Records are also available, through the Department of Science and the Environment, to Australian scientists for research in earth physics.

Defence

In the field of defence science, Australia collaborates with other countries through a variety of arrangements at intergovernmental level. Further information is given in Chapter 4, Defence.

Transport

Australia is represented at Federal and State levels on a number of transport research-orientated international organisations through a variety of arrangements at intergovernmental level. Further information is given in Chapter 20, Transport and Communication.

Other

At the non-governmental level, formal arrangements for scientific co-operation with counterpart institutions in other countries have been concluded by a number of Australian bodies. For example, an arrangement covering co-operation in astronomy exists between the University of Sydney and Cornell University (USA), while over a broader area the Australian National University has an arrangement with the University of Moscow which includes exchanges in the scientific fields.

Additional information

Additional information on topics presented in this chapter may be found in the annual reports of the organisations mentioned, particularly the Department of Science and the Environment, the CSIRO and its divisions, the Australian Atomic Energy Commission, and the Department of Defence. Statistical information for the years 1968–69, 1973–74 and 1976–77 may be found in the reports published by the Department of Science and the Environment on Project SCORE. Statistical information on R & D performed by Private enterprises for 1976–77 may be obtained from the Australian Bureau of Statistics publication *Research and Experimental Development—Private Enterprises,* 1976–77 (8104.0). The ABS will publish statistical information for all SCORE sector surveys for 1978–79 and biannually thereafter.

Also relevant are reports published by the former Office of Secondary Industry of the Department of Trade and Industry (*Survey of Industry Research and Development in Australia* (1968–69) and by the former Department of Manufacturing Industry (Bulletin No. 11, November 1974 *R & D in Manufacturing Industry* 1971–72).

Information on manufacturing industry research and development is contained in Chapter 6, Vol. 1A of ASTEC's report on *Science and Technology in Australia* 1977–78 (June 1978) Chapter 7, Vol. 1 of the Report of the Study Group on Structural Adjustment (March 1979) and the Report of the Senate Standing Committee on Science and the Environment on *Industrial Research and Development in Australia* (May 1979).

Landsat Satellite

Australian Landsat Station

Landsat is the name given to a series of U.S. National Aeronautics and Space Administration (NASA) experimental orbiting spacecraft designed to determine the usefulness of satellite-acquired data in managing the environment and natural resources.

To date NASA has launched three Landsat satellites: the first in 1972, the second in January 1975 and the third in March 1978. The first was turned off in January 1978 but data continued to be transmitted from the second and third satellites. A fourth satellite is due to be launched in 1982 and more are contemplated. Other countries such as Japan, the Soviet Union and France have plans to develop remote sensing satellites similar in many ways to Landsat.

For a number of years, Australian Federal and State government agencies, universities and colleges and industry have been investigating the application of Landsat remote sensing data in the Australian context and also the means of processing data electronically to improve its usefulness. For this work, investigators have relied on data recorded on an opportunity basis during satellite passes over Australia and have also had to contend with unavoidable delays in supply of data from the U.S.A.

In August 1977, the Government decided to establish its own receiving and processing facilities in Australia. The decision followed the completion in 1976–77 of an assessment of the value of remote sensing to Australia and took account of the overall technical success of the Landsat series of satellites.

The Landsat system

As a Landsat satellite orbits the Earth, its two main instruments, the multi-spectral scanner and return beam vidicon camera system, each construct images of an 185 km square scene of the Earth below. The multi-spectral scanner sweeps across the scene or segment in four wavelength bands: green (0.5-0.6 micrometres), red (0.6-0.7), infrared 1 (0.7-0.8) and infrared 2 (0.8-1.1). Its photo-electric detectors measure the intensity of sunlight reflecting back from individual units of the Earth's surface just under 80 metres square. These units are the fundamental elements of the picture and are known as pixels, some 7.5 million of which make up a standard 185 km square scene. The light intensity for each pixel is converted into electronic signals and transmitted to an appropriate ground receiving station.

Different materials on the Earth's surface such as water and crops and forests of different types reflect light differently, and the signals reaching the Earth can be measured and reconstructed to show the difference in detail and enable substances to be identified. Resource managers are then able to use photographic images or data classified by computer from magnetic tapes to monitor details of the Earth's surface.

Landsat spacecraft orbit the earth every 103 minutes, passing over each pole and crossing the Equator on the sunlit side of the Earth at the same local time each day, about 9.30 a.m. In this way, the satellites receive reflected sunlight of about the same illumination intensity arising from the same sun angle.

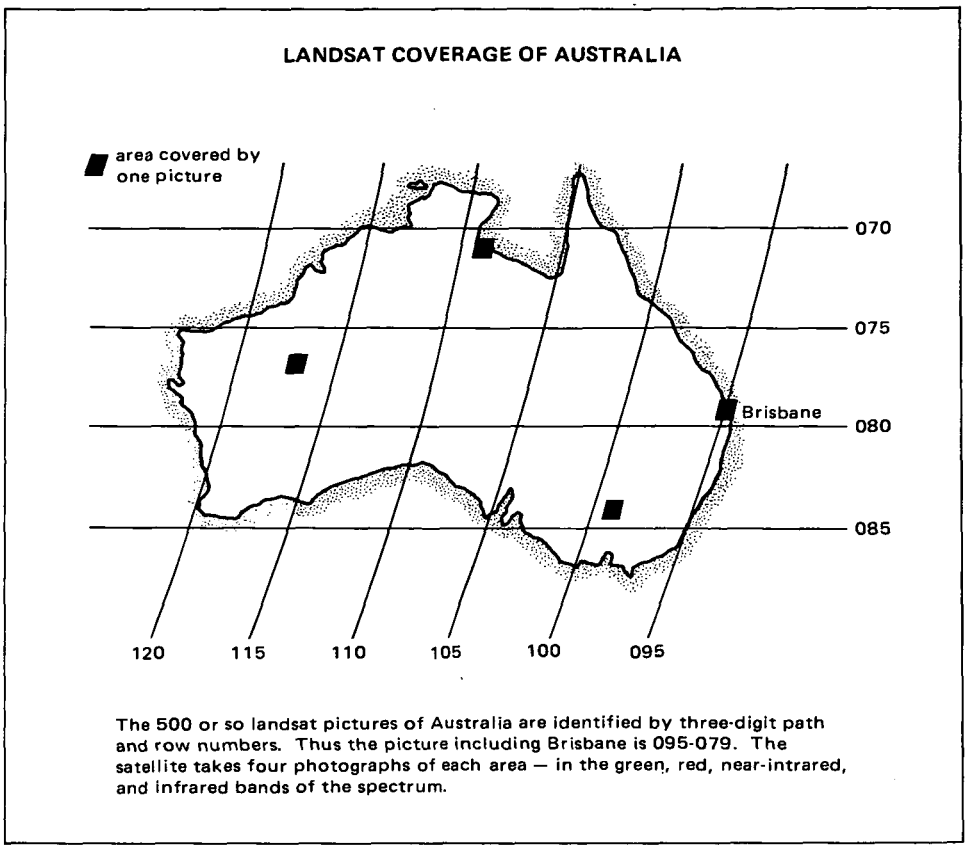
From its position in orbit 917 km above the Earth, each satellite views an area at the surface 185 km square. As each orbit proceeds, the satellite sees and transmits data for a swath 185 km wide, and the whole globe is scanned once every eighteen days. With two satellites in service, a spot on the Earth is scanned once every nine days.

Landsat applications

The advantages offered by remote sensing from space are now generally recognised as synoptic pictures of sizeable areas, acquisition of near real-time data, repeated coverage to record changing phenomena even in areas which have been well surveyed and mapped, reduced data acquisition time, uniform measurements, wide-area coverage reducing the problems of assembling broadscale mosaics, coverage of areas beyond practical range for aircraft, global survey without large on-site support requirements, and reduction in costs for large-scale coverage. While Landsat does not supplant aerial remote sensing, particularly photography, it is an important adjunct to it. For the cost of only a few dollars, Landsat products allow the performance of many monitoring functions which, if carried out by aircraft, would be prohibitively expensive.

Among the applications of Landsat imagery are monitoring of the environment, studies in agriculture and forestry, geography, geology and mineral resources, hydrology and water resources, oceanography and marine resources, the atmosphere and meteorology, and monitoring the effects of national disasters such as floods and bushfires.

In the Australian context, Landsat offers great benefits in agriculture in the management of wheat crops. The broad overview provided by satellite images allows annual planting of crops to be estimated accurately and the development of growth to be monitored for disease and climate stress. With further information, the Australian annual wheat yield can be estimated. Another area of proven benefit has been in mineral exploration, where the broad overview of geological features in areas previously lacking in detailed aerial survey or detailed geological mapping has enabled mineral prospectors to concentrate their search to areas of higher probability of success.



The 500 or so landsat pictures of Australia are identified by three-digit path and row numbers. Thus the picture including Brisbane is 095-079. The satellite takes four photographs of each area — in the green, red, near-intrared, and infrared bands of the spectrum.

PLATE 54

Data acquisition and processing facilities

Following the Government decision in 1977 to establish Landsat facilities in Australia, the Department of Science and the Environment took steps to have the Australian Landsat Station fully operational by March 1980. The station is managed by the Department and operated and maintained by private industry under contract to the Department. Formal arrangements between the Department and NASA permitting Australian reception and processing of Landsat data were concluded under a Memorandum of Understanding signed in January 1979.

The $4.2 million station consists of a Data Acquisition Facility at Alice Springs and a Data Processing Facility in Canberra.

The Data Acquisition Facility comprises a 9 metre steerable antenna capable of tracking Landsat satellites from horizon to horizon, and radio receiving, tape-formatting and recording equipment. The facility, which is located within the CSIRO Land Resources Management Field Centre, is able to receive imagery of every part of Australia. Magnetic tapes of data recorded during each Landsat pass over Australia are flown daily to Canberra for processing, archiving and meeting customer requirements.

The Canberra Data Acquisition Facility is fitted with modern computer, electronic printing and photographic reproduction equipment and provides a wide range of products to Australian and overseas customers. Products include computer-compatible magnetic tapes, which customers can process through their own computers to provide imagery in formats to meet their particular requirements, and a large number of photographic products corrected and enhanced in accordance with customers' wishes. Distribution of Landsat products is arranged direct from the Data Processing Facility or through outlets in each of the States.

The Department of Science and the Environment receives advice on user needs from the Australian Liaison Committee on Remote Sensing by Satellite, a committee comprising representatives from Commonwealth and State governments, universities and colleges and private industry. The committee also provides a useful forum for consultation and co-operation among users and potential users of remote sensing data.