Remote-Sensing Satellites

A satellite with remote sensors to observe the earth is called a remote-sensing satellite, or earth observation satellite. Meteorological satellites are sometimes discriminated from other remote-sensing satellites.

Remote-sensing satellites are characterized by their altitude, orbit, and sensor. The Television and Infrared Observation Satellite (**TIROS)** series (1960 - 1965), the first generation of National Oceanic and Atmospheric Administration (**NOAA)** satellites was the first operational remote-sensing satellite system.

The main purpose of the **geo-synchronous meteorological satellite (GMS),** with an altitude of 36,000 km, is meteorological observations,

while **LANDSAT,** with an altitude of about 700 km, is a polar orbit and is used mainly for land area observation.

The **NOAA** satellite series, the third generation meteorological satellites operated by the **NOAA** , USA, with **Advanced Very High Resolution Radiometer (AVHRR)** sensors, with an altitude of 850 km in a polar orbit, is mainly designed for meteorological observation but is also successfully used for vegetation monitoring. There are several remote- sensing satellite series in operation at present **(LANDSAT, NOAA, SPOT, MOS, JERS, ADEOS, ESR, RADARSAT, IRS, etc).**

In the future some remote-sensing satellites will have large payloads with many kinds of multipurpose sensors, such as the polar orbit platform (POP) project under the international cooperation of the US, EEC, Japan, and Canada. Also, there will be more specialized missions using small satellites. Different satellite systems have different characteristics, e. g. resolutions (spectral, spatial, temporal, radiometric), off nadir data acquisition for stereo capability, etc.

Table: Some optical sensor system characters of earth resources satellites used in the natural resources studies.

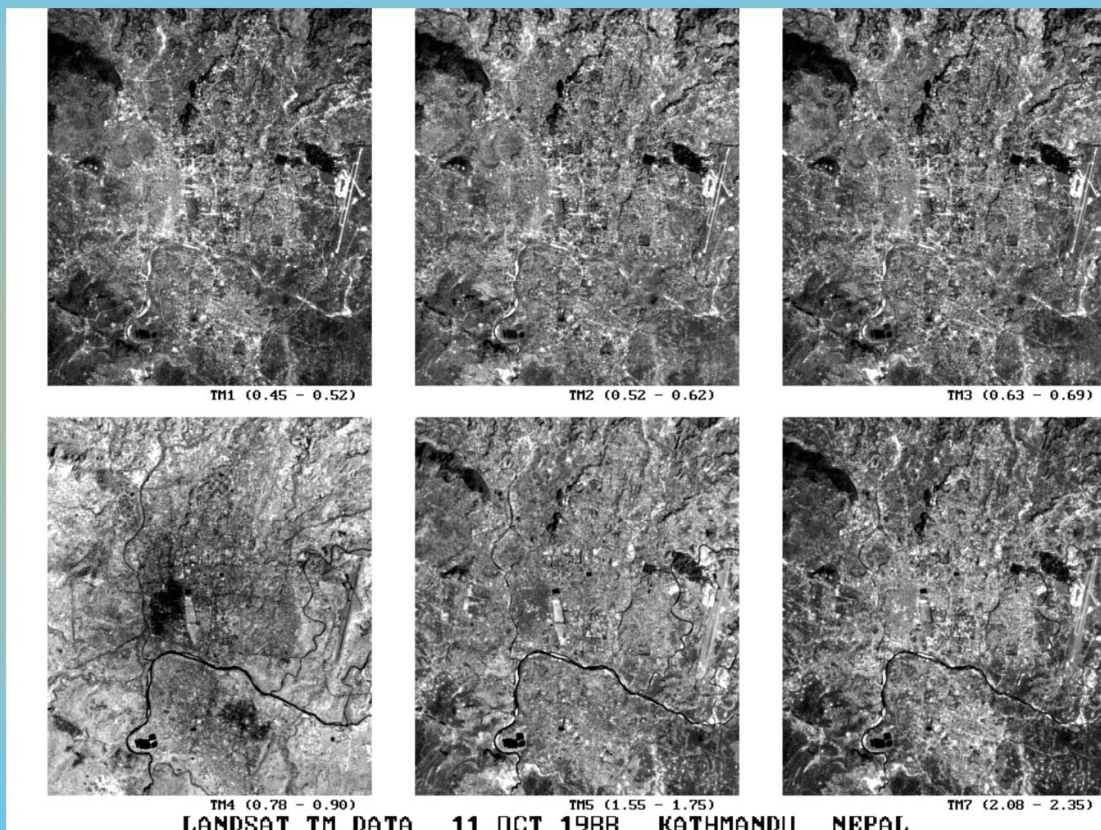
SATELLITE SYSTEM SOME OPTICAL SENSOR SYSTEM (launch dates)	LANDSAT 4/5 MSS (1982 L.SAT-4) (1985 L.SAT-5)	LANDSAT 4/5 TM (1982 L.SAT-4) (1984 L.SAT-5)	SPOT XS (1986 SPOT-1) (1990 SPOT-2) (1993 SPOT-3)	NOAA AVHRR (1984 NOAA9) (1986 NOAA10) (1994 NOAA14)	MOS MESSR (1987 MOS-1) (1990 MOS-1b)	JERS OPS VINR and SWIR (1992 JERS -1)	ADEOS AVNIR (1996 ADEOS -1)	IRS-1C LISS-III (1995 IRS-1C)	IRS-1C WiFS (1995 IRS-1C)
Sensor Altitude	Landsat1,2,3=900 km Landsat 4, 5 =705km	705 km	832 km	833 km	909 km	568 km	800 km	817 km	817 km
Spatial Resolution	80 m	30 m	20 m	1.1 km (LAC)	50 m	18 m X 24 m	16 m	24 m	188 m (200 m)
Temporal resolution (Revisit Cycle) (in days)	16	16	20 (nadir)	1 image/day	17	44	41 (nadir)	24 (nadir)	24 (nadir)
Radiometric Resolution (bits per pixel)	6-bit (scaled to 7 or 8 bit during ground processing)	8-bit	8-bit	10-bit	6-bit			7-bit	7-bit
Swath Width	185 km scene area = 185*170	185 km scene area = 185*170	60 km	2700 km	100 km	75 km	80 km	141 km	810 km
Off-nadir viewing (side-look) capability for the (PAN) Panchromatic mode for stereo image data acquisition)			SPOT PAN (10 m resolution) 0.51 - 0.73 µm 3 days revisit capability			JERS OPS VINR (18m X 24m) Bands 3 & 4 0.76 - 0.86 µm	ADEOS AVNIR PAN (8 m resolution) 0.52 - 0.72 µm	IRS-1C PAN (6 m resolution) (70 km swath width) 0.50 - 0.70 µm (6-bit)	
Spectral Resolution (Number of Bands)	Four	Seven	Three	Five	Four	Seven	Four	Four	Two
Spectral ranges (wave-length portion of EMR) in µm (micrometers)									
Blue		0.45 - 0.52					0.40 - 0.50		
Green	0.50 - 0.60	0.53 - 0.61	0.50 - 0.59		0.51 - 0.59	0.52 - 0.60	0.52 - 0.62	0.52 - 0.59	
Red	0.60 - 0.70	0.62 - 0.69	0.62 - 0.68	0.58 - 0.68	0.61 - 0.69	0.63 - 0.69	0.62 - 0.72	0.62 - 0.68	0.62 - 0.68
NIR	0.70 - 0.80	0.78 - 0.90	0.78 - 0.88	0.73 - 1.10	0.72 - 0.82	0.76 - 0.86		0.77 - 0.86	0.77 - 0.86
NIR	0.80 - 1.10				0.80 - 1.10		0.82 - 0.92		
IIR		1.57 - 1.78				1.60 - 1.71		1.55 - 1.75	
IIR		2.10 - 2.35		3.55 - 3.93		2.01 - 2.12			
IIR (MIR)						2.13 - 2.15			
IIR (MIR)						2.27 - 2.40			
ThIR		10.45 - 11.66		10.3 - 11.2					
FIR				11.5 - 12.5					

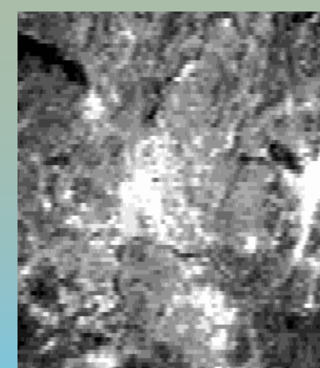
The SAR instrument characteristics for RADARSAT, ERS-1 & ERS-2, JERS-1

		RADARSAT	ERS-1 & ERS-2	JERS-1
SAR	*FREQUENCY*	C-band	C-band	L-band
	POLARISATION	HH	VV	HH
	SWATH	50 to 500 km	100 km	75 km
	RESOLUTION/ LOOKS	30 m/4 - 100m/8	30 m/4	30 m/4
	INCIDENCE ANGLE	20 - 50+ degrees	23 degrees	35 degrees
	ORIENTATION	Right	Right	Right
	ON-BOARD STORAGE	51 G bits	none	72 G bits
ORBIT	*INCLINATION*	98.6 degrees	97.5 degrees	98.5 degrees
	ALTITUDE	798 km	785 km	568 km
	REPEAT	**24 days**	**ERS-1 : various ERS-2 : 35 days**	**41 days**
	TYPE	**sun-synchronous dawn-dusk orientation**	**sun-synchronous**	**sun-synchronous**
MISSION	**LAUNCH**	**1995**	**1991; 1995**	**2/1992**
	LIFETIME	**5 years**	**2 -3 years +**	**2 years +**
OTHER INSTRUMENTS		**none**	**Radar Altimeter, Wind/Wave Scatterometer, Along-Track**	**Scanning Radiometer Optical Sensor**

SPOT PAN PANCHROMATIC MODE 20 DEC 1988 KATHMANDU NEPAL

(10 m RESOLUTION) 0.5 to 0.7 micrometers


TM1 (0.45 - 0.52)
TM2 (0.52 - 0.62)
TM3 (0.63 - 0.69)
TM4 (0.78 - 0.90)
TM5 (1.55 - 1.75)
TM7 (2.08 - 2.35)
LANDSAT TM DATA 11 OCT 1988 KATHMANDU NEPAL



TM6 (10.4 - 12.5)

Overview of RS Applications

Natural resources development and management	Type of information to be collected from RS data	Potential decisions based on information derived from RS
Water resources for hydro Power and irrigation	Mapping & monitoring of rivers, lakes, Reservoirs and their catchments	Investment decisions, e.g. by funding agencies
	Mapping & monitoring of snow cover; seasonal runoff forecasts	Management of reservoirs
Forest resources	Mapping & monitoring of existing forests	Zoning of protection forests; definition of policies on forestry, Forest Management
Mineral resources	Geological mapping; prospecting of minerals, oil, gas, etc.	Investment decisions
Agriculture		
Land use planning	Currant land use	Areas requiring intervention
	Historical land use and land use changes	Definition of meaningful land use plans
Soil conservation	Vegetation cover maps and DEMs as input to Soil erosion models such as USLE	Land use planning & zoning to improve management
	Mapping of areas affected by salination	Improved irrigation management
	Monitoring of land cover changes (e.g. Deforestation of catchments) leading to watershed degradation	land use planning
Food security	Regular status maps of important crops (Crop monitoring)	Early purchases on the world markets

Infrastructure development	Type of information to be collected from RS data	Potential decisions based on Information derived from RS
Transport *Telecommunication* *Tourist infrastructure*	Generation of topographic base maps incl. elevation Generation of DEMs Generation of photo maps	Planning of general projects, e.g. for roads Location of transmitters Trip planning; Investment decisions
Urban Development		
Uncontrolled urban growth *Urban densification*	Monitoring of urban areas, also with historic images Mapping of vacant urban lands	Regional development policy Location of new settlements

Disaster prevention and mitigation	Type of information to be collected from RS data	Potential decisions based on derived from RS information
Landslides	Tectonics and geomorphology	Hazard zonation
	Vegetation maps as input to model landslide-prone areas	Hazard zonation
	Mapping of abandoned agricultural lands	Identification of afforestation areas
	Weather forecasts	Evacuation of people in endangered areas
	Mapping of recent landslides, e.g. with SAR images	Targeting of rescue operations
Prolonged droughts	Vegetation indices	Food supplies
Floods	Mapping of flood-prone areas from historical satellite imagery	Hazard zonation; planning of flood protection schemes
	Mapping of flooded areas	Targeting of rescue & relief operations
Avalanches	Mapping & modeling of avalanche-prone areas	Hazard zonation
Social development and poverty alleviation		
Village level participatory exercises	Generation of photo maps to support discussions	Visualization, learning on spatial relations
Planning of large scale programs	Generation of topographic base maps	Identification of target areas