position Vector in kilometers times 10E+4
125-128	4	Z Position Vector in kilometers times 10E+4
129-132	4	X-dot Velocity Vector in kilometer/seconds times 10E+6
133-136	4	Y-dot Velocity Vector in kilometer/seconds times 10E+6
137-140	4	Z-dot Velocity Vector in kilometer/seconds times 10E+6
141-142	2	Reserved for Yaw fixed error correction in degrees times 1000
142-144	2	Reserved for Roll fixed error correction in degrees times 1000
145-146		Reserved for Pitch fixed error correction in degrees times 1000
147-end	var.	Spaces - zero filled to data record size

Cartesian Inertial True of Date Elements

BYTE #	# OF BYTES IN FIELD	CONTENT
141-148	8	X component of position vector in kilometers (xxxx.xxxx)
149-156	8	Y component of position vector in kilometers (xxxx.xxxx)
157-164	8	Z component of position vector in kilometers (xxxx.xxxx)
165-172	8	X-Dot component of the velocity vector in km/second (x.xxxxxx)
173-180	8	Y-Dot component of the velocity vector in km/second (x.xxxxxx)
181-188	8	Z-Dot component of the velocity vector in km/second (x.xxxxxx)
189-end	variable	Spares - Zero filled to the size of the data record (3220 or 14800)

LAC Data Set Information Each LAC data set contains two records per scan. The records are 7400 bytes long and are written in binary format. A design detail follows:

To calculate the size in megabytes of an AVHRR scene follow the formula\listed below:

- Two records at 7400 bytes each .... 14800 bytes
- Six lines/second capture rate (6 x 60 seconds). 360 lines/minute
- Using an average EROS pass of .... 12 minutes

- Formula: 14800 x 360 x 12 = 63.9 megabytes

The pre-September 1992 LAC/HRPT data record format:

BYTE #	# BYTES	CONTENTS
1-2	2	Scan line number from 1 to n
3-8	6	Time code - year, julian day, milliseconds
9-12	4	Quality indicators
13-52	40	Calibration coefficients
53	1	Number of meaningful zenith angles and Earth location points appended to scan (n)
54-104	51	Solar zenith angles
105-308	204	Earth location
309-448	140	Telemetry (header)
449-14104	13656	LAC/HRPT video data
14105-14800	696	Spares

Post-September 1992 LAC/HRPT data record format follows:

BYTE #	# BYTES	CONTENTS
1-14104	14104	Remain unchanged
14105-14124*	20	Additional decimal portion of the 51 solar zenith angles
14125-14800	676	Spares

The additional data use 19 bytes and 1 bit (3 bits per angle); the first bit in 14124 is used; all others are spares.

The LAC/HRPT video data contain five (channel) values for each of the 2048 points in a scan. There is a total of 10240 samples (5 channels x 2048 points) in the data.

GAC Data Set Information Data within each GAC data set has one logical record per scan. Each record contains 3220 binary bytes. The pre-September 1992 GAC format follows:

BYTE #	# BYTES	CONTENT
1-2	2	Scan line number from 1 to n
3-8	6	Time code (year, julian day, milliseconds)
9-12	4	Quality indicators
13-52	40	Calibration coefficients
53	1	Number of meaningful zenith angles and Earth location points appended to scan (n)
54-104	51	Solar zenith angles
105-308	204	Earth location
309-448	140	Telemetry (HRPT minor frame format)
449-3176	2728	GAC video data
3177-3220	44	Spare

The post-September 1992 GAC format follows:

BYTE #	# BYTES	CONTENT
1-3176	3176	Remains unchanged
3177-3196*	20	Additional decimal portion of 51 Solar Zenith angles
3197-3220	24	Spares

Additional data use 19 bytes and 1 bit (3 bits per angle); the first bit in 3196 is used; all others are spares.

The GAC video data consist of five (channel) readings for each of the 409 points in a scan. There is a total of 2045 samples (5 channels x 409 points) in the data. For TIROS-N, NOAA-6, -8, -10, and -12, there is no sensor for channel 5; therefore, channel 4 data are repeated in the fifth channel position.

Annex 10-2 Advanced Very High Resolution Radiometer Search Criteria

USGS

Advanced Very High Resolution Radiometer: Search Criteria

Geographic Coverage ?

Draw Area on World Map | Search by US Placename NEW

or enter coordinates (format = N/S, E/W DDD MM SS or +/-DDD MM SS or +/-DDD.NNNN)

Northernmost Latitude

Westernmost Longitude | Easternmost Longitude

Southernmost Latitude

Acquisition Date ?

The format for specifying date is YYYY/MM/DD

TO

Browse Availability ?

Select up to two values or choose ALL

ALL
NO
YES

Submit Search | Clear Entries | Additional Search Criteria

|| GLIS Home Page | GLIS Help ||

URL: http://edcwww.cr.usgs.gov/Webglis/glisbin/search.pl?AVHRR
Maintainer: webglis@edcwww.cr.usgs.gov;
Last modified: 30 April 1997

Annex 11 The Company for Applied Remote Sensing (GAF)

GAF Gesellschaft für Angewandte Fernerkundung mbH/ Company for Applied Remote Sensing

Celebrating 10 years of leadership in providing innovative solutions and quality products.

"Satellite Remote Sensing and GIS solutions for professional mapping and management of the worlds natural resources."

The Company for Applied Remote Sensing (GAF), founded in 1985, is an internationally active consultants firm in the fields of satellite remote sensing, digital image processing, and geographical information systems. GAF, a private sector enterprise located in Munich, is a member of the AHT GROUP Management Services .

euromap STA

IRS data reception for Europe Sistemas de Teledetección Aplicada

Homepage GAF mbH

GAF

A company uniquely committed to excellence in performance and quality in products and services.

Introduction to the Company

GAF is a private sector enterprise, founded in 1985 and located in Munich. The shareholders are Agrar- and Hydrotechnik (AHT) AHT Group Management Services, Essen, JKB Verwaltungsgesellschaft des Wittelsbacher Ausgleichsfond, Munich and Dr.Rupert Haydn, Munich.

The company is a member of the AHT-Group Management Service. GAF has established a Quality Management System (QMS) in 1995 and is fully certified according to International Standard Organisation (ISO) 9001 (Re-certified in 1996).

GAF's services are dedicated to the complete range of value-added services for remotely sensed data and GIS applications in the fields of environmental surveillance, forestry, agriculture, soil mapping, landuse/landcover mapping, hydrology, hydrogeology, exploration, geophysics and cartography. For the present GAF is employing a staff of 30 experts in these fields of earth sciences.

Striving to attain such competence and efficiency is based on GAF's belief that success in the rapidly advancing field of remote sensing requires not only a sound technical infrastructure, but also a profound understanding of the relationship between the fields of application and the available technology. GAF also believes that solving problems related to a broad spectrum of applications can only be done by interdisciplinary approach and experienced management.

Business structure

- GIS database design, generation, management and analysis for natural resources, environment / Forestry, agriculture
- Project planning, implementation and management / GIS, Management Information Systems
- Digital cartography and map production / GIS, training
- Satellite data distribution / Official distributor of EOSAT, Eurimage, Spotimage, Sovinformsputnik, Radarsat Int.
- Standard Satellite Data Processing / Laserfilmwriting Services
- Education & training

Affiliations and Owned Companies

euromap EUROMAP GmbH (a GAF company for IRS Satellite Data acquisition and distribution), Neustrelitz, Germany

GAF

Satellite Image Suppliers & Space Research Agencies

Satellite Images Suppliers:

EUROMAP. Germany

EURIMAGE. Italy

EOSAT. USA

SPOT IMAGE. France

Canadian Space Agency Agence spatiale canadienne RADARSAT - Canadian Space Agency

Instituto Nacional de Pesquisas Espaciais. Brazil

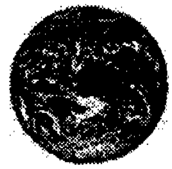
Space Research Organizations:

European Space Agency

The National Aeronautics and Space Administration

Deutsche Forschungsanstalt für Luft- und Raumfahrt e.V. DLR German Aerospace Research Stablishment

Centre National d'Etudes Spatiales

GAF World Wide Activities 

The Company for Applied Remote Sensing (**GAF**), founded in 1985, is today an internationally recognized consulting firm offering a full range of services specifically related to spaceborne remote sensing. **GAF** is a privately held company based in Munich, Germany, and a member of the Agrar- und Hydrotechnik (**AHT**) Group, based in Essen, Germany.

World-Wide Activites

As a highly specialised company, **GAF** is tied into the AHT GROUP of companies which has the capacitiy to provide the full spectrum of engineering and management services for the design, planning and implementation of agricultural, infra-structural and environmental projects world-wide.

GAF is registered at the **World Bank**, the **Asian and African Development Bank**, various units of the **European Union** including the PHARE and TACIS programmes and with the **FAO** in Rome.

Support to the Global Market

Services in satellite remote sensing often need support components from neighboring areas such as aerial photography, database technology, cartography, thematic mapping, and project planning.**GAF** has developed integrated approaches using best outside expertise to be found in the international market.

GAF has been a leader in forming international consortia and company-like structures into competetive business alliances to disseminate satellite remote sensing information to the global market.

Representatives and Affiliations:

GAF USA, Washington Representative
GAF Sweden, Scandinavian Representative
STA Sistemas de Teledetección Aplicada
euromap IRS data reception for Europe

GAF

Remote Sensing & GIS - Areas of application

GAF provides the complete range of technical services related to remote sensing and geographic information systems (GIS), and associated disciplines, including the following main sectors:

- Forestry
- Agriculture
- Regional planning
- Environmental monitoring
- Hydrology
- Geology, Lithology
- Natural hazard monitoring

The diversity of space and airborne sensor systems and potential applications requires a high conceptual and instrumental flexibility. GAF offers a complete range of services and represents a perfect partner for professional activities, ranging from satellite data distribution, image processing and interpretation and image recording on film to database design, GIS analysis and digital cartography. In addition, software development, consultancy and training are offered.

For more information, contact GAF

GAF Services Offered

Products & Services

GAF provides the complete range of technical services related to satellite remote sensing, geographic information systems (GIS), and associated disciplines, including:

- Project planning, implementation and management.
- Image processing and interpretation.
- GIS database management and analysis.
- Digital cartography and map production.
- Education and training.
- Application programme development.
- GAF & GEOSYSTEMS Image Processing Service
- Satellite data distribution.
- Research & Development.

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Satellite Data Distribution

GAF is national sales representative to support all customers and interested parties, offers a full scope of consultancy services concerning all technical, formal and commercial aspects of satellite data, from data acquisition to the delivery of final geoinformation products.

GAF is official distributor for EURIMAGE and SOVINFORMSPUTNIK and exclusive distributor for SPOTIMAGE in Germany. GAF can garantuee the optimal response to its clients data requirements. Since 1995 GAF is also exclusive distributor for RADARSAT Int. in Germany.

The following satellite data can directly be obtained through GAF:

- Landsat-MSS / -TM
- SPOT-XS / Pan
- IRS-1A, B, C
- NOAA-AVHRR
- RESURS
- ERS-1/2 SAR
- J-ERS-1 SAR
- Radarsat (all modes)
- KVR-1000
- TK350
- KFA
- MOMS-02-D2

LANDSAT-TM and MSS-data

As international sales representative of EURIMAGE, GAF acquires LANDSAT-TM and MSS data and products from ground receiving stations worldwide, including Frascati (Italy), Kiruna (Sweden) and Maspalomas (Spain) in Europe. Good contacts exist also to receiving stations in South Africa, Thailand, Indonesia, Pakistan, Brazil and Australia.

Indian Remote Sensing satellite data

GAF is prime contact for the customer support to the recently established europeanwide distributor network. For more information please refer to EUROMAP

SPOT data

As official distributor of SPOT IMAGE products, GAF also disseminates satellite data worldwide.

Russian satellite data

GAF, as sales representative of SOVINFORMSPUTNIK handles the acquisition and distribution of KFA-1000 photographs. For some years now, these high resolution space photographs, taken by the Russian satellite series KOSMOS and the space station MIR, have been increasingly used in the field of environmental monitoring and regional planning.

Radar satellite data

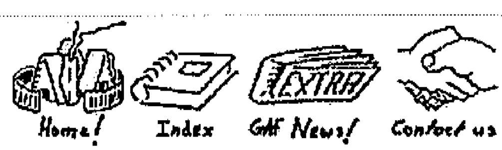
Through EURIMAGE all ERS-1/2 SAR and J-ERS-1 SAR data can be ordered directly at GAF. Since 1995 GAF is also exclusive distributor for RADARSAT Int. in Germany.

Customer Support

- GAF distribution personnel and the company's applications specialists are always updated on the newest developments in the field of remote sensing, geographic information systems (GIS) and related disciplines.
- The company's technical and operational expertise is at the customer's disposal for selecting the appropriate sensor, the preferable spectral resolution and the best possible acquisition dates for his specific project needs.
- GAF has special information support for SPOT data users. SPOT newsletters *(in German)* with dedicated information on products, applications and prices will be send to all interested clients.

Requests for Satellite Imagery

- Through on-line connections to the digital data catalogues like of EURIMAGE and SPOT IMAGE, and access to the constantly updated EOSAT microfiche catalogue, GAF can perform an instant search in these archives, check the availability of scenes and conduct an initial quality control of the data.
- When a scene is not available from the archive, or when new images are needed, a special acquisition can be performed by programming a satellite to acquire the image needed by the customer.



GAF GIPS - GAF Image Processing Services

Satellite image data are normally provided in digital form and processed by dedicated hard-and software.

The output of digital data on film is useful for graphic and visual control of the processing results, for poster production and as a basis for image interpretation. For these purposes, high quality film products should have excellent color consistency, clarity and sharpness.

After exposure, the film is a flexible basis for the production of large scale photo prints or color slides, posters and the like.

Content ...

CIRRUS LC-3000E Laser Film Recorder ...

GAF & Geosystems Image Processing Services include the recording of digital images on film by CIRRUS laser film recorder. This service is offered to all interested parties. For a most reasonable rate, any user now has access to the most advanced technology for generating high-quality film outputs.

CIRRUS are the latest in state-of-the-art film recorders, offering many advantages:

- simultaneous 3-color (red green blue), full 24-bit image recording.
- eliminates color mis-registration through single pass red/green/blue plotting.
- produces crisp pixels on high resolution film by using high intensity, short pulse exposures.
- creates sharp, square pixels from user's choice of projected apertures down to 10 microns.
- high color, fast and brilliant outputs.
- sophisticated software for image preprocessing images and cartographic annotation.
- permanent quality control of film characteristics.

Technical specifications are ...

- **Input format and medium:**

  all usual formats on CCT, Exabyte, DAT, QIC, TK70, CDROM and floppy disks.

- **Maximum output raster size:**

  23600 columns to 24500 rows at 10 microns.

- **Resolution:**

  apertures of 10, 12.5, 15, 20, 25, 28.5 and 30 multiples from 2x to 8x (interpolation option) itended for general plotting as well as for accurate 1:1,000,000, 1:500,000 and 1:250,000 recording of LANDSAT, SPOT, IRS-IA-C, KVR-1000, KFA-3000 data, ...

- **Film format:**

  8x10 inch or 10x10 inch sheet film.

- **Film types:**

  color reversal, color negative, black & white negative films.

- **Mechanical accuracy:**

  x/y-axis positional accuracy over a specified range of 1000 ± 0.5 micron.

Standard Plots are ...

Input medium:

» 1/2" CCT 6250 bpi » 1/4" QIC 6250 bpi 150 MB -2.5 GB » 8 mm Exabyte 8200 - 8505XL » 4 mm DAT 2-8 GB » CD-ROM ISO9660

Interfaces:

» UNIX, PC » ERDAS/Imagine BSQ

Data processing:

» Data contrast enhanced 0-255

Band structure:

» Raw image data » Band sequential (BSQ) without header files or records » File sequence: Red - Green - Blue

Film type:

» Kodak Ektachrome 64 Colour Positive » Kodak Vericolor III Type S Colour Negative » Kodak LL7 B/W Negative/Positive

Film format:

» 8" x 10"

Plot Options are ...

Layout:

» Contrast stretching / Image enhancement » Annotation » Image cropping (Zoom) » Scale bar » Control wedges

Filmformat:

» 10"x 10"

Other mediums / interfaces:

» on special request

Resolutions are ...

Resolution in Microns	max. Number of Columns and Rows (x,y)			
Film Size [inch]	8 x 10		10 x 10	
	Standard			
20 - 30	7000	6000		
	Options			
10,0	23600	19500	23600	24500
12,5	18800	15600	18800	19600
15	15700	13000	15700	16300
20	11800	9700	11800	12200
25	9400	7800	9400	9800
28,5	8200	6800	8200	8500
30	7800	6500	7800	8100

Contact Information:

GAF mbH
Leonrodstr. 68
D-80636, Munich, Germany
Phone: +49 89 12 15 28 0
Fax: +49 89 123 31 48
Email: cirrus@gaf.de

Annex 12 Digitales Nachweissystem für Satellitenbilddaten (DNS) of the Federal Istitute for Geosciences and Natural Resources (BGR, Hannover)
- currently the description is available only in German language-

Digitales Nachweissystem für Satellitenbilddaten (DNS)

Abfrageergebnis

Auswahlkriterien:

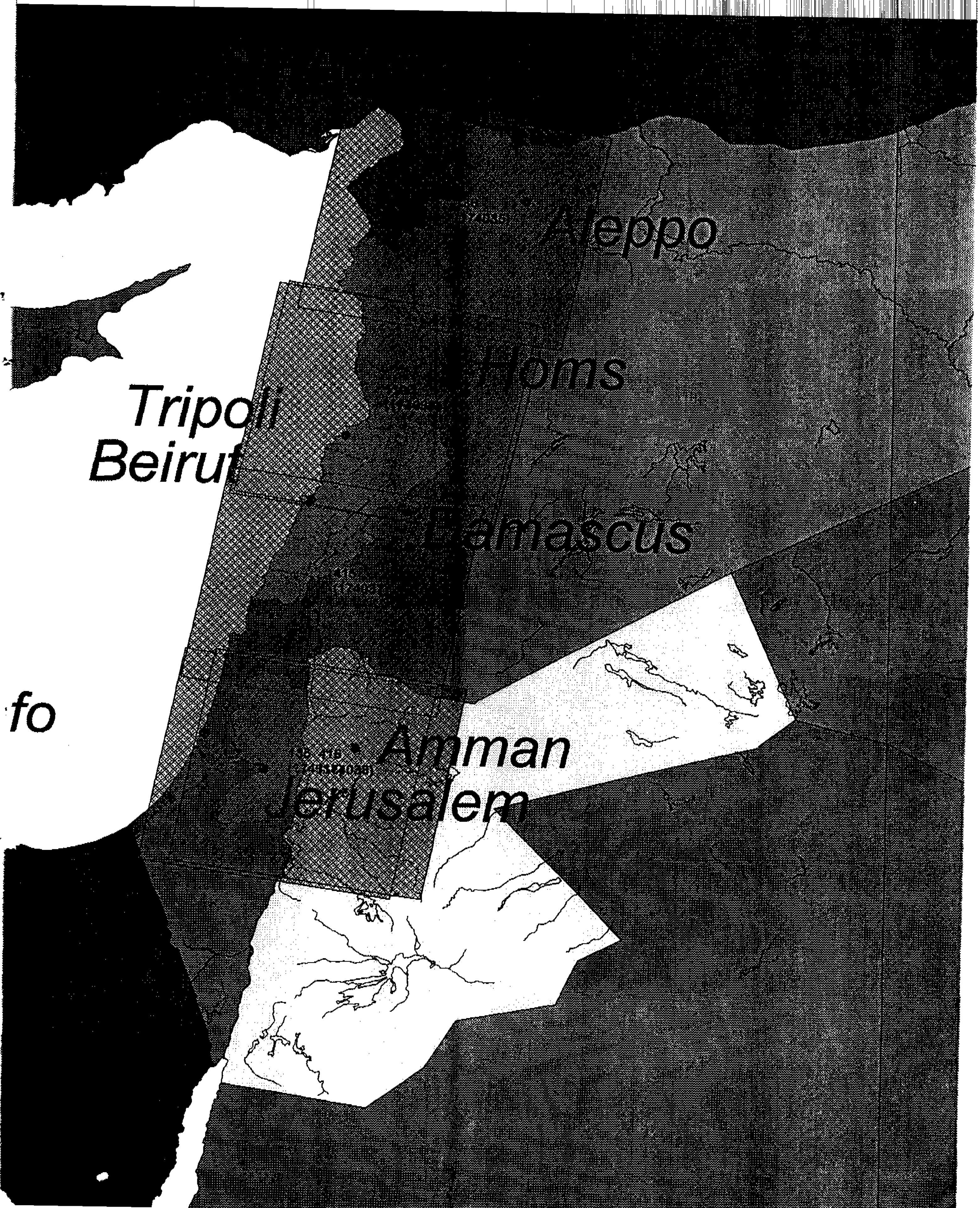
Primärdatentyp: Satbild
Staat:
Trägersystem:
Aufnahmesystem:
Aufnahmedatum:

Path: 173 bis 174
Row: 035 bis 038
Koordinaten:
Projekt:

Anzeigekriterium: Lfd_Nr, Staat, Trägersystem, Sensor, Path, Row, XMD, YMD, Aufnahmedatum, Gebiet, Szene, Archiv_Nr, Datenlieferant

Sortierkriterium:

lfd_Nr	Staat	Trägersystem	Sensor	Path	Row	XMD	YMD	Aufnahmedat	Gebiet	Szene	Archiv_Nr	Datenlieferant
103	Syrien,_,_	Landsat 4	TM	174	036	36,15	34,60	04.07.1984		???	0113	???
119	Syrien,_,_	Landsat 4	MSS	174	036	36,10	34,60	28.09.1993		???	0131	???
135	Jordanien,_,_	Landsat 4	MSS	174	038	35,42	31,75	07.04.1984	El Lajjoun	???	0146	???
136	Syrien,_,_	Landsat 5	TM	174	035	36,62	36,05	04.07.1984		???	0147	???
366	Syrien,_,_	Landsat 5	TM	173	037	0,00	0,00	22.11.1991	Jabal ad Duruz	FULL	0542	???
367	Jordanien,_,_	Landsat 5	TM	173	038	0,00	0,00	26.10.1993	Tell el Asfar	FULL	0543	???
415	Syrien,Libanon,Israel	Landsat 4-5	TM	174	037	0,00	0,00	28.09.1992		FULL	0583	GAF
416	Syrien,Libanon,Israel	Landsat 4-5	TM	174	038	0,00	0,00	30.10.1992		FULL	0584	GAF



Aleppo
Homs
Tripoli
Beirut
Damascus
fo
Amman
Jerusalem

Annex 13 Access to Landsat Data in the USA and from Non-US Ground Stations
Eros Data Center on-line catalog systems
How to contact Space Imaging Eosat

ACCESS TO LANDSAT DATA IN THE USA AND FROM NON-US GROUND STATIONS

IN THE USA

Landsat Multispectral Scanner (MSS) and Thematic Mapper (TM) data are available in the United States through the US Geological Survey's EROS Data Center (EDC) and Space Imaging EOSAT.

Data users interested in MSS digital data and hardcopy products should direct inquiries to the EDC.

"US Government and Affiliated Users" (USGAU) interested in TM digital data and hardcopy products should direct inquiries to the EDC.

Other users of TM data should direct inquiries to the EDC if the data of interest were acquired prior to October 1992, or to Space Imaging EOSAT for acquisitions more recent than October 1992.

How to contact the EROS Data Center:

E-mail: custserv@mail.cr.usgs.gov

Telephone: 605-594-6151
Fax: 605-594-6589

By Mail:

Customer Services
US Geological Survey

EROS Data Center

Sioux Falls, SD 57198

EDC on-line catalog systems:

Information on Landsat data from the EDC can be obtained over the Internet through the Global Land Information System (GLIS), and the "V0 IMS."

GLIS is an interactive computer system that provides information on land data sets. GLIS contains references to regional, continental, and global data sets including land use, soils, topography, and data from aircraft and satellites. Direct access to GLIS is also available through wide area networks and dial-up interfaces.

- WEBGLIS: http://edcwww.cr.usgs.gov/webglis
- Text terminal access: telnet glis.cf.usgs.gov
- Xwindows terminal access: telnet xglis.cr.usgs.gov
- PC access dial-up modem: Contact GLIS user assistance to request PC dial-up GLIS software or download the software over the Internet from sun1.cr.usgs.gov/pub/software/pcglis

GLIS user assistance:

Landsat Data Access (USA)

Telephone: 1-800-252-4547

Fax: 605-594-6589

Email: glis@glis.cr.usgs.gov

V0 IMS is the information management system for the Earth Observation System Data and Information System (EOSDIS) operated through the Land Processes Distributed Active Archive Center (DAAC) at the EDC. V0 IMS contains information on all EOS land data sets including Landsat. V0 IMS is less intuitive to use than GLIS but it contains information on some special Landsat data sets not currently listed through GLIS.

Note: Because of an agreement between the USG and EOSAT Corporation (now Space Imaging EOSAT) regarding cost and reproduction rights for Landsat TM data sold to US government and affiliated users, all such users should order Landsat data through the EDC to obtain the lowest price.

How to contact Space Imaging EOSAT:

To serve customers, EOSAT maintains marketing and sales, applications and customer services departments. EOSAT encourages customers to review product requirements with the EOSAT staff. All customer inquiries and orders are confidential.

E-mail: info@spaceimage.com

Telephone: 301-552-0537 or toll free 800-344-9933

An online data catalog for EOSAT is also available.

LANDSAT DATA FROM NON-US GROUND STATIONS

Data from Landsat satellites is received and distributed by an international network of ground stations. A table of connections via the Internet to the stations and the on-line catalog systems of the stations is available.

Return, or go, to:

Landsat homepage	Landsat Program summary	Homepage Table of Contents

(END)
Last modified: 5/1/97

Annex 14 Current Status and Summary of Agreement between LANDSAT Program Management and EOSAT Corporation on Cost and Reproduction Rights for LANDSAT 4/5 Thematic Mapper Data

Current Status and Summary of Agreement Between Landsat Program Management and EOSAT Corporation on Cost and Reproduction Rights for Landsat 4/5 Thematic Mapper Data

On April 11, 1994, Landsat Program management and the EOSAT Corporation entered into an agreement on cost and reproduction rights for Landsat 4/5 Thematic Mapper (TM) data purchased and/or distributed by the US government and affiliated users (USGAU*) for non commercial purposes. The primary provisions of the agreement and the definition of USGAU are given below.

Current Status of the Agreement

The agreement established a schedule for implementing several of its provisions. **The status of those provisions as of October 1, 1996** is as follows:

1) New Landsat 4/5 TM data (Level 1) purchased by USGAU from EOSAT shall be no more than $2500/scene. (Price to general public is $4400/scene.)

2) TM scenes physically residing in the National Satellite Land Remote sensing Data Archive (NSLRSDA) at EROS Data Center (EDC) are available to USGAU at $425 per scene for systematically corrected data.

3) For scenes not in the EDC archive, the NSLRSDA may purchase **raw data** from EOSAT and process and distribute the data to USGAU for non-commercial purposes. The cost of such data is **$425 per scene plus $70 times the number of scenes on the EOSAT HDT archive tape (as many as 25-30 scenes per tape)** on which the scene of interest is stored.

4) Scenes previously purchased by USGAU from EOSAT for which a copy is in the archive at EDC are available to USGAU "as is" i.e. systematic, UTM, nearest neighbor, SOM, for $150 per scene.

5) All TM data now owned or purchased by USGAU may be copied and distributed without restriction among USGAU organizations for non commercial purposes.

Landsat TM Data Distribution Rights/Pricing

(Determine your customer Category and Date of Sensing of the scene to be ordered and use the table to determine the distribution site.)

Effective October 1, 1995

	July 16, 1982 to 10 years ago	10 years ago to 1 year ago	1 year ago to present
General Public	NSLRSDA	EOSAT	EOSAT
USGAU	NSLRSDA	NSLRSDA	EOSAT

Effective October 1, 1996

	July 16, 1982 to 10 years ago	10 years ago to Present
General Public	NSLRSDA	EOSAT
USGAU	NSLRSDA	NSLRSDA

Primary Provisions of April 11 Agreement and Definition of USGAU

1. Cost of Landsat TM data purchased by US government and affiliated users (USGAU)

- $3500 for scenes purchased between 4/11/94 and 12/31/94.
- $2500 for scenes purchased after 12/31/94.
- For **raw data** purchased by the National Satellite Land Remote Sensing Data Archive (EDC): $70/scene until 5 years after demise of Landsat 4/5 (cost of shipping data thereafter.)

2. USGAU rights to copy data for, and redistribute data among, USGAU for noncommercial use

- Unrestricted rights for TM scenes purchased after 4/11/94.
- For data purchased prior to 4/11/94: prior to 10/1/95 - unrestricted rights to data purchased more than two (2) years previous (moving window); after 10/1/95 - unrestricted rights.

3. USGAU rights to process data from the NSLRSDA for USGAU for noncommercial use

- Until 9/30/94: restrictions in place at time of purchase apply.
- 10/1/94 through 10/1/95: restricted for data sensed more than two (2) years previous (moving window).
- 10/2/95 through 10/1/96: unrestricted for data sensed more than one year previous (moving window).
- After 10/1/96: unrestricted rights

***USGAU is defined as:**
1. US government agencies
2. US government contractors
3. Researchers and institutions conducting scientific investigations related to global change funded by, or defined in agreements with, US CEES member agencies.
4. US Global Change Research Program international programs, i.e. global change research programs in countries other than the US as well as global change research programs of the World Meteorological Organization (WMO), the United Nations Enviroglobal change research programs of the World Meteorological Organization (WMO), the United Nations Environmental Programme (UNEP), Intergovernmental Oceanographic Commission (IOC)
5. Other researchers (individuals or entities conducting scientific investigations, not necessarily related to the Global Change Research Program) that have signed with the US government a cooperative agreement involving the use of Landsat data for noncommercial purposes.
6. Educational institutions for noncommercial purposes.
7. Nonprofit, public interest entities.

Return, or go, to:

Landsat homepage	Landsat Program summary	Access to Landsat data

Comments, questions:
Write to *esheffner@gaia.arc.nasa.gov*
END (Last modified 5/1/97)

Annex 15 The USGS EROS Data Center
USGS Special Project Images
USGS Products and Services
USGS Products Available from the USGS EROS Data Center
-Global Hydrologic Data-

USGS
science for a changing world

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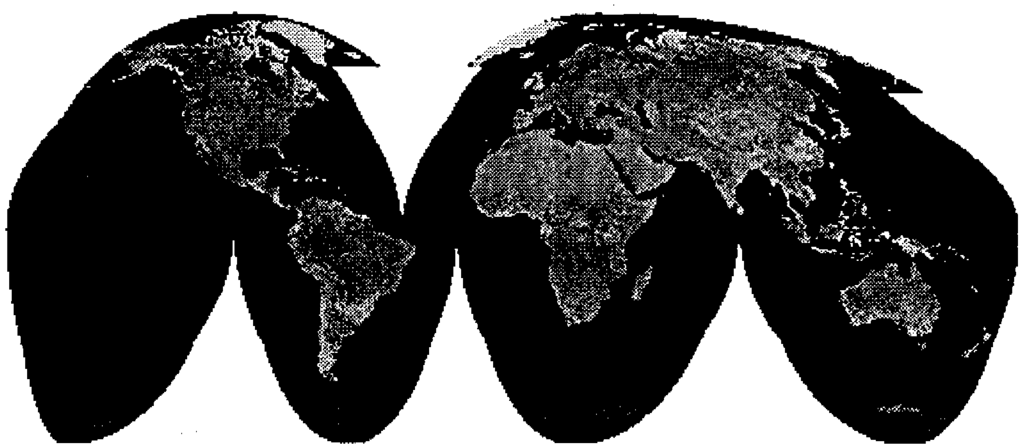
EROS Data Center

Earth Resources Observation Systems



"We are stewards of land remote sensing and associated data, advancing the availability and applicability of these data for scientific and land management users worldwide."

-- EROS Data Center Vision Statement

Features:Special Projects Images and Earthshots

|| USGS Home Page || Mapping ||

Please read this general **Disclaimer**
URL:http://edcwww.cr.usgs.gov/eros-home.html
Maintainer: edcweb@edcwww.cr.usgs. gov
Last modified: 16 June 1997.

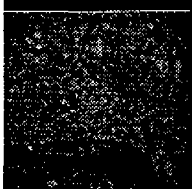
USGS

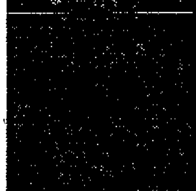
Special Projects Images

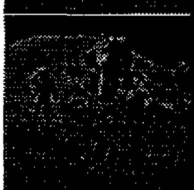
The EROS Data Center houses millions of images -- aerial photographs, mainly for mapping, and various kinds of satellite images for scientific study. Among all these pictures, naturally, are some that are beautiful, some that record events of historic significance, and some that stir the imagination for other reasons.

This page contains a selection of such images, available from EROS Customer Services as photographic products in sizes up to 40 inches square. Next to each image is the size of the graphic file in bytes, as an approximate indication of download time.

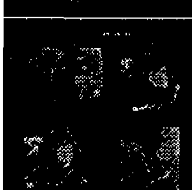

STATES

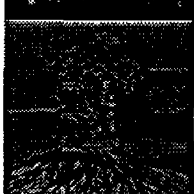

CITIES of the US


CITIES of the World

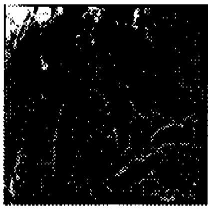

SPACE


COUNTRIES and CONTINENTS


WEATHER


NATURAL HAZARDS

satellite data, aerial photographs: EROS Spec...



NATURAL FEATURES

|| EROS Home Page ||

URL:http://edcwww.cr.usgs.gov/pao/pao1.html
Maintainer: edcweb@edcwww.cr.usgs.gov
Last modified: 19 June 1997

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USGS

Products and Services

The USGS EROS Data Center houses millions of aerial photographs of the United States, as well as images from several series of satellites covering the entire Earth.

The EDC also is host to the sales data base for digital products of the USGS's National Mapping Division, of which it is part. These products, prominently including Digital Line Graphs and Digital Elevation Models, are know collectively as US GeoData. A number of US GeoData files are distributed over our anonymous FTP server at no charge.

All of these USGS product lines are described briefly in a List of products . To launch an online search for a specific product go to the GLOBAL Land Information System, or GLIS .

The EDC also serves as the Land Processes Distributed Active Archive Center, or DAAC , for NASA's Mission to Planet Earth program, serving satellite data "packaged" for various scientific and resource-planning applications.

- On-Line Search For Products (GLIS)
- List, with samples of USGS products
- NASA DAAC products

|| EROS Home Page | Contact Customer Services||

Please read this general **Disclaimer**
URL:http://edcwww.cr.usgs.gov/content_products.html
Maintainer: edcweb@edcwww.cr.usgs.gov
Last modified: 29 May 1997.

USGS Products Available from the USGS EROS Data Center

Here are some "quick links" to:
[Map Dealers] [Online Data]

The U.S. Geological Survey provides a variety of cartographic, geographic, earth science, and remotely sensed data, products, and services in support of Federal, State, and public interests. These products and services include information about the Earth's natural and cultural features, base maps and special maps in several scales, digital cartographic data, aerial photographs and other remotely sensed data.

Photographs | Digital Satellite and Aerial Data | Digital Cartographic Data | Digital Elevation Data | Digital Landuse/Landcover Data | Thematic Regional Data | Digital Climate Data | Digital Geologic Data | Digital Hydrologic Data | Digital Soils Data

Printed Maps

Product	Description			Product Access		Sample Gallery
	Technical Abstract	User Guide	Fact Sheet	Search & Order	FTP Download	
Maps - Indexes, Catalogs, and Lists	■	■	■	■	-	-
Maps Large Scale-Covers small area	■	■	■	■	-	-
Maps - World and Planets	■	■	■	■	-	-
Maps Small Scale-Covers large area	■	■	■	■	-	-

Photographs

Product	Description			Product Access		Sample Gallery
	Technical Abstract	User Guide	Fact Sheet	Search & Order	FTP Download	
Declassified Intel. Satellite Photos	■	■	■	■	-	■
Digital Orthophoto Quads: County CD	■	■	■	■	-	■
Digital Orthophoto Quads: Quarter Quads	■	■	■	■	-	■
U.S. Government Aerial Photography	■	■	-	■	-	-
Skylab, Gemini, and Apollo Photography	■	■	-	■	-	-
National Aerial Photography Program	■	■	■	■	-	■
NASA Aerial Photography	■	■	-	■	-	-
Scientific Committee/Antarctic Research	■	■	-	■	-	-
Space Shuttle Earth Observation Program	■	■	-	■	-	-
US Geological Survey Aerial Photography	■	■	-	■	-	-
EROS Special Projects Images	-	-	-	■	-	-

Digital Satellite and Aerial Data

Product	Description			Product Access		Sample Gallery
	Technical Abstract	User Guide	Fact Sheet	Search & Order	FTP Download	
Alaska AVHRR Twice Monthly						

Alaska AVHRR Twice-Monthly Composites	■	■	■	■	-	-
Advanced Very High Resolution Radiometer	■	■	-	■	-	■
Conterminous U.S. AVHRR	■	■	■	■	-	■
Global Experimental Bi-Weekly Norm. Diff	■	■	-	■	-	■
MultiSpectral Scanner Landsat Data	■	■	■	■	-	■
Thematic Mapper Landsat Data	■	■	■	■	-	■
LGSOWG MultiSpectral Scanner Landsat	■	■	■	■	-	■
LGSOWG Thematic Mapper Landsat	■	■	■	■	-	■
MRLC Landsat TM Basic	■	■	-	■	-	-
MRLC Landsat TM Derivative	■	■	-	■	-	-
MRLC Landsat TM Geocoded	■	■	-	■	-	-
Northern Great Plains 1988 AVHRR	■	■	■	■	-	-
Sahel & NW Africa 14-Day NDVI Composites	■	■	-	■	-	■
Side-Looking Airborne Radar	■	■	■	■	-	-
SPOT High Resolution Visible Data	■	■	-	■	-	-

Digital Cartographic Data

Product	Description			Product Access		Sample Gallery
	Technical Abstract	User Guide	Fact Sheet	Search & Order	FTP Download	
Digital Line Graphs (DLG)						
1:24000-Large Scale	■	■	■	■	-	-
1:100000-Intermediate Scale	■	■	■	■	■	■
1:2000000-Small Scale	■	■	■		■	■
Digital Raster Graphics (DRG)	■	■	■	■	-	-
Geographic Names Information Systems	■	■	■	■	-	-

Digital Topgraphic Data

Product	Description			Product Access		Sample Gallery
	Technical Abstract	User Guide	Fact Sheet	Search & Order	FTP Download	
Digital Elevation Models (DEM)						
7.5 minute-Large Scale	■	■	■	■	-	■
15 minute-Large Scale	■	■	■	■	-	■
2 Arc Second-Intermediate Scale	■	■	■	■	-	■
1-degree-Small Scale	■	■	■	■	■	■

Digital Landuse/Landcover Data

Product	Description			Product Access		Sample Gallery
	Technical Abstract	User Guide	Fact Sheet	Search & Order	FTP Download	
Land Use & Land Cover Digital Data	■	■	■	■	-	■

Thematic Regional Data

Product	Description			Product Access		Sample Gallery
	Technical Abstract	User Guide	Fact Sheet	Search & Order	FTP Download	
Upper Mississippi & Lower Missouri Data Base	-	-	■	-	■	■

Digital Climate Data

Product	Description			Product Access		Sample Gallery
	Technical Abstract	User Guide	Fact Sheet	Search & Order	FTP Download	
Omernik Ecoregions Data	■	■	-	■	-	-
Major World Ecosystems	■	■	-	■	-	-

Digital Geologic Data

Product	Description			Product Access		Sample Gallery
	Technical Abstract	User Guide	Fact Sheet	Search & Order	FTP Download	
Geophysical Data	■	■	-	■	-	-
National Geochronological Data	■	■	-	■	-	-
National Uranium Resource Evaluation	■	■	-	■	-	-

Digital Hydrologic Data

Product	Description			Product Access		Sample Gallery
	Technical Abstract	User Guide	Fact Sheet	Search & Order	FTP Download	
1:2,000,000-Scale Hydrologic Unit Maps	■	■	-	■	-	-
Global Hydrologic Data	■	■	-	■	-	-

Digital Soils Data

Product	Description			Product Access		Sample Gallery
	Technical Abstract	User Guide	Fact Sheet	Search & Order	FTP Download	
FAO-Digital Soil Map of the World	■	■	-	■	-	-
State Soil Geographic Data Base	■	■	-	■	-	-
Zobler World Soils Date Set	■	■	-	■	-	-

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||**Products and Services Page**|| **EDC Home Page**||

URL: http://edcwww.cr.usgs.gov/dsprod/prod.html
Maintainer: edcweb@edcwww.cr.usgs.gov
Last modified: 27 June 1997

USGS

USGS EDC Global Land Information System (GLIS)

The Global Land Information System (GLIS) is an interactive computer system developed by the U.S. Geological Survey (USGS) for scientists seeking sources of information about the Earth's land surfaces. GLIS contains metadata that is, descriptive information about data sets. Through GLIS, scientists can evaluate data sets, determine their availability, and place online requests for products. GLIS is more than a mere list of products. It offers online samples of earth science data that may be ordered through the system.

Scientists can use GLIS to display outlines of the geographic areas covered by the data sets. Using digital browse functions to manipulate the data, they can determine such information as the amount of cloud coverage or the quality of an image.

Online requests can be placed via GLIS for earth science data. The producing organization will receive the request and provide the user with price and ordering information.

GLIS contains references to regional, continental, and global land information including land use, land cover, and soils data; cultural and topographic data; and remotely sensed satellite and aircraft data. GLIS is routinely updated with new data set descriptions, as they are contributed by the global change scientific community. GLIS inventories are reviewed daily to assure access to the most current information. The system operates 24 hours a day, 7 days a week for world-wide connectivity and availability.

Web version of GLIS:
Users with a table enabled browser can access Webglis at http://edcwww.cr.usgs.gov/webglis .
Webglis supports graphic-based query and browse functions.

X Version of GLIS:
Users wishing to perform higher level graphic-based functions can access the X version of GLIS using an X terminal or X terminal emulator package on a PC.

```
From
INTERNET:       TELNET xglis.cr.usgs.gov
```

A copy of the **xglis client**, that you can run locally on a **Data General**, **SUN Solaris**, or **Silicon Graphics**, is available over anonymous FTP (Make sure to read the README file). Further Instructions, and the anonymous FTP address, can be found under xglis NEWS .

|| EROS Home Page ||

URL:http://edcwww.cr.usgs.gov/glis/glis.html
Maintainer: *edcweb@edcwww.cr.usgs.gov*

Annex 15-1 The USGS EROS DATA CENTER
A Brief History of the LANDSAT Program
Characteristics of the LANDSAT System
Characteristics of LANDSAT Data
Applications of LANDSAT Data

U.S. Department of the Interior
U.S. Geological Survey
EROS Data Center

Landsat Data

A Brief History of the Landsat Program

The concept of a civilian Earth resources satellite was conceived in the Department of Interior in the mid-1960's. The National Aeronautics and Space Administration (NASA) embarked on an initiative to develop and launch the first Earth monitoring satellite to meet the needs of resources managers and Earth scientists. The USGS entered into a partnership with NASA in the early 1970's to assume responsibility for data archiving and distribution of data products. On July 23, 1972, NASA launched the first in a series of satellites designed to provide repetitive global coverage of the Earth's land masses. Designated initially as the Earth Resources Technology Satellite-A (ERTS-A), it used a Nimbus-type platform that was modified to carry sensor systems and data relay equipment. When operational orbit was achieved, it was designated ERTS-1.

The satellite continued to function beyond its designed life expectancy of 1 year and finally ceased to operate on January 6, 1978, more than 5 years after its launch date. The second in this series of Earth resources satellites (designated ERTS-B) was launched January 22, 1975. It was renamed Landsat 2 by NASA, which also renamed ERTS-1 to Landsat 1. Three additional Landsats were launched in 1978, 1982 and 1984(Landsat 3, 4 and 5 respectively). Each successive satellite system had improved sensor and communications capabilities(table 1).

Table 1
Background information and status of Landsat satellites.

Satellite	Launched	Decommissioned	Sensors
Landsat 1	July 23, 1972	January 6, 1978	MSS and RBV
Landsat 2	January 22, 1975	February 25, 1982	MSS and RBV
Landsat 3	March 5, 1978	March 31, 1983	MSS and RBV
Landsat 4	July 16, 1982	*	TM and MSS
Landsat 5	March 1, 1984	**	TM and MSS
Landsat 6	October 5, 1993	***	ETM
Landsat 7	Fall 1998****		ETR +*****

```
*     in stand by mode
**    operational
***   never achieved orbit
****  anticipated launch
*****      The sensor onboard Landsat 6 was called the enhanced
      thematic mapper (ETM). Landsat 7 will carry the
      enhanced thematic mapper plus (ETM+)
```

NASA was responsible for operating the Landsats through the early 1980's. In January 1983, operations of the Landsat system were transferred to the National Oceanic and Atmospheric

Administration (NOAA). In October 1985, the Landsat system was commercialized and the Earth Observation Satellite Company assumed responsibility for its operation. Throughout these changes, the EDC retained primary responsibility as the Government archive of Landsat data. The Land Remote Sensing Policy Act of 1992 (Public Law 102-555) officially authorized the National Satellite Land Remote Sensing Data Archive and assigned responsibility to the Department of the Interior. In addition to its Landsat data management responsibility the EDC investigates new methods of characterizing and studying changes on the land surface with Landsat data.

Characteristics of the Landsat System

Landsats 1 through 3 operated in a near-polar orbit at an altitude of 920 km with an 18-day repeat coverage cycle. These satellites circled the Earth every 103 minutes, completing 14 orbits a day. Eighteen day and 251 overlapping orbits were required to provide nearly complete coverage of the Earth's surface with 185 km wide image swaths. The amount of swath overlap or sidelap varies from 14 percent at the Equator to a maximum of approximately 85 percent at 81 degrees north or south latitude. These satellites carried two sensors: a return beam vidicom (RBV) and a MSS. The RBV sensor was essentially a television camera and did not achieve the popularity of the MSS sensor. The MSS sensor scanned the Earth's surface from west to east as the satellite moved in its descending (north-to-south) orbit over the sunlit side of the Earth. Six detectors for each spectral band provided six scan lines on each active scan. The combination of scanning geometry, satellite orbit, and Earth rotation produced the global coverage necessary for studying land surface change. The resolution of the MSS sensor was approximately 80 m with radiometric coverage in four spectral bands from the visible green to the near-infrared(IR) wavelengths. Only the MSS sensor on Laevery 103 minutes, completing 14 orbits a d

Landsats 4 and 5 carry both the MSS and the TM sensors: however, routine collection of MSS data was terminated in late 1992. They orbit at an altitude of 705 km and provide a 16 day, 233-orbit cycle with a swath overlap that varies from 7 percent at the Equator to nearly 84 percent at 81 degrees north or south latitude. These satellites were also designed and operated to collect data over a 185 km swath. The MSS sensors aboard Landsat 4 and 5 are identical to the ones that were carried on Landsat 1 and 2. The MSS and TM sensors primarily detect reflected radiation from the Earth in the visible and IR wavelengths, but the TM sensor provides more radiometric information than the MSS sensor. The wavelength range for the TM sensor is from the visible (blue), through the mid-IR, into the thermal-IR portion of the electromagnetic spectrum. Sixteen detectors for the visible and mid-IR wavelength bands in the TM sensor provide 16 scan lines on each active scan. Four detectors for the thermal-IR band provide four scan lines on each active scan. The TM sensor has a spatial resolution of 120 m for the thermal IR band and 30 m for the other six radiometric bands.

All of the Landsats have been in sun-synchronous orbits with equatorial crossing times ranging from 8:30 a.m. for Landsat 1 to 9 a.m. for Landsat 2 to the current time of 9:45 a.m. for Landsat 5, and the proposed time of 10 a.m. for Landsat 7.

Characteristics of Landsat Data

Since 1972 these satellites have provided repetitive, synoptic, global coverage of high-resolution multi spectral imagery. The characteristics of the MSS and TM bands were selected to maximize their capabilities for detecting and monitoring different types of Earth's resources. For example, MSS band 1 (band 2 of TM)can detect green reflectance from healthy vegetation, and band 2 of MSS (band 3 of TM) is designed for detecting chlorophyll absorption in vegetation. MSS bands 3 and 4 (TM band 4) are ideal for near-IR reflectance peaks in healthy green vegetation and for detecting water-MSS and TM bands were selected to maximize their capabilities for detecting and monitoring different types of Earth's resources. For example, MSS band 1 (band 2 of TM)can detect green reflectance from healthy vegetation, and band 2 of MSS (band 3 of TM) is designed for detecting chlorophyll absorption in vegetation. MSS bands 3 and 4 (TM band 4) are ideal for near-IR reflectance peaks in healthy green vegetation and for detecting water-land interfa

Typically, MSS Bands 4, 2, and 1 can be combined to make false-color composite images where band 4 represents red, band 2, green, and band 1, blue. This band combination makes vegetation appear as shades of red, brighter reds indicating more vigorously growing vegetation. Soils with no or sparse vegetation will range from white (sands) to greens or browns depending on moistublue. This band combination makes vegetation appear as shades of red, brighter reds indicating more vigorously growing vegetation. Soils with no or sparse vegetation will range from white (sands) to greens or browns depending on moisture and organic matter content. Water bodies will appear blue. Deep, clear water will be dark blue to black in color, while sediment-laden or shallow waters will appear lighter in color. Urban areas will appear blue-gray in color. Clouds a

Applications of Landsat Data

Landsat data have been used by government, commercial. industrial, civilian, and educational communities in the U.S. and worldwide. They are being used to support a wide range of applications in such areas as global change research, agriculture, forestry, geology, resources management, geography, mapping, water quality, and oceanography.

From "Historical Landsat Data Comparisons, Illustrations of the Earth's Changing Surface" U.S. Department of the Interior, U.S. Geological Survey, EROS Data Center, March 1995.

Return to Product Table Page **Return to EROS Data Center Home Page**

<URL:http://edcwww.cr.usgs.gov/factsheets/landsat_fact.html>

Page owner: < custserv@edcmail.cr.usgs.gov>
Last modified: 2 May 1997

Annex 15-2 Information Catalog: **EROS DATA CENTER**

EROS Data Center Supports the GLOBE

(Global Learning and Observations to Benef)....U.S. Geological Survey --EROS Data Center. EROS Data Center Supports the GLOBE (Global Learning and Observations to Benefit the Environment) Prograrn....

http://edcwww.cr. usgs.gov/pecora/gacke/abstract.html - *size 2K - J0.Oct.96 - English*

Welcome to the EROS Data Center International WWW Server

The following WWW Pages are available from this machine... Africa Data Dissernination Service. Greater Horn of Africa. Inter-Arnerican Geospstial Data...

http://edcintl.cr.usgs.gov/ - *size 655 bytes - 4.Sep.96 - English*

EROS Data Center Links

EROS Data Center Links... EROS Data Center - the home page. USGS/EROS Data Center. EROS Data Center's Landsat Archive and Pathfinder. EROS Data Center....

http://137.216.192.44/sps/tammy/eros.htm - *size 1K - 21.May'.97 - English*

Science Highlight: EROS Data Center

Science Highlight: EROS Data Center. A Rernote Sensing Based Vegetation Classification Logic for Global Land Cover Analysis. Running, S. W., T. R.....

http://www-nsidc.colorado.edu/NASA/YEARBOOK _1994/eros.html - *size 4K - 28.Feb.96 - English*

EROS Data Center

The EROS Data Center. The EROS Data Center **(EDC)** is home to the EOS-DIS Land Processes Distributed Active Archive Center (LP-DAAC). The primary role of...

http://glcts.maxey.dri.edu/glcts/project/edc.html - size 743 bytes - 10.Jan.96 - Eng/ish

EROS Data Center Supports the GLOBE (Global Learning and Observations to Benef

U.S. Geological Survey --EROS Data Center. GLOBE Project--Savannah, GA. Images of Savannah. This image is 99K....

http://edcwww.cr.usgs.gov/pecora/gacke/savannah.html - *size 1K - 10.Oct96 - English*

Landsat Pathfinder Processing Support at the EROS Data Center

U.S. Geological Survey --EROS Data Center. HTFIP Project Deliverables. A sample image is shown below. Retum to Landsat Pathfinder Processing Title Page.

http://edcwww. cr.usgs.gov/pecora/larson/htfiproduct.html - *size 786 bytes - 10.OcL96 - English*

EOSDIS DAAC at EROS Data Center

Welcome to the EDC DAAC. The Earth Resources Observation Systems (EROS) Data Center Distributed Active Archive Center (EDC DAAC) was established as part...

http://edcwww.cr.usgs.gov/landdaac/landdaac.html - *size 3K - 8.May.97 - English*

EROS Data Center

EROS Data Center. The Earth Resources Observation Systems (EROS) Data Center, located in Sioux Falls, SD is a data management, systems development, and...

http://edcwww.cr.usgs.gov/doc/edc.html - *size 2K - 1.Apr.96 - Eng/ish*

Landsat Pathfinder Processing Support at the EROS Data Center

U.S. Geological Survey --EROS Data Center. GLCTS Processing Data Layers. To view a larger view of a particular image, click on the labels. 57-meter MSS...
http://edcwww.cr.usgs.gov/pecora/larson/data.html - size 1K - 10.Oct.96 - English

Collected EOS Messages: (fwd) Introducing the EROS Data Center DAAC

fwd) Introducing the EROS Data Center DAAC. DUNLOP Douglas (ddunlop@ ella) Tue, 28 Jun 94 17:49:39+O2OO. Messages sorted by: [date][thread][subject...
httv://www.eol.ists.calmail-hsts/cos/0005.htinl - size 10K - 22.May.97 - English

About EROS Data Center

EROS Home Page: The Web site for the USGS EROS Data Center.
http://edcwww.cr.usgs.gov/content about. html - size 9K - 7.May.97 - English

Information about USGS/EROS Data Center

U.S. Geological Survey(USGS) Earth Resorces Observation Systems(EROS) Data Center. Address: Sioux Falls, SD 57198 USA. The USGS EROS Data Center(EDC) was..
http://www.goin.nasda.go. jp/GOIN/TRIC/eros.html - size 1K - 6.Jun.95 - Eng/ish

Programs at EROS Data Center

What's New Home Page: The Web site for the USGS EROS Data Center.
http://edcftp.cr.usgs.gov/content programs. html - size 5K - 7.May.97 - Eng/ish

EROS Data Center Supports the GLOBE (Global Learning and Observations to Benef

U.S. Geological Survey --EROS Data Center. EROS Data Center Supports the GLOBE (Global Learning and Observations to Benefit the Environment) Program....
http://edcwww.cr.usgs.gov/pecora/gacke/gacke.html - size 3K - 10.Oct.96 - English

EROS Data Center Address page

U.S. Geological Survey National Mapping Division MS *508,* Room 2B-312B 12201 Reston Parkway Reston, VA 22092 USA USA Tel: 703-648-5781 Fax: 703-648-5939...
http://edcwww.cr.usgs.gov/landdaac/1KM/edcaddress - size 268 bytes - 25.Apr.96 - English

Landsat Pathfinder Processing Support at the EROS Data Center

U.S. Geological Survey --EROS Data Center. Landsat Pathfinder Processing Support at the EROS Data Center. Gayla Evans, Kelly Feistner, Charles Larson,...
http://edcwww.cr.usgs.gov/pecora/larson/abstract. html - size 2K - 10.Oct.96 - English

Products from the USGS EROS Data Center

U.S. Department of the Interior U.S. Geological Survey. Products from the USGS EROS Data Center. The Earth Resources Observation Systems Data Center...
http://www-nmd.usgs.gov/mac/isb/pubs/factsheets/edc prod. html - size 5K - 24.May.97 - English

Programs at EROS Data Center

What's New Home Page: The Web site for the USGS EROS Data Center.
http://edcwww.cr. usgs.gov/content_products.html - size 4K - 7.May.97 - English

USGS: EROS Data Center

U.S. Geological Survey - National Mapping Information - EROS Data Center. (230KB) EROS

Data Center--Who We Are and What We Do. The Earth Resources...
http://edcwww. cr. usgs.gov/doc/edchome/erosinfo/erosgen/background.html - *size 3K - 3.Mar.96 - English*

MAGIC II Quarterly Meeting at the EROS Data Center

MAGIC II Quarterly Meeting Page: The Web site for MAGIC II Quarterly Meeting held at the USGS EROS Data Center.
http://edciss1.cr.usgs.gov/magic/meeting.html - *size 4K - 21.May.97 - English*

The EROS Data Center's Landsat Archive & Landsat Pathfinder

Introduction to EROS Data Center's Landsat Archive and Landsat Pathfinder Project
http://grid2.cr.usgs.gov/landsat/ - *size 4K - 1.May.97 - English*

EROS Data Centerg U.S. Geological Survey

EROS Data Center. U.S. Geological Survey. Sioux Falls SD 57198. FAX *(605)* 594-6589. Contact. Customer Service. *(605)* 594-6151. Transfer Media: Internet,...
http://www.lmic.state.mn.us/gc/dir/usgseros.htm - *size 2K - 20.May.97 - English*

EROS Data Center (EDC) DAAC

EROS Data Center (EDC) DAAC. The EDC DAAC is used by Earth and global change scientists to study, characterize, and monitor biologic, geologic,...
http://www-nsidc.colorado.edu/NASA/YEARBOOK 1994/eros2.html - *size 4K - 28.Feb.96 - English*

EROS Data Center: Earthshots: main menu

Earthshots: satellite images of environmental change. EROS Data Center, U.S. Geological Survey, U.S. Department of the Interior. The Landsat archive is at.
http://edcwww.cr.usgs.gov/Earthshots/ - *size 10K - 25.Mar.97 - English*

USGS/EROS Data Center (EDC) Landsat 7 Image Assessment System (IAS)

USGS/EROS Data Center (EDC) Landsat 7 Image Assessment System (IAS) Geometric Algorithms. --> Usually Under Construction! --> --> Landsat 7 **IAS Geometric..**
http://edcwww.cr.usgs.gov/ias/ - *size 2K - 14.Mar.97 - English*

USGS/EROS Data Center (ED) Landsat 7 Image Assessment System (IAS) Algorithm

USGS/EROS Data Center (EDC) Landsat 7 Image Assessment System (IAS) Note: The algorithm descriptions have been superceded by the ATBD. Geometric Levell...
http://edcwww.cr.usgs.gov/ias/algo.html - *size 2K - 3.Feb.97 - English*

USGS: Landsat Ground Station Operations Working Group

U.S. Geological Survey - National Mapping Information - EROS Data Center. U.S. Department of the Interior U.S. Geological Survey. Landsat Ground Station...
http://edcftp.cr.usgs.gov/factsheets/lgsowg.html - *size 3K - 6.May.97 - English*

USGS: World Data Center Background

U.S. Geological Survey - National Mapping Information - EROS Data Center. U.S. Geological Survey - National Mapping Information - EROS Data Center. World..
htt ://edcwww.cr.us s. ov/doc/edchome/world/worlddaL html - *size 9K - 18.Mar.97 - English*

Annex 16 LANDSAT Thematic Mapper Imagery

Summary
Attributes
Data Center
Personnel
Reference

DIF Display

If you have further questions or noticed a need for an update, please contact the GCMD staff scientists!.

Landsat Thematic Mapper Imagery

Summary

Last Updated: 1996-05-13

Landsat thematic mapper (TM) data from the Landsat satellite series are available from the National Satellite Land Remote Sensing Data Archive located at the U.S. Geological Survey's EROS Data Center and from the Earth Observation Satellite Company (EOSAT). These data are distributed in accordance with the Land Remote Sensing Policy Act of 1992, Public Law 102-555, as amended, and related contractual agreements.

Landsat TM data are also collected by a series of foreign receiving stations (i.e., Landsat Ground Stations Working Group (LGSOWG) participants) and are available from several distribution sites including Australia, Brazil, Canada, Italy, Japan, Maspalomas, Pakistan, South Africa, and Sweden. Purchasers are subject to individual distribution site policy and pricing directives.

The Global Land Information System (GLIS) and the EOSDIS Information Management System (IMS) are interactive query systems providing information on a variety of data sets. These systems also support data visualization and ordering services. For more information about these systems, see the following home pages:

GLIS Home Page: http://edcwww.cr.usgs.gov/glis/glis.html

EDC DAAC Home Page: http://edcwww.cr.usgs.gov/landdaac/landdaac.html

Attributes

Entry_ID:LANDSAT_TM
Originating Center:EDC

Temporal Coverage
From: 1982-07-16

Geographic Coverage

SouthWest Extent: 81S,180W   NorthEast Extent: 81N,180E

Sources:
LANDSAT
LANDSAT-4
LANDSAT-5

Sensors:
TM > Thematic Mapper

Distribution Media:

Distribution Media:Film

Distribution Media:Magnetic Tapes

Storage Media: Film

Storage Media: Magnetic Tapes

Parameters: Category > Topic > Term > Variable:
EARTH SCIENCE > RADIANCE OR IMAGERY > INFRARED WAVELENGTHS > INFRARED IM

EARTH SCIENCE > RADIANCE OR IMAGERY > VISIBLE WAVELENGTHS > VISIBLE IMAG

Discipline > Subdiscipline:
EARTH SCIENCE

Location Keywords:
AFRICA
ANTARCTIC
ASIA
AUSTRALIA
EUROPE
GLOBAL
NORTH AMERICA
SOUTH AMERICA

General Keywords:
DAAC
EDC
EOSAT
EOSDIS
EROS
EURASIA
IMAGERY
LANDSAT
LGSOWG
NLAPS
RADIANCE
REMOTE SENSING
SATELLITE
THEMATIC MAPPER

TM
USGS

Review Date: 1996-04-22
Revision Date: 1996-05-13

Data Center

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Data Center:EDC_DAAC > EROS Data Center Distributed Active Archive Center
     Data Center URL:http://edcwww.cr.usgs.gov/landdaac/landdaac.html
Data Center Contact:EDC_DAAC_USER_SERVICES,PLEASE_CONTACT

     Phone:     605-594-6116
     Phone:     FAX 605-594-6963
     Email:     INTERNET > EDC@EOS.NASA.GOV

     EDC DAAC User Services
     U.S. Geological Survey
     EROS Data Center
     Sioux Falls, SD  57198
     USA


Data Center:EOSAT > Earth Observation Satellite Company
Data Center Contact:EOSAT,PLEASE CONTACT

     Phone:     301-552-0500
     Phone:     800-344-9933

     Customer Services
     EOSAT
     4300 Forbes Boulevard
     Lanham, MD  20706
     USA


Data Center:EROS > Earth Resources Observation Systems Data Center
     Data Center URL:http://edcwww.cr.usgs.gov/eros-home.html
Data Center Contact:CUSTOMER_SERVICES,PLEASE_CONTACT

     Phone:     605-594-6151
     Phone:     FAX 605-594-6589
     Email:     INTERNET > CUSTSERV@EDCMAIL.CR.USGS.GOV

     Customer Services
     U.S. Geological Survey
     EROS Data Center
     Sioux Falls, SD  57198
     USA
```

Personnel

```
Tech Contact: CUSTOMER_SERVICES,PLEASE_CONTACT
              Phone:605-594-6151

              Phone:FAX 605-594-6589
              Email:INTERNET > CUSTSERV@EDCMAIL.CR.USGS.GOV

              Customer Services
              U.S. Geological Survey
              EROS Data Center
              Sioux Falls, SD  57198
              USA
DIF Entry Author: INFORMATION_SYSTEMS_MANAGEMENT,PLEASE_CONTACT
              Phone:605-594-6594

              Phone:FAX 605-594-6589
              Email:INTERNET > CUSTSERV@EDCMAIL.CR.USGS.GOV

              Information Systems Management
              U.S. Geological Survey
              EROS Data Center
              Sioux Falls, SD  57198
              USA
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Reference

National Oceanic and Atmospheric Administration, 1984, Landsat data users notes: [Sioux Falls, S. Dak.], National Oceanic and Atmospheric Administration [variously paged].

U.S. Geological Survey and National Oceanic and Atmospheric Administration, 1984, Landsat 4 data users handbook: [Washington, D.C.], U.S. Geological Survey and National Oceanic and Atmospheric Administration [variously paged].

Supplementary Information Menu

Data Center: EDC_DAAC > EROS Data Center Distributed Active Archive Center

Data Center: EROS > Earth Resources Observation Systems Data Center

Source: LANDSAT

Source: LANDSAT-4

Source: LANDSAT-5

Annex 17 Thematic Mapper Landsat Data

Thematic Mapper Landsat Data

Table of Contents

Background

The U.S. Geological Survey's (USGS) EROS Data Center (EDC) has managed the Landsat data archive for more than two decades. This archive provides a rich collection of information about the Earth's land surface. Major characteristics and changes to the surface of the planet can be detected, measured, and analyzed using Landsat data. The effects of desertification, deforestation, pollution, cataclysmic volcanic activity, and other natural and anthropogenic events can be examined using data acquired from the Landsat series of Earth-observing satellites. The information obtainable from the historical and current Landsat data play a key role in studying changes to the Earth's surface.

This document provides an overview of the Landsat program and illustrates the application of the data to monitor changes occurring on the surface of the Earth. Landsat multispectral scanner (MSS) data provide a historical record of the Earth's land surface from the early 1970's to the early 1990's. Landsat thematic mapper (TM) data provide land surface information from the early 1980's to the present.

A Brief History of the Landsat Program

The idea of a civilian Earth resources satellite was conceived in the Department of Interior in the mid-1960's. The National Aeronautics and Space Administration (NASA) embarked on an initiative to develop and launch the first Earth monitoring satellite to meet the needs of resource managers and Earth scientists. The USGS entered into a partnership with NASA in the early 1970's to assume responsibility for the archive management and distribution of Landsat data products. On July 23, 1972, NASA launched the first in a series of satellites designed to provide repetitive global coverage of the Earth's land masses. Designated initially as the Earth Resources Technology Satellite-A (ERTS-A), it used a Nimbus-type platform that was modified to carry sensor systems and data relay equipment. When operational orbit was achieved, it was designated ERTS-1.

The satellite continued to function beyond its designed life expectancy of 1 year and finally ceased to operate on January 6, 1978, more than 5 years after its launch date. The second in this series of Earth resources satellites (designated ERTS-B) was launched January 22, 1975. It was renamed Landsat 2 by NASA, which also renamed ERTS-1 to Landsat 1. Three additional Landsats were launched in 1978, 1982, and 1984 (Landsats 3, 4, and 5 respectively). Each successive satellite system had improved sensor and communications capabilities.

LANDSAT_TM

NASA was responsible for operating the Landsats through the early 1980's. In January 1983, operations of the Landsat system were transferred to the National Oceanic and Atmospheric Administration (NOAA). In October 1985, the Landsat system was commercialized. After that date, all Landsat commercial rights became the property of Space Imaging EOSAT with exclusive sales rights to all thematic mapper (TM) data. Throughout these changes, the EDC retained primary responsibility as the Government archive of Landsat data. The Land Remote Sensing Policy Act of 1992 (Public Law 102-555) officially authorized the National Satellite Land Remote Sensing Data Archive and assigned responsibility to the Department of Interior. All Landsat data over ten years old is available from the National Archive at the EROS Data Center. In addition to its Landsat data management responsibility the EDC investigates new methods of characterizing and studying changes on the land surface with Landsat data.

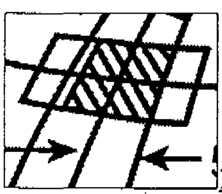
Example image:


Glasgow, MO (115.7 kb)

Characteristics of the Landsat System

Landsats 4 and 5 carry both the MSS and the thematic mapper (TM) sensors; however, routine collection of MSS data was terminated in late 1992. They orbit at an altitude of 705 km and provide a 16-day, 233-orbit cycle with a swath overlap that varies from 7 percent at the Equator to nearly 84 percent at 81 north or south latitude. These satellites were also designed and operated to collect data over a 185 km swath. The MSS sensors aboard Landsats 4 and 5 are identical to the ones that were carried on Landsats 1 and 2. The MSS and TM sensors primarily detect reflected radiation from the Earth surface in the visible and near-infrared (IR) wavelengths, but the TM sensor provides more radiometric information than the MSS sensor. The wavelength range for the TM sensor is from the visible (blue), through the mid-IR, into the thermal-IR portion of the electromagnetic spectrum. Sixteen detectors for the visible and mid-IR wavelength bands in the TM sensor provide 16 scan lines on each active scan. Four detectors for the thermal-IR band provide four scan lines on each active scan. The TM sensor has a spatial resolution of 30 m for the visible, near-IR, and mid-IR wavelengths and a spatial resolution of 120 m for the thermal-IR band.

All of the Landsats have been in sun-synchronous orbits with equatorial crossing times ranging from 8:30 a.m. for Landsat 1, 9 a.m. for Landsat 2, to 9:45 a.m. for Landsat 5.


Landsat Orbit (29.4 kb)

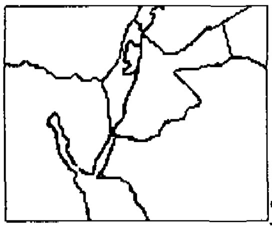
Extent of Coverage

The Landsat system provides for global data between 81 degrees north latitude and 81 degrees south latitude.

Acquisition

The Landsat platforms operate from a sun-synchronous, near-polar orbit imaging the same 185 km (115 miles) ground swath every 16 days. Thematic mapper (TM) data are received directly from Landsats 4 and 5 by a network of 16 worldwide ground stations. The United States ground station in Norman, Oklahoma, receives TM downlinks daily, and records them on high density tapes (HDTS). These HDTs are then sent to Space Imaging EOSAT's Image Processing Facility (IDPF) located in Lanham, Maryland. Also, data are transmitted via a Tracking and Data Relay Satellite (TDRS) to its ground terminal at White Sands, New Mexico, and then relayed via a domestic communications satellite (DOMSAT) to the Space Imaging EOSAT data processing facility in Norman, Oklahoma.

The TDRS System (TDRSS) satellites are in geosynchronous orbits. This configuration allowed the acquisition of MSS data for nearly all of the Earth's surface, except for an area between 50 degrees north and 67 degrees east by 50 degrees south and 82 degrees east. That area may be covered in part by data recorders at the Thailand and India ground stations.


TDRS Coverage Gap (8.7 kb)

Processing Steps

The Space Imaging EOSAT Image Data Processing Facility in Lanham, Maryland, receives the HDTs from the Norman, Oklahoma, acquisition facility. The newly acquired data are manually and automatically screened for cloud cover and data quality through the Preprocessing and Data Classification System (PDCS). HDTs that are required for customer products continue through the image processing stream. The remaining data are stored locally for approximately six months; after temporary storage, they are permanently archived in Jessup, Maryland. The HDTs are also shipped to the EDC where they are copied and the original returned to the Space Imaging EOSAT.

Systematic correction data (SCD) is generated as follows:

- Correcting and validating the mirror scan and payload correction data

- Providing for image framing by generating a series of scene center parameters

- Synchronizing telemetry data with video data

- Estimating linear motion deviation of scan mirror/scan line corrections

- Generating benchmark correction matrices for specified map projections

- Producing along- and across-scan high-frequency line matrices

The Space Imaging EOSAT Image Processing System (EIPS) has the capability to produce precision-corrected, geocoded, mosaicked, and terrain-corrected products. Insufficient control points in the Control Point Library (CPT) requires a single band (Band 4) tape be produced and processed on the Control Point Extraction System (CPES) for control point (chip) selection. Upon successful completion, the product is reprocessed via the EIPS. Digital elevation model (DEM) and digital terrain model (DTM) data are ingested through EIPS for terrain-corrected and mosaic products.

A 3-band digital data tape is provided with each film product request and is used in the Film Process Generation System (FPGS). The 3-band digital data are ingested, Look Up Tables (LUTs) are constructed, and the ordered RGB is assigned for output. The latent image is processed using a Colorfire-240. Further processing is completed per customer request and tranported via a commercial vendor. These products include: paper print, color positive, transparency, or processed negatidata

The Space Imaging EOSAT initiated a Fast Format for TM digital data. The general formatting criteria follows:

1. Field definitions strictly follow American National Standards Institute (ANSI) and International Organization for Standardization (ISO) standards.
2. Only Band Sequential (BSQ) image structure is supported, because data are made available a single band at a time. Geometric corrections to the data are done one band at a time.
3. Image files consist of a single band of data.
4. A digital product is referred to as a volume set. Individual tapes are referred to as volumes. A volume set may have one or more volumes depending on image size and output tape density. Multi-resolution data sets have a volume set for each resolution.

For further information on the MSS processing systems refer to:

- EROS Digital Image Processing System (EDIPS)
- National Landsat Archive Production System (NLAPS)

Data Characteristics

Since 1972 these satellites have provided repetitive, synoptic, global coverage of high-resolution multispectral imagery. The characteristics of the MSS and TM bands were selected to maximize their capabilities for detecting and monitoring different types of Earth resources. For example, TM band 2 can detect green reflectance from healthy vegetation, and band 3 of TM is designed for detecting chlorophyll absorption in vegetation. TM band 4 is ideal for near-IR reflectance peaks in healthy green vegetation and for detecting water-land interfaces. TM band 1 can penetrate water for bathymetric mapping along coastal areas and is useful for soil-vegetation differentiation and for distinguishing forest types. The two mid-IR red bands on TM (bands 5 and 7) are useful for vegetation and soil moisture studies, and discriminating between rock and mineral types. The thermal-IR band on TM (band 6) is designed to assist in thermal mapping, and for soil moisture and vegetation studies.

Typically, TM Bands 4, 3, and 2 can be combined to make false-color composite images where band 4 represents red, band 3, green, and band 2, blue. This band combination makes vegetation appear as shades of red, brighter reds indicating more vigorously growing vegetation. Soils with no or sparse vegetation will range from white (sands) to greens or browns depending on moisture and organic matter content. Water bodies will appear blue. Deep, clear water will be dark blue to black in color, while sediment-laden or shallow waters will appear lighter in color. Urban areas will appear blue-gray in color. Clouds and snow will be bright white. They are usually distinguishable from each other by the shadows associated with the clouds.

Spatial Resolution

A Landsat 4 and 5 TM scene has an instantaneous field of view (IFOV) of 30 square meters in bands 1 through 5 and band 7, band 6 has an IFOV of 120 square meters on the ground.

The resolution for the TM sensor is shown below:

Landsats 4-5	Resolution (meters)
Band 1	30
Band 2	30
Band 3	30
Band 4	30
Band 5	30
Band 6	120
Band 7	30

Temporal Coverage

Background information and status of Landsat satellites.

Satellite	Launched	Decommissioned	Sensors
Landsat 1	July 23, 1972	January 6, 1978	MSS and RBV
Landsat 2	January 22, 1975	February 25, 1982	MSS and RBV
Landsat 3	March 5, 1978	March 31, 1983	MSS and RBV
Landsat 4	July 16, 1982	*	TM and MSS
Landsat 5	March 1, 1984	**	TM and MSS

* in standby mode used for range and command as of December 14, 1993.

** currently operational

Spectral Range

The thematic mapper (TM) is an advanced, multispectral scanning, Earth resources sensor designed to achieve higher image resolution, sharper spectral separation, improved geometric fidelity, and greater radiometric accuracy and resolution than the MSS sensor. TM data are scanned simultaneously in seven spectral bands. Band 6 scans thermal (heat) infrared radiation.

Radiometric range of bands and resolution for the TM sensor (from Landsat 4 Data Users Handbook, 1984, USGS).

Landsats 4-5	Wavelength (micrometers)	Resolution (meters)
Band 1	0.45-0.52	30
Band 2	0.52-0.60	30
Band 3	0.63-0.69	30
Band 4	0.76-0.90	30
Band 5	1.55-1.75	30
Band 6	10.40-12.50	120
Band 7	2.08-2.35	30

Micrometers and their relationship to the electromagnetic spectrum are explained in the glossary.

Data Organization

The Space Imaging EOSAT Fast Format volume set contains a header file, image files, and a trailer file.

The first file on each volume, a Read-Me-First file, contains header data. It is in American Standard Code for Information Interchange (ASCII) format and adheres to ANSI and ISO standards. The header file contains a single 1536-byte ASCII record. All alphanumerics are left justified, and all numerics are right justified.

All image files contain only one TM band of image pixels. There are no header records within the image file, nor are there prefix and/or suffix data in the individual image records. Image data may be blocked or unblocked.

The blocking factor is a procedure used to minimize the number of digital tapes required to accommodate a full-scene seven-band image set. Image data are written to tape in individual records and between each record is an inter-record gap (IRG), 0.35 of an inch, separating image file records. Unblocked data contain one line of image data per tape record.

The last volume of the Fast Format image set includes a trailer file. The trailer file contains ephemeris information to compute the approximate spacecraft position for each pixel in the image. This file is in ASCII format and adheres to ANSI and ISO standards.

The structure for a single-volume and a multi-volume set are presented below. Each file is followed by an End-Of-File (EOF) marker. An End-Of-Volume (EOV) marker consists of three EOFs.

```
Single Volume                     Multi Volume
 Volume Set                        Volume Set

                       Volume 1               Volume 2

 Header File          Header File            Header File

    EOF                  EOF                    EOF
  Band 1               Band 1                 Band 5
    EOF                  EOF                    EOF
  Band 2               Band 2                 Band 6
    EOF                  EOF                    EOF
  Band 3               Band 3                 Band 7
    EOF                  EOF                    EOF
  Band 4               BAND 4                 EOV
    EOF                  EOF                 Trailer File
  Band 5                 EOV
    EOF               Trailer File
  Band 6
    EOF
  Band 7
    EOF
    EOV
Trailer File
```

Data Availability

Procedures for Obtaining Data

To place orders and to obtain additional information regarding technical details, ancillary products, and pricing schedules, contact:
Customer Services, EROS Data Center

The GLIS INVENTORY and ORDER screens also may be used for further information on ordering Thematic Mapper data.

Products and Services

The EROS Data Center offers TM digital products on 8 mm cartridge tapes and Compact Disc Recordables, (CDRs).

The following products and prices will be offered by USGS-EDC to U.S. Governmentand its Affiliated Users (USGAU). This group is comprised of U.S. Government agencies; U.S. Government contractors; researchers involved with the U.S. Global ChaU.S. Government agencies; U.S. Government contractors; researchers involved with the U.S. Global Change Research Program and its international counterpart programs; and other researchers and international entities that have signed with the U.

All prices listed in the table are based on the TM data physically residing in the National Land Remote Sensing Data Archive (NSLRSDA) at EDC; the HDT access fee does not apply.

However, an HDT Access Fee must be added to the listed product price for all TM scenes that were acquired after October 28, 1992 and are not physically in the NSLRDA at the EDC. The HDT Access Fee is equal to $70 times the number of scenes on each HDT that must be purchased from Space Imaging EOSAT to fulfill the order. NOTE: No HDT access fee will be applied for the TM data acquired after October 28, 1992, if the data physically resides in the NSLRSDA.

DESCRIPTION	PRICE
TM Level 0 Raw	$300.00
TM Level 1 NASA/CCRS	$300.00
TM Systematic Single	$425.00
TM Systematic Multiple	$425.00 + $200.00 each additional scene
MSS Systematic Single	$200.00
MSS Systematic Multiple	$200.00 + $120.00 each additional scene
TM Map Reg. Single	$600.00
TM Map Reg. Multiple	$600.00 + $360.00 each additional scene
MSS Map Reg. Single	$375.00
MSS Map Reg. Multiple	$375.00 + $225.00 each additional scene
TM Terrain-Cor Single	$900.00
TM Terrain-Cor Multiple	$900.00 + $360.00 each additional scene
MSS Terrain-Cor Single	$675.00
MSS Terrain-Cor Multiple	$675.00 + $225.00 each additional scene

The following are the only products that will be offered by the USGS-EDC to the General Public. The General Public has access to only 10-year and older data and all of these data physically reside in the NSLRSDA at EDC, therefore, no HDT access fee applies.

DESCRIPTION	PRICE
TM Systematic Single	$425.00
TM Systematic Multiple	$425.00 + 200.00 each scene
MSS Systematic Single	$200.00
MSS Systematic Multiple	$200.00 + $120.00 each additional scene

Determine your Customer Category (general public or USGAU) and Date of Sensing of the scene to be ordered and use the tables to determine the distribution site (USGS-EDC or Space Imaging EOSAT).

	July 16, 1982 to 10 years ago	10 years ago to 1 year ago	1 year ago to Present
General Public	USGS-EDC	Space Imaging EOSAT	Space Imaging EOSAT
USGAU	USGS-EDC	USGS-EDC	Space Imaging EOSAT

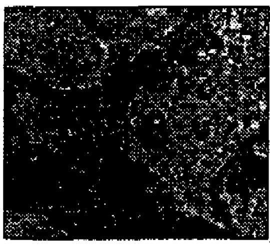
Effective October 1, 1996

	July 16, 1982 to 10 years ago	10 years ago to Present
General Public	USGS-EDC	Space Imaging EOSAT
USGAU	USGS-EDC	USGS-EDC

<u>Space Imaging EOSAT</u> thematic mapper products consist of black and white and color film and paper products and various digital products.

Applications and Related Data Sets

Landsat data have been used by government, commercial, industrial, civilian, and educational communities in the U.S. and worldwide. They are being used to support a wide range of applications in such areas as global change research, agriculture, forestry, geology, resources management, geography, mapping, water quality, and oceanography. Landsat data have potential applications for monitoring the conditions of the Earth's land surface. The images can be used to map anthropogenic and natural changes on the Earth over periods of several months to more than 15 years. The types of changes that can be identified include agricultural development, deforestation, natural disasters, urbanization, and the development and degradation of water resources. The MSS archive has over 630,000 scenes with a data volume of 20 terabytes. The TM archive has over 300,000 scenes with a data volume of over 50 terabytes.


TM Scene (59.2 kb)

References

Earth Observation Satellite Company, 1985, User's guide for Landsat thematic mapper computer-compatible tapes: Lanham, Md., Earth Observation Satellite Company [variously paged].

Earth Observation Satellite Company, 1994, Landsat system status report--September 1994: Lanham, Md., Earth Observation Satellite Company, p. 1-11.

National Aeronautics and Space Administration, 1981, Draft Landsat-D worldwide reference system (WRS) users guide: [Greenbelt, Md.], National Aeronautics and Space Administration [variously paged].

National Oceanic and Atmospheric Administration, 1983, Landsat data users notes: [Sioux Falls, S. Dak.], National Oceanic and Atmospheric Administration [variously paged]

U.S. Geological Survey and National Oceanic and Atmospheric Administration, 1984, Landsat 4 data users handbook: [Washington, D.C.], U.S. Geological Survey and National Oceanic and Atmospheric Administration [variously paged].

Appendix

- Worldwide Reference System (WRS)

Annex 18 USGS Thematic Mapper Landsat Data: Search Criteria

Geographic Coverage

Acquisition Date

Path/Row Search

Cloud Cover

LANDSAT Data Dictionary

USGS

Thematic Mapper Landsat Data: Search Criteria

NOTICE: The price for TM data varies significantly for U.S. Government and Affiliated Users (USGAU) and commercial users. Please Note: The GLIS price estimate defaults to the commercial price. Refer to the GLIS TM Guide or the Price Option for specific TM product/price information.

Geographic Coverage

Draw Area on World Map | Search by US Placename NEW

or enter coordinates (format = N/S, E/W DDD MM SS or +/-DDD MM SS or +/-DDD.NNNN)

Northernmost Latitude

Westernmost Longitude | Easternmost Longitude

Southernmost Latitude

Acquisition Date

The format for specifying date is YYYY/MM/DD

TO

Browse Availability

Select up to two values or choose ALL

ALL
NO
YES

Path/Row Search

Path TO

Row TO

Cloud Cover

Thematic Mapper Landsat Data: Search Criteria

TO

Entity Id ?

DCT Availability ?

Select up to two values or choose ALL

ALL
N DCT's are not available
Y DCT's are available

Product Distribution Site ?

Select up to two values or choose ALL

ALL
10 years and older from EDC
USGS-EDC and EOSAT

Submit Search | Clear Entries | Additional Search Criteria

|| GLIS Home Page|GLIS Help||

URL:http://edcwww.cr.usgs.gov/Webglis/glisbin/search.pl?LANDSAT_TM
Maintainer: webglis@edcwww.cr.usgs.gov;
Last modified: 30 April 1997

USGS

HELP: Landsat Data Dictionary

Area Indicator

- *Field Definition*: An indicator to note how well a search area is covered by an inventory entity.

Valid codes include:
P = Partial coverage of the search area within the entity.
C = The entity coverage is within the search area.
S = The search area is within the entity coverage.

This field only applies to geographic searches. If searching by a non-geographic method (e.g., entity IDs), this field will be blank.

B/W Film Availability

- *Field Definition:* A flag to indicate the availability of data products or visual aids. This includes such things as enhanced color composite, black-and-white film, etc.

Valid codes:
Y = Yes, B&W photos are available for this scene.

N = No, Standard photo products are not available.

Browse Availability

- *Field Definition:* This flag identifies whether or not the entity has a browse image available with it. A browse image provides the user with a visual overview of an inventory item. This is an on-line digital (raster format) image of an individual scene.

Note: Preview images are resampled from the original data and may not accurately represent the full resolution product. For more information see "Overview of GLIS Preview Image Strategies".

Cloud Cover

- *Field Definition:* Cloud Cover is the percentage of the entire image obscured by clouds and their shadows. The percentage is displayed in increments of 10%.

Cloud Cover is a subjective call made from interpreting a single band of the image on film. It is therefore, approximate in nature.

Valid Codes include:

```
0 = 0% but less than 10%
1 = 10% but less than 20%%
2 = 20% but less than 30%
3 = 30% but less than 40%
4 = 40% but less than 50%
5 = 50% but less than 60%
6 = 60% but less than 70%
7 = 70% but less than 80%
8 = 80% but less than 90%
9 = 90% up to 100%
```

CCT Availability (Full Scene)

- *Field Definition:* A field that indicates the availability of computer compatible tape (CCT) products for an entire scene.

Valid codes:

CCT is not available.

X type CCT is available.

CCT Availability (Scene Quadrangles)

- *Field Definition:* This field indicates the availability of computer compatible tape (CCT)products.

Valid codes:

N = No, CCTs are not available for all quads of this scene.
U = Radiometrically uncorrected quads exist for this scene.

Condition

- *Field Definition:* Condition equates to a special image defect or condition in data processing that affects a scene or group of scenes. The scene may not be downgraded in quality but its condition is important to note.

Valid codes:
= Not applicable; no special condition evident in this scene.

P = Pre-WRS data. Image data was accepted prior to stabilizing the orbit to its nominal status. Therefore, the data may be geographically off from other WRS scenes of the same path.

R = Radiometric Engineering data. The image was a part of a calibration study for radiometric correction.

K = Space Imaging EOSAT supplied nominal center coordinates.

D = Sensor warm-up problem.

N = New scenes generated by TMACS processing.

Q = New TMACS/Post Launch stabilization data.

Acquisition Date

- *Field Definition:* The date the data was acquired.

Date of Update

- *Field Definition:* The Date of Update refers to the date the inventory record was added to the inventory, or the date the record was last updated.

DCT Availability

- *Field Definition:* Indicates availability of image on digital cassette tape.

```
TM:      Y = DCT is available
         N = DCT is not available
```

Digital Cassette Tape (DCT) availability of yes means that the TM DCT source is in the National Land Remote Sensing Data Archive (NLRSDA) at the EROS Data Center. Therefore, the High Density Tape (HDT) access fee will not be charged to U.S. Government and Affiliated Users (USGAU). Refer to the TM Guide or Price file on the main menu for further information.

Entity ID

- *Field Definition:* This field uniquely identifies data which can be ordered in any combination of unique products.

Example:
TM Entity ID: LT5043034008628110

```
WHERE:
     L = Landsat
     T = Thematic Mapper
     5 = Satellite number.  This should be validated
         against the satellite field if used exclusively.
   043 = Path
   034 = Row
    00 = WRS row offset (set to 00)
    86 = Last two digits-year of acquisition
   281 = Julian date of acquisition
     9 = Instrument mode (LS 4/5-TM=1 and MSS=9,
         LS 7 - 0=night acquisitions
         1=TM bands 1-7, 2=bands 4,6,7 panchromatic,
         3=bands 4,5,6 panchromatic
     0 = Instrument multiplexor (MUX) on board the spacecraft
         This will always be 0 for LS 4/5.
         LS 7 and beyond will be 1 or 2.
```

Geographic Coverage
There are three options for entering coordinate information to define the geographic coverage of interest.

1. Draw Area on Map: Displays a map of the world in which you select coordinates.

   Pan
   Clicking within the map redraws the globe to center on that particular point.

   Define Zoom Box
   Selects a portion of the globe to view by defining a box to zoom in on. To define the zoom box, click on the upper left corner of the area to be zoomed in on. After document reloads, click on the lower right corner to complete the box.

   Define a Point for searching
   Click on any point within the map area. The point selected to search on is identified with a crossmark. The coordinate information will be displayed in the text fields after the point has been selected.

   Define Range
   To define the range, click on the upper left corner of the area to be zoomed in on. After document reloads, click on the lower right corner to complete the box. The area selected to search on is identified with a rectangular outline. The coordinate information will be displayed in the text fields after the range has been defined.

2. Search by U.S. Place Name: Allows you to enter a feature name to define the geographic coverage of interest. This is a multi-step process.

   Step 1 (Search U.S. Placenames)
   Name **(Required)**
   Enter in the name of the feature you wish to search on. (example: Sioux Falls)

State: **(Required)**
Enter the two digit code for the state in which the feature resides. (Example: SD)

Feature Type.
Select a feature type that corresponds with the feature name you entered.(example: Populated Place, PPL, City, town, village, subdivision)

OK button
Click on the OK button to submit the place name entry.

Step 2 (Select One or More Placenames.)
To select a feature, click on the button next to the feature name. The name you have selected will be used to search the inventory. You may add additional criteria to your search by scrolling to other fields (such as Acquisition Date or Map name) and by entering the requested information.

Draw Area on World Map
Click on the Draw Area on World Map button if you would like to select a feature from a map instead of the list.

Step 3 (World Map)
A map will be presented to you showing the area of the features that matched your place name entry from the first step. For instructions on how to define an area within the map see Geographic Coverage: Draw Area on Map.

Rather than select an area using the map, you may want to use the map to reference the list of features (matching your entry) listed below the map. Use pan and zoom to get close to the feature names to determine which feature best matches your area of interest. You can then select a feature from the list by clicking on the button next to the feature name. You may add additional criteria to your search by scrolling to other fields (such as Acquisition Date or Map name) and by entering the requested information.

NOTE: If you define an area on the map and select a feature from the list, the search will be executed using the Placename selected. The area defined on the map will be ignored.

3. Type in Coordinates:

Point: Type in Northernmost Latitude and Westernmost Longitude.
Range (Rectangular box): Allows you to type in four points to define a rectangular search area.

(format = +/-DDD MM SS or +/-DDD.NNNN)
The plus (+) sign represents northern latitude and eastern longitude.
The minus (-) sign represents southern latitude and western longitude.

Microframe Number

- *Field Definition:* The location of the browse microfiche or digital file. Identifies the location of the microframe image (cassette/fiche and frame number). Prefixes of 1, 2 and

3 identify Goddard Space Flight Center generated images. A 7 prefix represents EROS generated references. The second digit identifies the coverage area of the microframe source; U.S. coverage = 1, Non-U.S. = 2, and mixed coverage = 9. Over 1200 scenes may exist on one reel of film or one set of microfiche.

Example:

Microframe : 7902450178

```
WHERE:
      79   = EROS generated, mixed coverage
    0245   = The cassette or roll number
    0178   = The frame number on the source that represents the
             scene of interest
```

Overall Quality

The specified Scene ID's digital band quality rating is a single code derived from geometric, radiometric and image quality digital assessments. A scale of 0 - 9 / A - C is used with C = the highest digital quality and 0 = the lowest digital quality. Valid codes are based on a GSFC combined rating system of excellent, good or acceptable for each of the three categories referenced below:

Code Definition	Image Quality	Radiometric Quality	Geometric Quality
C = Very Best:	excellent	excellent	excellent
B = Best:	excellent	excellent	good
A = Best:	excellent	good	excellent
9 = Very Good:	good	excellent	excellent
8 = Good:	excellent	good	good
7 = Good:	good	excellent	good
6 = Fair:	good	good	excellent
5 = Fair:	good	good	good
4 = Fair;	acceptable	excellent	excellent
3 = Poor:	acceptable	excellent	good
2 = Poor:	acceptable	good	excellent
1 = Poor;	acceptable	good	good
0 = Very Poor:	acceptable	acceptable	acceptable
M = Scene/band identified as unreadable on this HDT digital source.			
# = Not applicable; no HDT digital quality available.			

Digital Band Quality Rating System:

IMAGE QUALITY = (major frame sync losses + minor frame sync losses / 20.0) + (uncorrected bit errors / 20.0)
If the image quality is 4.5, image quality is "acceptable".

RADIOMETRIC QUALITY = During radiometric correction, a process called "histogramming" is performed, and the maximum difference between detectors in a band is calculated.
If the maximum difference is 2.0 , radiometric quality = "acceptable".

GEOMETRIC QUALITY is related to the number of control points used. There are six variables that can be estimated if there are sufficient control points that are accurate. These variables are: 1) Pitch Bias, 2) Yaw, 3) Roll Bias, 4) Radial Displacement, 5) Pitch Rate and 6) Roll Rate.

Path/Row

Annex 19 LANDSAT Ground Station Operations Working Group (LGSOWG) TM

Background

Extent of Coverage

Acquisition

- Processing Steps

Data Characteristics

- Spatial Resolution
- Temporal Coverage
- Spectral Range

Data Organization

Data Availability

- Procedures for Obtaining Data
- Products and Services

Applications and Related Data Sets

References

Appendix

Landsat Ground Station Operations Working Group (LGSOWG) TM

Table of Contents

Background

The first satellite in the Earth Resources Technology Satellite (ERTS) program was launched July 23, 1972 and designated ERTS 1. In 1975 the program was redesignated as the Landsat program to emphasize its primary area of interest, land resources. The mission of Landsat is to provide for repetitive acquisition of high resolution multispectral data of the earth's surface on a global basis.

The complete Landsat system consisted of an observation platform in a near-polar Earth orbit and ground installations to receive, process, and distribute the data provided by the sensors carried on board the satellite. The platform carried two remote sensor systems, communication links, attitude-control and orbit-adjust systems, and a power supply to send the image to ground receiving stations and to receive ground control commands.

The Landsat satellites are in a sun-synchronous, near polar orbit with a ground swath extending 185 km (115 miles) in both directions. Landsat 4 and 5 are inclined 98 degrees, have an orbital cycle of 16 days, and an equatorial crossing of 9:45 AM local time. The altitude of the satellites varied between 920 km (571 miles) for Landsats 1-3 and 705 km (437 miles) for Landsats 4 and 5.

Landsat 4 was launched on July 16, 1982 and was the first time that the Thematic Mapper (TM) sensor was carried on a Landsat platform.

The Landsat Ground Station Operations Working Group (LGSOWG) TM data base lists all TM Landsat scenes held by participating countries (excluding USA).

Extent of Coverage

The Landsat system provides for global data between 82 degrees North latitude and 82 degrees South latitude.

Acquisition

The Landsat platforms operate from a sun-synchronous, near polar orbit imaging the same 185 km (115 miles) ground swath every 16 days. Thematic Mapper (TM) data are received directly from Landsats 4 and 5 by the LGSOWG network of worldwide ground stations.

Processing Steps

The processing subsystem at each LGSOWG station may vary, but usually consists of the TM data being processed and reformatted onto a digital tape for use during the geometric correction process.

The TM processing steps include:

- Correcting and validating the mirror scan and payload correction data
- Providing for image framing by generating a series of scene center parameters
- Synchronizing telemetry data with video data
- Estimating linear motion deviation of scan mirror/scan line corrections
- Generating benchmark correction matrices for specified map projections
- Producing along- and across-scan high-frequency scan line matrices

Data Characteristics

Spatial Resolution

A TM scene has an IFOV of 30 square meters in bands 1-5 and 7 while band 6 has an IFOV of 120 square meters on the ground.

Temporal Coverage

	Launch Date	Deactivated	Sensor
Landsat 4	07/16/82	----	TM
Landsat 5	03/01/84	----	TM

Spectral Range

The Thematic Mapper (TM) is an advanced, multispectral scanning, earth resources sensor designed to achieve higher image resolution, sharper spectral separation, improved geometric fidelity and greater radiometric accuracy and resolution than the MSS sensor. TM data are sensed in seven spectral bands simultaneously with band 6 sensing thermal (heat) infrared radiation.

Thematic Mapper (TM)

Band	Micrometers	Resolution
1	.45 - 0.53	30m
2	.52 - 0.60	30m
3	.63 - 0.69	30m
4	.76 - 0.90	30m
5	1.55 - 1.75	30m
6	10.40 - 12.5	120m
7	2.08 - 2.35	30m

Micrometers and their relationship to the electromagnetic spectrum are explained in the glossary.

Data Organization

Two types of image data are offered:

- Fully processed data with both geometric and radiometric corrections applied.
- Partially processed data with only radiometric corrections applied.

Processing Codes

Fully Processed	Partially Processed
TM = CCT-P	TM = CCT-A

Both processing levels offer either a Band-Interleaved-by-Line (BIL) or a Band-Sequential (BSQ) image data format.

Current CCT's include a comprehensive field location and data description information superstructure. This superstructure consists of:

- A volume directory file which generally describes the data configuration and provides pointers to each data file.
- A file descriptor record for each data file which describes the data structure within the file and provides pointers to certain fields within the file.

The entire superstructure is composed of four records. Three records (volume descriptor, text, file pointer) reside in a volume directory file. The fourth record is the file descriptor record which is the first record of each data file. The four superstructure records are similar to one another in content as well as in format. The purpose of these records is to identify, describe and locate data in the data files. Thus, superstructure records primarily supply information about the data on the CCT rather than carrying data themselves.

Data Availability

Procedures for Obtaining Data

To obtain additional LGSOWG TM information regarding other technical details, ancillary products, and pricing schedules contact one of the:
LGSOWG Stations

The specific LGSOWG station can be determined from the first two characters of each scene's Entity ID based upon:

YG - Australia
YB - Brazil
YC - Canada
YD - Italy (via European Space Agency)
YJ - Japan
YM - Maspalomas (via European Space Agency)
YP - Pakistan
YF - South Africa
YE - Sweden (via European Space Agency)

The GLIS INVENTORY and ORDER screens may also be used for further information on ordering Landsat data.

Products and Services

Requests for LGSOWG TM data will be forwarded to the proper LGSOWG center. U.S. Federal users interested in purchasing data may contact:
Customer Services, EROS Data Center

Applications and Related Data Sets

Landsat data are used for many varying studies, inventories and analysis. Crop acreage inventories, timber class identifications, soil identification and mapping, range cover and forage production analysis, plant stress detection, regional land use classifications, generation of photo-maps, mineral and petroleum exploration, pollution monitoring, geological mapping and interpretation, areal snow extent assessments, and shallow bathymetric measurements are but a few of the applications of Landsat TM data.

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USGS, NOAA, 1984. 'Landsat 4 Data Users Handbook,' Department of Interior, U.S. Geological Survey and Department of Commerce, National Oceanic and Atmospheric Administration, Arlington, VA.

Appendix

- TM Data Organization
- Worldwide Reference System (WRS)

TM Data Organization

The imagery logical volume contains the image data, preceded by a leader file containing header, map ancillary and radiometric ancillary information and followed by a trailer file. The format of this volume has been standardized to a detailed level, so that it will be identical in format, regardless of the processing facility or country of origin, for all TM CCTs. All records are 4320 bytes or less in length for CCT-Ps and the CCT-A leader file and 3600 bytes or less for other CCT-A files. They are coded in ASCII or unsigned binary only.

TM BSQ Tape Layout

TM BIL Tape Layout

Both CCT types begin with standard volume directories, introduce files with descriptor records, use the standard introductory record information, and have 180-byte multiple record lengths. The format tables for the types of records on the CCT-Ps and CCT-As contain byte numbers, descriptions of the byte contents and a type of data designator. The data types are:

Binary A = Alphanumeric ASCII I – Integer R = Real N designates the number of bytes in a field (e.g., I*2 or R*4)

All files, except volume directory files, begin with a file descriptor record, followed by the data records. All records within a file have a constant length. With the exception of the volume directory file, the file class names, codes and contents are listed below:

Class Name	Class Code	File Contents
Leader File	LEAD	Scene header/map projection radiometric calibration
Imagery File	IMGY	Imagery
Trailer File	TRAI	Trailer
A-Supplemental	ASUP	Scene definition/unprocessed SCD/

```
                             control points/geometric modeling/hi
                             frequency matrices/annotation
P-Supplemental   PSUP        Band quality/annotation
```

Each of the records in a file contains standard introductory information in the first 12 bytes: record sequence number, record type code (and subtypes) and record length. The record number is in bytes 1 through 4 of each record; its value starts at 1 and increases sequentially in the subsequent file records. Bytes 5 through 8 contain the type codes and are used to identify the type of information in the record. The record type is made up of four separate 1-byte codes: a type code and three subtype codes.

The type code indicates the basic data type in a record, and the three sub-types are used to further classify the data and format. There are seven data types: superstructure, header, annotation, ancillary, data, trailer and text. Bytes 9 through 12 contain the record length. The three types of superstructure records have the following lengths:

```
1. Volume Descriptor Record - 360 bytes
2. File Pointer Record ------ 360 bytes
3. File Descriptor Record --- 360 bytes
   (if other records in file are variable)
```

Standard formats are either binary or ASCII encoded. Binary fields are either unsigned integer values or specified number codes. The most significant bit (MSB) in each field is the MSB of the first byte within the field and the least significant bit (LSB) is the LSB of the last byte within a field. For binary fields more than 1 byte (8 bits) long, no DIGITAL VAX inversion effects are permitted; that is, the first byte of the field must appear first on the tape.

ASCII data are encoded as one 7-bit character per byte. The ASCII character occupies the first 7 bits (0-6) and bit 7 is equal to zero. Numeric data represented in ASrepresented in ASCII format are always right-justified and blank-filled on the left. Character data within a field are always left-justified and blank-fill

The beginning-of-tape (BOT) and end-of-tape (EOT) markers are small pieces of reflective tape located on the non-reading side of the CCT at least 10 feet from the beginning and 14 feet from the end of each reel. These markers define the permissible recording area of the CCT.

The identification burst is recorded on tape by the tape drive and begins at least 1.7 inches before the trailing edge of the BOT marker. It extends no closer than 0.5 inch from the first data block. An initial gap (a minimum of 3 inches and a maximum of 25 feet) separates the BOT marker from the first data block.

Adjacent files are separated by an EOF tape mark preceded by an inter-block gap (IBG) tape mark and followed by a standard IBG. Adjacent records within a file are separated by a standard IBG.

Annex 20 The Earth Observing System (EOS) World Wide Web
-Information Server-
The EOS Distributed Active Archive Center (DAAC)

Welcome to the

Earth Observing System World Wide Web Information Server

The intention of this site is to provide convenient access to program information for those involved or interested in the EOS program.

NASA WWW Servers

Distributed Active Archive Centers (DAACS)

EOS Project Related WWW Servers

Servers of Related Interest

Services

Problems or comments should be sent to www@eos.nasa.gov.

Last Modified:
Sept 30, 1996

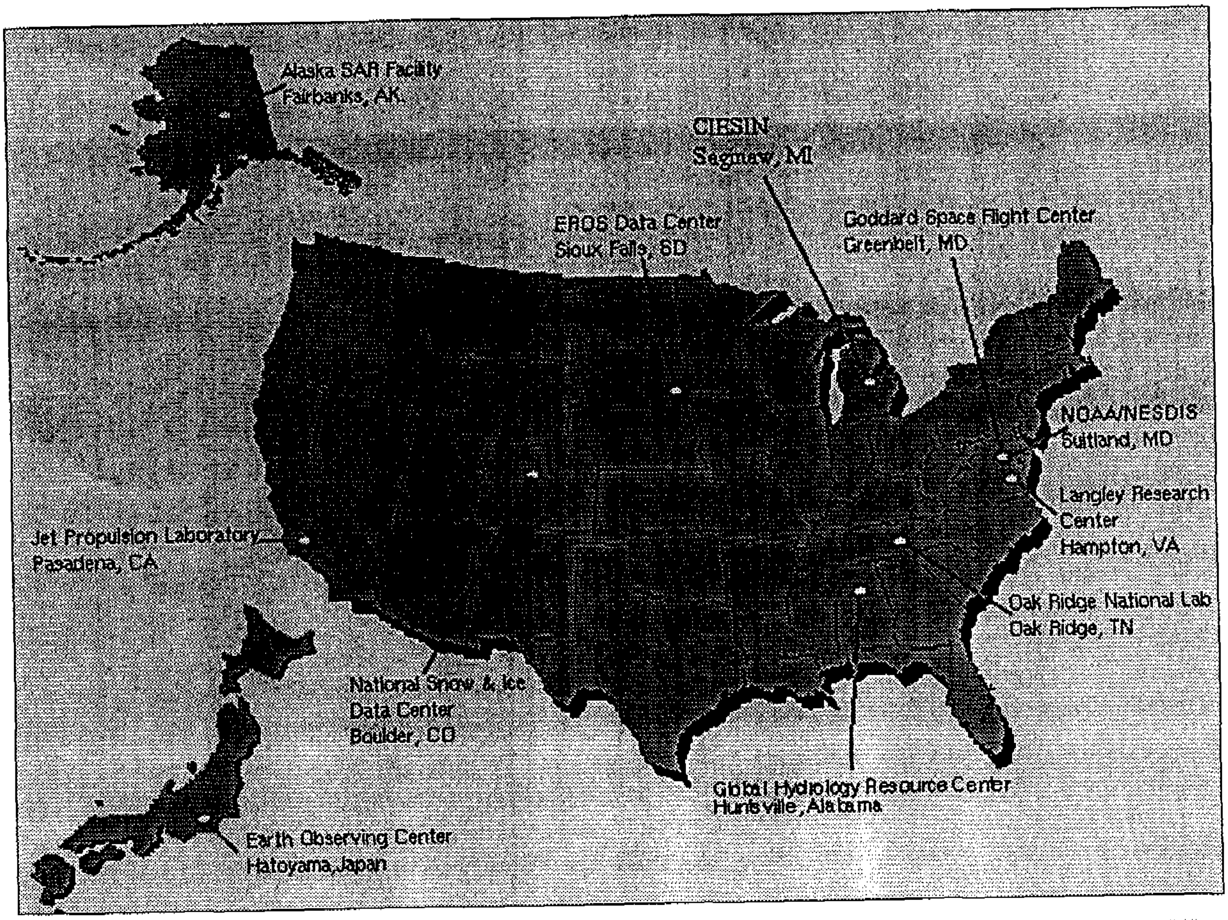
Curator:
EOS V0 Network Support Office,
Jhon Honce, Hughes STX,
Jhon.Honce@gsfc.nasa.gov.

Responsible Organization:
EOS Project Office/Code 505 GSFC,
Richard desJardins, Network Engineer,
Richard.desJardins@gsfc.nasa.gov.

EOSDIS
D istributed
A ctive
A rchive
C enter

This page provides links to all DAAC sites that are running WWW servers. Links may be accessed from the imagemap below or <u>here</u> for a list of DAAC sites.

Click on the DAAC SITE NAME you wish to connect to:



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Last Modified:
July 10, 1995
Curator:
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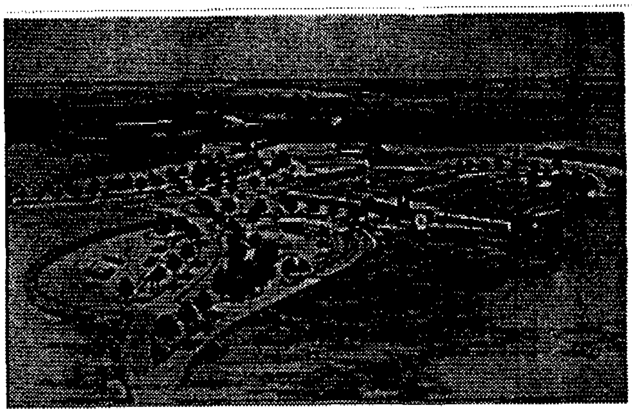
Jhon Honce, Hughes STX,
<u>Jhon.Honce@gsfc.nasa.gov</u>.

Responsible Organization:

EOS Project Office/Code 505 GSFC,
Richard desJardins, Network Engineer,
Richard.desJardins@gsfc.nasa.gov.



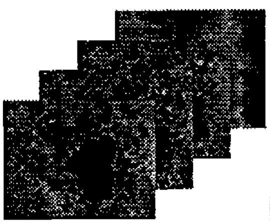
Welcome to the EDC DAAC

The Earth Resources Observation Systems (EROS) Data Center Distributed Active Archive Center (EDC DAAC) was established as part of NASA's Earth Observing System Data and Information System (EOSDIS) initiative to promote the interdisciplinary study and understanding of the integrated Earth system. Access to land processes data, including satellite- and aircraft-acquired data stored in the EDC DAAC's archives, plays an important role in promoting such study and understanding.

Research performed by Earth and global change scientists investigating the conditions and processes that affect land-atmosphere and land-ocean interactions is supported by enhanced access to archived data and data products. Information about and procedures for obtaining these data are provided through the EOSDIS Information Management System.

Products

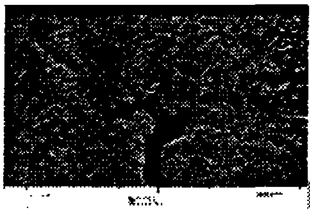
Global 1KM AVHRR Data



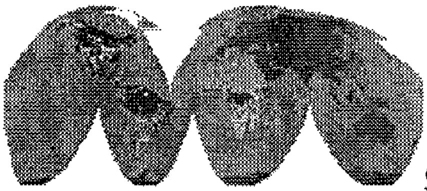
Landsat Pathfinder Data

Global 30 Arc-Second Elevation Data Set

EOSDIS DAAC at EROS Data Center

SIR-C:

- Survey Data
- Precision Data Inventory
- Educational CD-ROM:

Global Land Cover Characterization

Services

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EDC DAAC User Services Office
Other DAAC User Services Offices

Other WWW Servers

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Connect to NASA EOSDIS home page
Connect to USGS/EROS Data Center home page
Connect to Global Change Master Directory
Connect to the ECS Science Office
Connect to V0 IMS Web Gateway

DAAC User Services Survey

<URL:http://edcwww.cr.usgs.gov/landdaac/landdaac.html>
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Last modified: 8 May 1997.

Annex 21 ERDAS IMAGE PROCESSING

ERDAS IMAGINE 8.3 Platform Specifications

ERDAS Africa and Middle East Distributers

Technical Info/Tools

ERDAS IMAGINE 8.3 Platform Specifications

ERDAS IMAGINE is available on these platforms and operating systems:

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- Hewlett-Packard 9000 Series 700 and 800 (HP-UX 10.10 and 10.20)
- IBM RS/6000 Series (AIX 4.1.4, 4.1.5 and 4.2)
- Silicon Graphics R4400 through R10000 Series (IRIX 6.2 and 6.3)
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Ethiopia
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Region Manager Barrie Collins
404-248-9000 Phone
404-320-8451 Fax
email: collins@erdas.com

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233-21-230097 Fax

Israel
Systematics
972-3-495111 Phone
972-3-6471094 Fax
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Jordan
Autographics in Jordan
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962-2-5531600 Fax

Kenya
RSI Ltd.
254-2-241131 Phone
254-2-241131 Fax

Kuwait
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Region Manager Barrie Collins
404-248-9000 Phone
404-320-8451 Fax
email: collins@erdas.com

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Geomatic
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GIMS
27-11-315-0390 Phone
27-11-315-0395 Fax

Nigeria
ERDAS Africa/Middle East
Region Manager Barrie Collins
404-248-9000 Phone
404-320-8451 Fax
email: collins@erdas.com

Oman
Geosystems
971-4-522-500 Phone
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Pakistan
BSI
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Senegal
ERDAS Africa/Middle East
Region Manager Barrie Collins
404-248-9000 Phone
404-320-8451 Fax
email: collins@erdas.com

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Zambia
GIMS
27-11-315-0390 Phone
27-11-315-0395 Fax

Zimbabwe
GIMS
27-11-315-0390 Phone
27-11-315-0395 Fax

ERDAS International Offices
email: international@erdas.com

Headquarters
2801 Buford Highway, Suite 300
Atlanta, Georgia 30329-2137
USA
404/248-9000 phone
404/320-8451 fax

United Kingdom
Telford House
Fulbourn, Cambridge CB1 5HB
United Kingdom
44-1223-881-774 phone
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Unit A, 12/F, Bldg. A, Fuhua Mansion
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Dong Cheng District, Beijing 10027
People's Republic of China
Phone: +(86-10)6554-1618-21
Fax: +(86-10)6554-4600
Email: officxsf@public3.bta.net.cn
Email: salesxsf@public3.bta.net.cn
Email: techxs@public3.bta.net.cn

Hong Kong
Horizon Technologies

Mr. John Zhao
Miss Winne Tang
Room 601, 113 Argyle Street
Mongkok, Kowloon
Hong Kong
Phone: +(852)2548-8737/9436-6376
Fax: +(852)2548-8965
Email: wtang@horizontech.com.hk
Email: johnc@horizontech.com.hk

India
ESRI India
Mr. Dinesh Gupta
Balaji Estate
8 Sudarshan Munjal Marg
Kalkaji
New Delhi 110 019
Phone: + 91 11 6203801
Fax: +91 11 620 3838
Email: dgupta%niit@iris.ernet.in

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ESRI-South Asia (Jakarta)
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Level 17
Jl. Jenderal Sudirman, Kav. 10-11
Jakarta 10220
Phone: +(62-21)570-7685
Fax: +(62-21)570-7686
Email:rina@esri.co.id

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Bldg. No. 57, Shahid Ghandi Ave.
Palizi Square
P.O. Box 15875/1414 Tehran 15567
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Fax: +(98-21)860-0967

Israel
Systematics Technologies
Mr. Oded Leventer
4 Raoul Wallenberg Street
Tel Aviv 69719
Phone: +(972-3)649-5111
Fax: +(972-3)647-1094
Email: yossil@systematics.co.il

Japan
PASCO Corporation

Mr. T. Okuyama
1-2, 1-Chome Higashiyama
Higashiyama Bldg, 8F
Meguro-ku
Tokyo 153
Phone: +(81-3)3715-1601
Fax: +(81-3)3715-1607
Email: kikaku@pasco.co.jp

Jordan
Infograph
Mr. Munir Kawar
Abdali, Akorco Building
4th Floor, Office #12
P.O. Box 911021
Amman
Phone: +(962-6)603-546
Fax: +(962-6)602-891
Email: infograph@nets.com.jo

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Seocho-gu
Seoul
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Daiyah Area 1, Street 17, Building 14
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ESRI-South Asia (Malaysia)
Level 6B, Menara PKNS-PJ
17, Jalan Yong Shook Lin
46050 PETALING JAYA
Phone: +(60-3)757-9930
Fax: +(60-3)757-9679
Email: bbundock@esri.com.my

Oman
Khatib & Alami Consolidated Engineering Co.
Mr. Faisal Alami
P.O. Box 238
Muscat, 112
Phone: +(968)602-016/602-076
Fax: +(968)602-098
Email: knamct@gto.net.om

Pakistan
Pakistan Resources Development Services, Ltd.
Ms. Anjla Ashraf
29, Block 7&8 D.C.H.S.
Sharea Faisal
Karachi-75350
Phone: +(92-21)453-0926
Fax: +(92-21)453-4619
Email: sales@prds.isb.erum.com.pk
Email: kmirza@biruni.erum.com.pk

Philippines
Geodata Systems Technologies, Inc.
Ms. Francisca Dayrit
19th Floor Strata 100 Building
Emerald Ave., Ortigas Center
Pasig City, 1605 Philippines
Phone: +(63-2)637-4447 to 49
Fax: +(63-2)633-6873
Email: geodata@mozcom.com

Qatar
Mannai Trading Company
Mr. K. Venugopalan
Salwa Industrial Complex
P.O. Box 76
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Saudi Arabia
Moammar Information Systems
Mr.Khalid Al Moammar
P.O. Box 16116
Riyadh 11464
Phone: +(966-1)463-1270
Fax: +(966-1)465-9035
Email: mismail@khalee.net.bh

Singapore
ESRI-South Asia
Mr. Jim Durana
350 Orchard Road
Shaw House, #12-01/03
Singapore 0923
Phone: +(65)735-8755
Fax: +(65)735-5629
Email: jdurana@esri.com.sg

Sri Lanka
EMSO Limited
Mr. Anil Wijewardene
50 Hyde Park Corner
P.O. Box 312
Colombo 2
Phone: +(94-1)435-059
Fax: +(94-1)447-881

Syria
HI-TECH HOUSE
Mr. Samaan Alkouri
Bab Charki, Tabala Road
Kassis Building
P.O. Box 25982
Damascus
Phone: +(963-11)543-0799
Fax: +(963-11)542-2832
Email:

Taiwan
Hitron Technology Inc.
Mr. C.C. Wu
P.O. Box 17-77
Hsin Chuang, Taipei
Taiwan
Phone: +(886-2)298-3456
Fax: +(886-2)298-2200

Email: chuck@hq.ht.net.tw
URL http://www.hq.ht.net.tw

Thailand

ESRI-Thailand
Mr. Krairop Luang-Uthai
CDG House
202 Rachada-Nanglinchi Road
Chongnonsi, Yannawa
Bangkok 10120
Phone: +(66-2)678-0707
Fax: +(66-2)678-0321-3
Email: channarong.t@cdg.co.th
Email: krairop.l@cdg.co.th

United Arab Emirates

GISTEC
Mr. Manoj Kumer Dhall
10th Floor, Corniche Plaza
P.O. Box 5026
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Phone: +(971-6)723636
Fax: +(971-6)724490
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Mr. Mazen Aman
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