

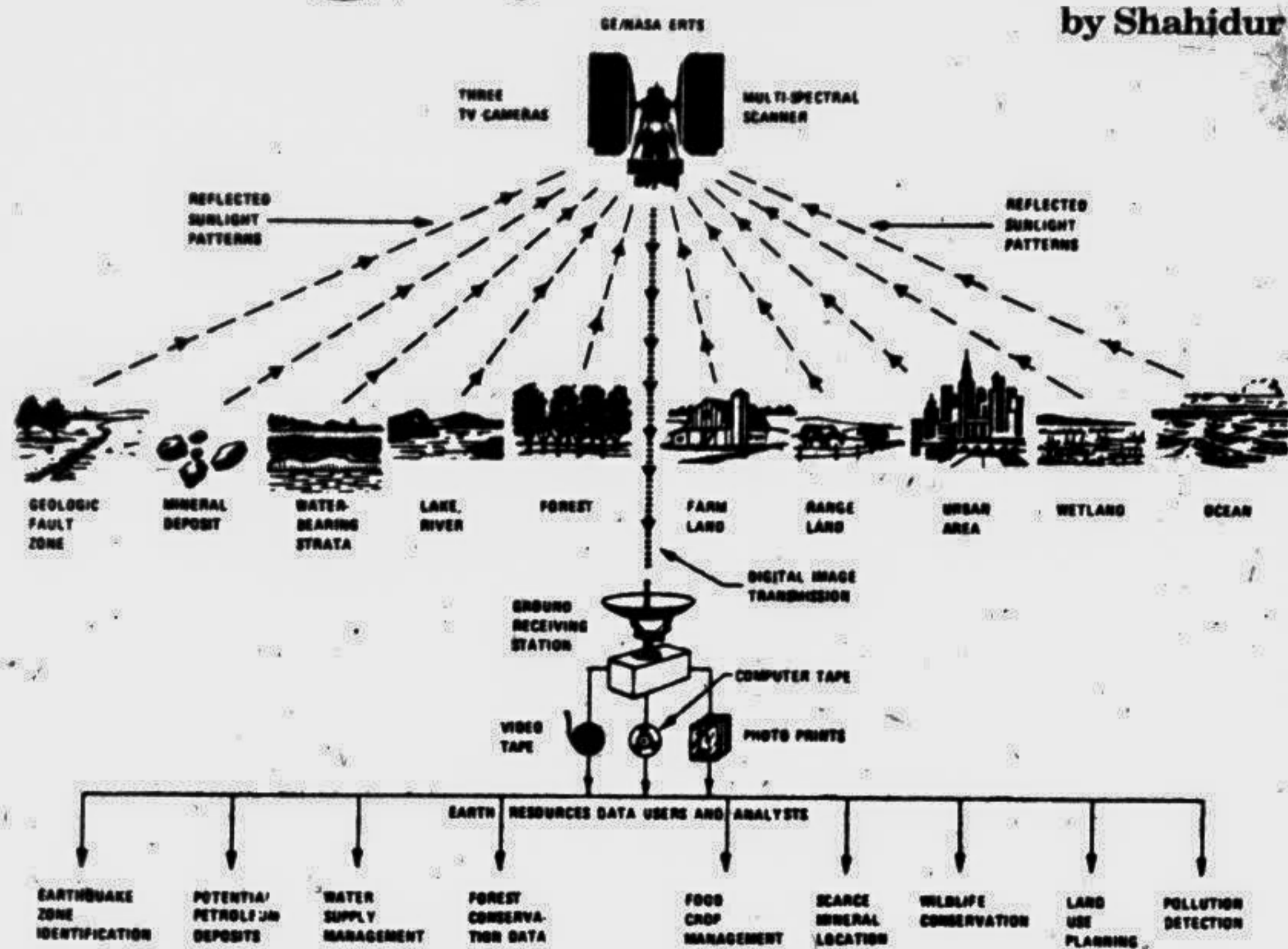
# Satellite Imagery for Better Natural Resources Monitoring

by Shahidur Rahman Khan

THE process of economic development consists largely of organising the development and productive exploitation of natural resources. These resources are themselves inter-related, changes affecting one can have repercussions on others. An optimum and effective management of natural resources like soils, water, vegetation, mineral resources, energy resources, terrain etc., calls for a thorough and routinely updated information about the environment and associated dynamic phenomena. Major advances in gathering of data about earth's resources over large areas and from a considerable distance came with the invention of the photographic camera and airplane.

The advantages of the airplane as a platform was limited by the area it can cover in any one photographic scene, by the cost involvement and by the difference in degree of uniformity between repetitive coverage of the same scene at different times or in its coverage of different scenes at the same suntime. With the coming of space programme, orbiting space crafts provided an ideal platform to overcome the above limitations. The combination of new type of sensors with a space platform proved to be more than a high altitude extension of aerial photography.

Sensing of earth surface from satellites and preparation of image is known as 'Satellite Imagery'. The examination, sampling or measurement of the earth's surface features by aerial survey or land survey to correlate, what is seen on the remote-sensing data products with what actually exists on the ground is called 'Ground Truthing'. For qualitative study Ground Truthing may not be so important, but for quantitative or for comparative information Ground Truthing is essential.



Schematic diagram of collection and transmission of data by a satellite

**The Technology:** The recording of observations of the earth's surface from an orbiting spacecraft began in 1960 with the first US meteorological satellite TIROS-1. Significant experiments in earth resource sensing was initiated in 1972 with the launching of the first Earth Resources Technology Satellite (ERTS-1, subsequently renamed LANDSAT).

Other than LANDSAT of USA, different countries have their own satellites for resources imagery and for other purposes. For earth resources imagery French SPOT, Japanese JERS, European Space

Agency's ERS, Indian IRS etc., are scanning the earth's surface continuously. They have different technical specifications as well as different resolutions. (LANDSAT MSS 80m x 80m, LANDSAT TM 30m x 30m, SPOT MSS 20m x 20m, IRS 36m x 36m & so on).

The solar arrays of satellite's independent solar panels provide necessary power to the systems as well as recharge the storage batteries. The batteries are needed when the satellite moves on the dark side of the earth. The Telemetry, Tracking and Command subsystem on board the satellite has four functions: i) to transmit satellite's house-keeping information to the operations control centre and global network of tracking stations and to receive commands from the control stations as needed to control the spacecraft; ii) to transmit the collected data to ground stations wherever they may be. A station can receive data from a satellite, while the spacecraft is within its line of sight. The surface area within each a station's ambit is called the 'Foot Print' of the satellite; iii) to dump the data stored on the recorders to ground stations; and iv) to relay data picked from remote unmanned Data Collection System (DCS) platforms on different places of earth to the tracking stations and local user terminals.

The satellites circle the globe in a circular, near-polar orbit and cross the equator at a 99 degree angle. From this high altitude the satellite offers a synoptic view of a large area in one scene. It makes numbers of orbits a day and repeats its coverage of any specific point on the earth's surface at about 9:30 am local time after a constant interval. Repetitive coverage enables comparison of scenes of same location at different dates. The strip viewed by the sensors of LANDSAT satellite in a single pass is 185 km wide. A day later the satellite passes over a

point at the equator 170km west of previous strip and senses a contiguous strip of 185 km wide. This results in an overlap of 15km at the edge of each strip on 2 consecutive days' observation.

**The Sensors of Satellites:** Sensor instruments of satellites contain i) Multiple Scanner System (MSS) and Return Beam Vidicon (RBV) cameras, ii) Data Collection System (DCS) receivers, and iii) video tape recorders. Every object on earth, bombarded by the sun with radiation having a broad range of wave lengths reflects different proportions of each wavelength received. The physical properties of the object itself establish how much of the solar radiation of each wavelength is reflected. This reflected energy with its distinct spectral or wavelength distribution for each object is selectively observed by the MSS in four small portions or bands of the electromagnetic spectrum by its four channel radiometer. The RBV and MSS sensors use seven bands in the visible and near-infrared portions of spectrum. Within each

MSS band are six detectors which convert the received radiations into electrical signals.

During each sweep of the satellite, the scanning mirror takes in reflected radiation signals from six parallel lines of landscape and feeds these lines of signals to the detectors; the signals from one scanned geographic line directed to one of the six detectors in each of the four spectral bands. Each continuous line of signals acquired by the scanning mirror is divided into 3,200 separable signals, each of which is passed on to one detector in each of the spectral bands. The detector translate the single signal into an electrical signal for ultimate reproduction in the satellite imagery product as one 'Picture Element' or 'Pixel'. A pixel in a LANDSAT image represents an area about 80 m square on earth's surface (also called 'Resolution' of the system). Some pixels such as those from oceans, forests, deserts etc will have a high degree of variation of composition.

The different levels of intensity and their variations in uniformity provide the basis for remote-sensing of earth's resources. The original digital mode of MSS data permits quick transmission of different stations as well as rapid processing by computers. The MSS System can acquire data from the infrared regions of spectrum which is beyond the range of optical camera system. The three RBV television cameras simultaneously photograph the same portion of earth in three different spectral bands of green, red and near-infrared. The LANDSAT television cameras photograph 185 km square area every 25 seconds having an overlap of 18.5 km with the next scene. Each television picture has 4,125 lines having 4,000 elements in each line.

**Data Processing:** The information received from a satellite has to undergo annotation and correction before further processing. 'Annotation' consists of attaching selected information about the source to the data product. The following corrections are required to be done on pri-

mary data: radiometric corrections relating to the functioning of the sensors, the recording of the data, and errors in processing; geometric correction of band and scene for variation in position of satellite with respect to earth, variation in altitude and velocity of the satellite and other mechanical scanning errors; and registration corrections to adjust the images from the different bands of the same scene to get valid composite images.

Annotated and corrected data are processed as satellite images in black and white forms, in false colour composite forms and as Computer Compatible Tapes (CCTs). The 64 levels of intensity of the original tape are reduced to 10-15 shades of gray; the range which human eye can distinguish. Each scene of LANDSAT image covers an area of 185 km by 185 km. Human eye can distinguish many hundreds of colour variations. In contrast to its limited capacity for shades of gray, in colour composites the different levels of intensities are expressed as different colours or variations in colour tone. The colour employed are not the same as the original colour of the features as seen by the human eye. These coloured images are called 'False Colour Composites'. The original video tape data containing distinct MSS intensity levels are first processed into Intermediate High Density Digital Tapes (IHDDTs) and then into CCTs. The CCTs can be fed into computers for digital analysis of the spectral properties and preparation of desired information in tabular forms. The tapes can also be used to produce Thematic Maps (TM).

**Practical Applications of Imagery:** Fields of application of imagery are gradually expanding with its successful application in more and more new fields. Some of the major uses related to natural resources are:

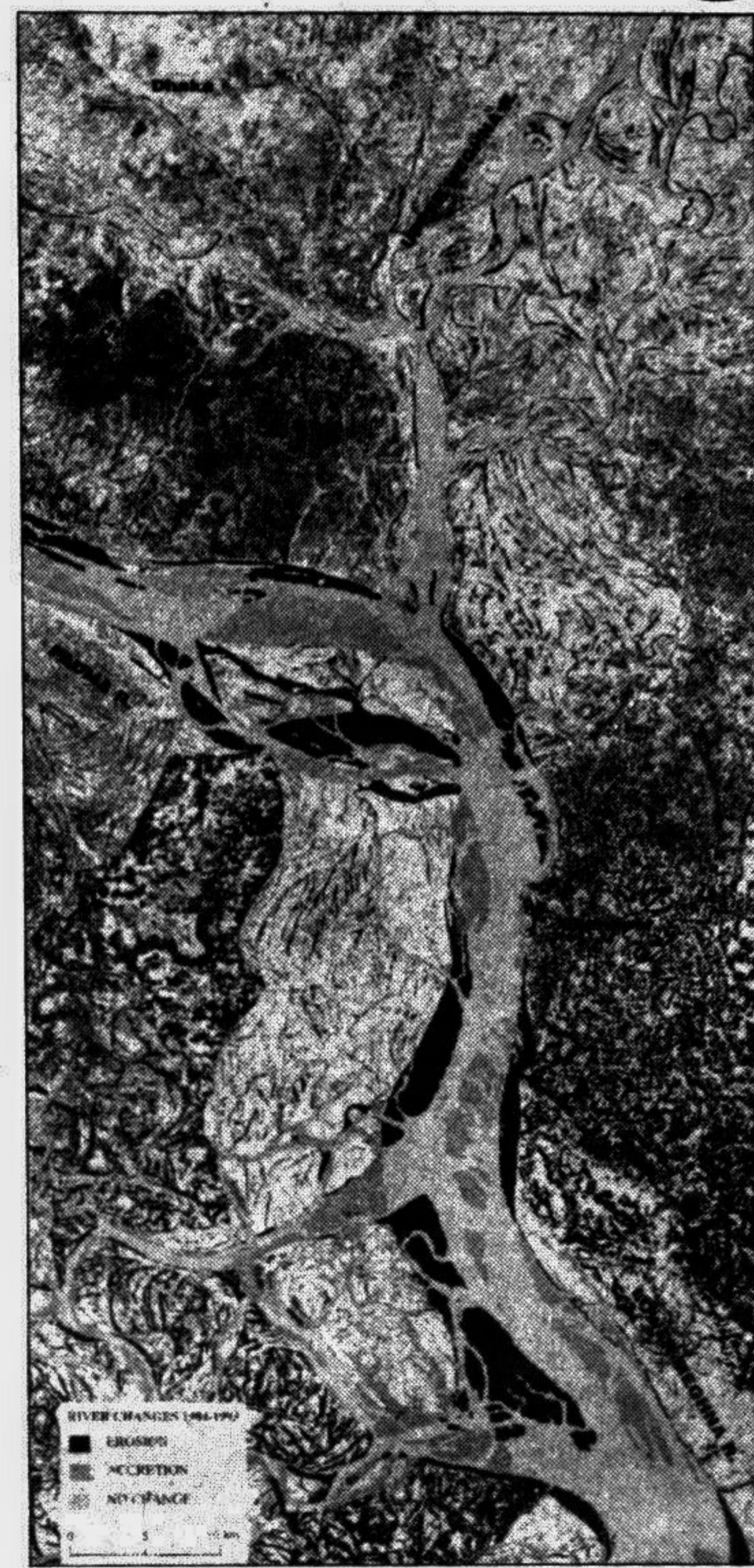
a) **Cartography:** Use of satellite imagery are useful in making fast and accurate — the preparation of topographic maps. The distinct advantages are: uniformity of view over a large area, near vertical angle, geometric and radiometric fidelity, sharp definition of natural features, quick processing possibility etc.

b) **Geologic Survey and Mineral Exploration:** Satellite data reveals the distribution, character and structure of rock bodies. It also gives an idea about earthquake and shoreline processes. These help in improved geologic mapping and subsequent efficient mineral resources exploitations.

c) **Land Use and Regional Planning:** It is possible to have quick information about land use over large areas and monitor land conversion from images, which is useful in regional planning and land conservation.

d) **Agricultural production:** Remote-sensing in agriculture can deal with soil survey, operation of irrigation and drainage projects, inventory of crop acreage, assessment of crop damage, forecasting of crop yield etc.

e) **Range Land Management:** Satellite sensing mainly focus on inventory of range vegetation, evaluation of range feed,



Map, showing the Ganges-Jamuna confluence

monitoring of range land improvement and changes etc.

f) **Forest Management:** Satellite imagery is helpful in forest management by reducing forest inventory time and costs. The data have proved useful with respect to, estimation of timber volume, monitoring of forest cutting and other various damages to forests.

g) **Water resource management:** Satellite images clearly show water bodies and stream networks. Changes in water bodies and stream networks over a large area can be monitored in a short time. They provide data needed for design and operation of large-scale water resource development project.

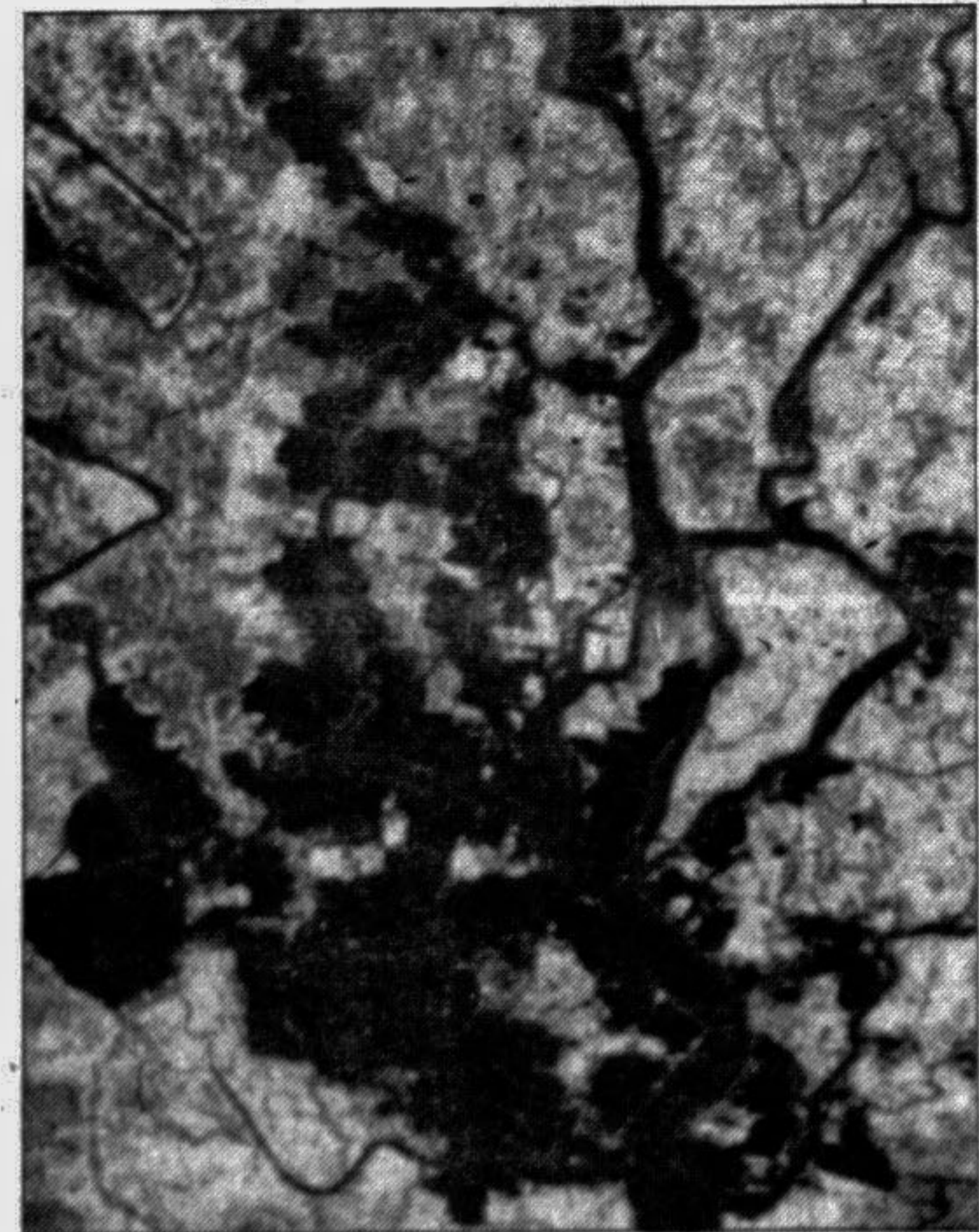
h) **Morphological prediction:** Any flood plain development project or river bank protection project needs morphological information for design and for monitoring of affectivity of the measures. Accuracy of morphological prediction is dependent on information of

large area at a time and chronological changes that took place over a considerable period of time. False colour composites can provide the superimposed condition for different years over a vast area of interest.

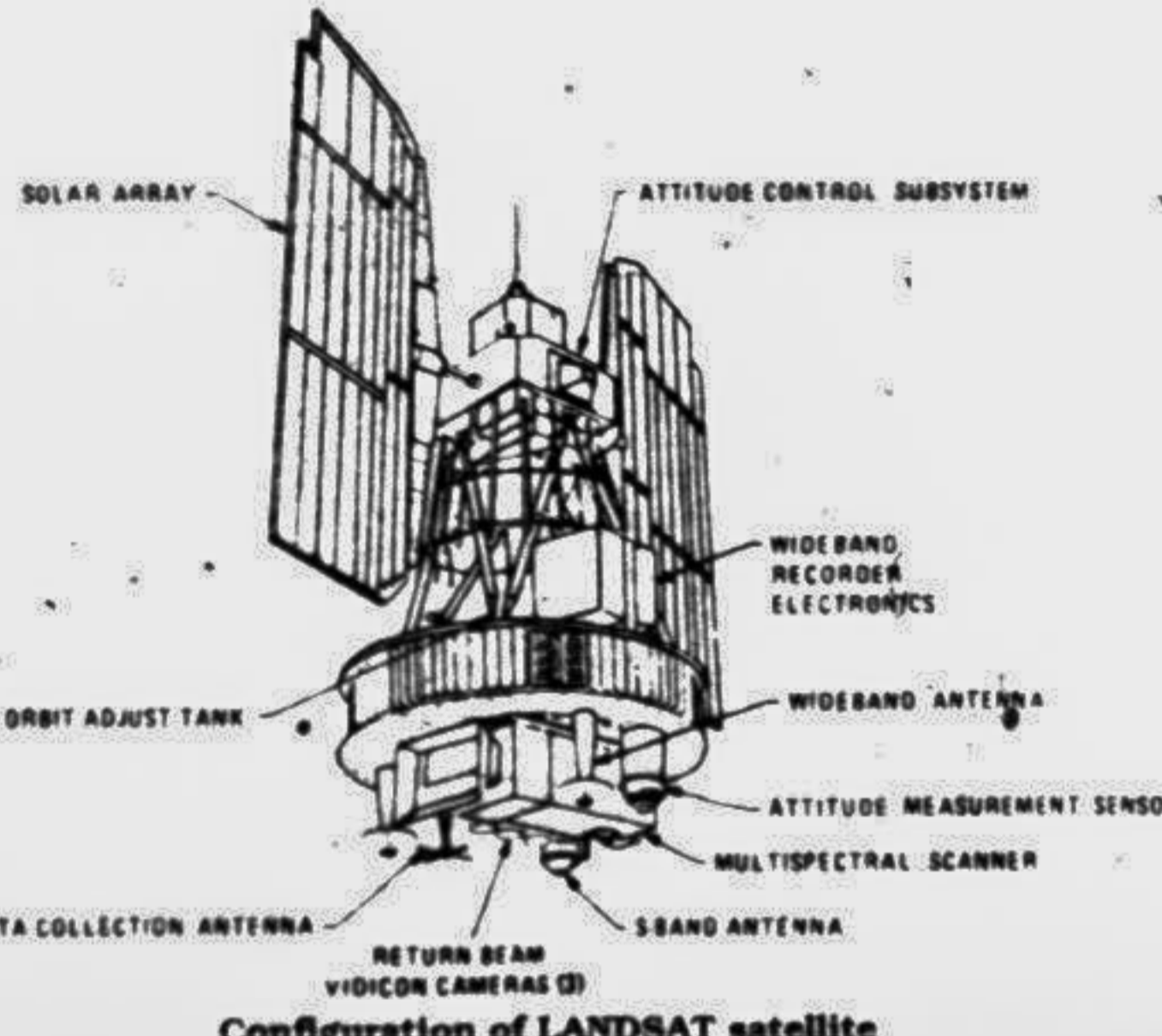
i) **Disaster warning and disaster management:** Satellite images and data collection systems have value in pre-warning and post assessment of floods, earthquakes, volcanic eruptions, environmental pollution etc.

Remote sensing makes possible delineation of inundated areas, permits identification of flood-prone lands. Satellite data provide useful information related to planning of flood control and protection measures. These are also extremely helpful in quick planning and implementation relief efforts and disaster management activities.

The writer, an engineer, works with satellite-related technologies.



Inundated areas in '88 flood



Configuration of LANDSAT satellite

## The Daily Star Entertainment Guide

Tuesday 7th May

(All programmes are in local time. We recommend programmes printed in bold. There may be changes in the programmes)

### BTV

3:30 Opening Announcement Al-Quran Programme Summary 3:10 Recreation From The Geeta 3:15 Documentary Film: Cinema Europe 4:30 News in Bangla 4:15 Esho Para Shikhi: Mass Education 4:45 Cartoon Series: The animals of Perthburgund 5:00 News in Bangla 5:20 Sangeta: Modern Songs 6:00pm News in Bangla 6:05 National Television Debate Competition 7:00 The News 7:05 Open University 7:25 Comedy Series: Sunfield 8:00 News in Bangla 8:40 Drama Serial 10:00 News in English 10:30 Ghare Baire: Women's Magazine 10:55 Mini Series: Return To Eden 11:30 News in Bangla 11:35 Wednesday's programme 11:40 Close down

### BBC

6:00 BBC Newsroom inc. World Business Report/Asa Today/24 Hours 9:00 BBC World Headlines 9:05 Panorama 10:00 BBC Newsday 1:00pm BBC World News 1:15 Panorama 2:00 BBC World News 2:30 Time Out: Nature 2:30 BBC World News 2:30 Time Out: Tomcrows's World 3:00 BBC Newsdesk 6:00pm BBC World News 6:15 The Money Programme 7:00 BBC World News 7:15 World Business Report 8:00 BBC Newshour Asia & Pacific 8:30 Time Out: Holiday 9:00 BBC World News 9:15 Panorama 10:00 BBC World News 10:30 Time Out: Film '96 11:00 The World Today 1:00 BBC World Headlines 1:05 Panorama 2:00 BBC World News 2:30 Time Out: Cats 3:00 BBC World Report inc. World Business Report/24 Hours 4:00 BBC World Report inc. World Business Report/24 Hours 5:00 BBC World News 5:10 Newsnight

### CHANNEL V

7:00am Rewind VJ Sophia 8:00 Jump Star VJ Trey 10:00 Frame By Frame 12:00noon The Vibe VJ Luke 1:00 By Demand VJ Trey 2:00 Rewind VJ Sophia 3:00 Big Bang VJ Alessandra 4:30 By Demand VJ Trey 5:30 Rewind VJ Sophia 6:00am 6:30 The Vibe VJ Luke 6:30am 7:30 First Day First Show 8:30 Big Bang VJ Alessandra 8:30 VJ Alessandra 9:30 The Best Of Ek Ka Teen 9:30 Top Of The Pops 10:00 Big Bang VJ Alessandra 10:30 First Day First Show 11:00 Rewind VJ Sophia 12:00am Sony Yako 1:00 Haysat 2:00 By Demand VJ Trey 3:00 Frame By Frame

### STAR PLUS

6:30am Transformers 7:00 Teenage Mutant Ninja Turtles 7:30 G.I. Joe 8:00 The Duke-Di's 8:30 The Wind in the Willows 9:00 Aerobics Di Style 9:30 Nanny and the Professor 10:00 Mr. Belvedere 10:30 Yan Can Cook 11:00 For Your Entertainment 11:30 Gabriella 12:30 Santa Barbara 1:30 The Bold & The Beautiful 2:00 The Oprah Winfrey Show 3:00 Remington Steele 4:00 Yan Can Cook 4:30 For Your Entertainment 5:00 Teenage Mutant Ninja Turtles 5:30 New Lassie 6:00pm The Adventures Of The Black Stallion 6:30 Batman 7:00 Home and

### STAR Sports

6:30am 1996 ABC Junior Championship For Women 1st Semi Final 7:00 Spanish Football League Hits 7:30 World Wrestling Federation-Mania 8:30 Asia Sports Show 9:00 1996 Wld Short Track Speed Skating Team Champ 9:30 Formula Asia Rounds 3&4 Fm Shah Alam, Malaysia 10:30 ATP Tour XI Bermuda Open From

Haarstein on Zee TV, Tonight at 10:00



Sallaab on Zee TV, Tonight at 9:00

Away 7:30 Entertainment Tonight 8:00 MASH 8:30 The Flying Doctors 9:30 The Extraordinary 11:00 The Bold & The Beautiful 12:00am Santa Barbara 12:00am Hard Copy 12:30 Baywatch 1:30 Andros Targets 2:30 Entertainment Tonight 3:00 The Oprah Winfrey Show 4:00 Hard Copy 4:30 Home And Away 5:00 The Sullivans 5:30 Gabriella

### STAR Movies

6:30am Family: Doing Time on Maple Drive 15 (Arabic Subtitles) 9:30 Classic: It's A Wonderful Life PG (Arabic Subtitles) 11:30 Adventure: The Four Musketers 12 (Hindi Subtitles) 1:30 Romance: Memories of Midnight Pts. 1 & 2 (Hindi Subtitles) 4:30pm Family: The Count of Monte Cristo (Animated) 5:30 Documentary: A Century of Cinema 15 (Hindi Subtitles) 7:30 Adventure: Superman III 12 (Hindi Subtitles) 9:00 Hollywood 1 on 1 9:30 Action: Backstreet Justice 18 (Hindi Subtitles) 11:15 The Bulletin 11:30 Cannes Classics: MASH 15 (Arabic Subtitles) 1:30 Thriller: The Name of the Rose (Arabic Subtitles) 3:30 Romance: Desperate Remedies 18 (Arabic Subtitles) 5:30 Action: Flashfire 18 (Arabic Subtitles)

### ZEE TV

5:30am Infotainment (TMM) 6:00 News 6:30 Jagran 7:00 ZED-Naya A to Z 7:30 ZED-Networking 8:00 ZED-Naya A To Z 8:30 Hum Honge Kaamyaab 9:00 Insight 9:30 Gaane Anjane 10:00 Ligat Khana Khazana 10:30 Duruya 11:00 Close Up Antakshri 11:30 Norma Kaha 12:00 No Problem 12:30 TMKB 1:00 ZED Chota Byte 1:30 Aasan Sky Show 2:30 Tara 3:00 Film Chakkor 3:30 Manasi 4:00 Ashvanya 4:30 Rasna Spread Ek Minute 5:00 ZED Chota Byte 5:30 Do Se Bale Teen 6:00 It's My Show 6:30 Through the Gears 7:00 Shashi Dawat 7:30 Gaane Anjane 8:00 Film Deewane 8:30 Hum Paanch 9:00 Sallaab 9:30 Tara 10:00 Haarstein 10:30 News Roundup 11:00 Gharonda 11:30 Tanava 12:00 Daraar 12:30 TVS So Re Ga Ma 1:00 TVS Sarangam (Shirley Show) 1:30 Galazzano 2:00 Gaane Anjane 2:30 Infotainment (TMM)

### PTV

8:00am Tawaf Aur Tarjuma Harid/Naat - 8:20 Cartoon 8:30 Khabraan 8:45 Beauty Care 8:50 Fun Katha 9:10 Dhanak & Health Tips 10:05 Hartaan He Deepak 10:30 English Film: Home Improvement 10:55 Mili Naghma 11:00 Khabraan 11:10 Anata (Serial) 12:00noon Sports Hour 12:55 Duran-e-Hakum 1:02 Bismillah 1:15 The Science Show 2:00 Yeh Janah 2:25 Animated Classics 3:15 Geography & Samra School 4:20 Mitti Soni 5:00 Allah Huma Labbaik 5:25 Qabhi Mein Soochta Hoon 6:25 Anu Courses 7:00 Dhanak 7:45 English News 8:15 UN Qum 8:45 Jab 9:00 Break for Headline News 10:00 Khabraana & Commercial News & Khushal Pakistan 11:20 VCD Top Ten 12:30 Dr Qum 1:35 Khas Khas Khabri/ Close down

### SONY ET

8:30am Gaane Jaane Manne 9:00 The Three Stooges 9:30 Dennis The Menace 10:00 I Dream Of Jeannie 10:30 Public Keyo Bola 11:00 Panchan 11:30 Cine Matione-Hindi Feature Film 2:30pm Hospital 3:00 Ashat 3:30 Mere Message Meri Geet 4:00 Surf Wheel Of Fortune 4:30 Ja De Hanuman 5:00 10 Gull Lows 5:30 The Three Stooges 9:00 Dennis The Menace 9:30 I Dream Of Jeannie 7:00 Mere Message Meri Geet 7:30 Gaane Jaane Manne Bengali Movie Club Film Show

### DD 7

8:05 Janmadini 8:20 Binodan 8:30 Dpo Nalagana 9:00 Janam 9:30 Naan 10:00 Adhunik Gaan 10:30 Instrumental Music 12:30 Janam (Serial) 1:00 Janam (Serial) 1:30 Bengali Movie Club Film Show

### DD 7

8:05 Science Prog 5:30 News 5:35 Tale Play Durbuddhi 6:00 Palki Katha 6:30 Chitrangad 6:55 Anake Dekhun 7:30 Bangla Sam 7:55 Dinandan 8:30 Naari 9:00 Mohd. Rafi Special 1:00 Dhar Mendra Special 2:00 Jeetendra Special 3:00 Karz 3:30 Soryy Men Lorry 4:00 Jawab Do 4:30 Namaskaar 5:00 F. It's My Choice 5:30 Rekha Special 6:30 RD Burman Special 7:30 Sargam 8:00 Godrej Stereoview Film: Cha't 8:30 Teen Do Paanch 9:00 Song Yatra 9:30 Furush Kshetra 10:30 Newsline 11:00 RD Burman Special, 12:00 Dance Dance 05:00 Tarane

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