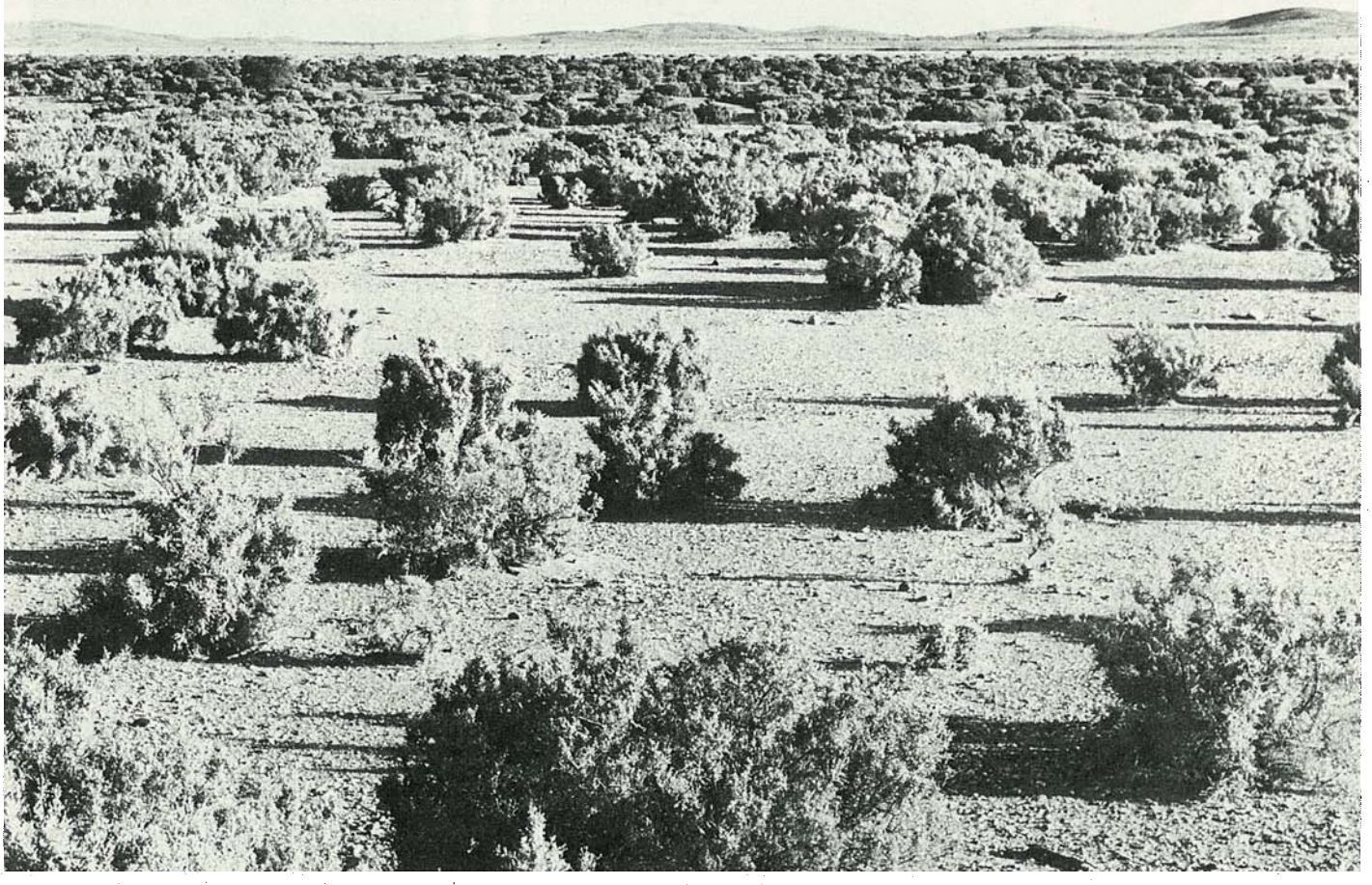
Trial run for the Australian ecological survey

Heavily grazed bluebush shrubland not far from Peterborough. This is the dominant landscape feature in its environmental association.



Recently, an 'extinct' wattle was re-discovered in the Flinders Ranges of South Australia. Not long ago, also, a colony of tammar wallabies turned up in bush near Cleve on the Eyre Peninsula — a lost relic of this marsupial that was once common on the South Australian mainland.

On South Australia's eastern border an area of about 2000 sq km of mallee scrub occupies vacant Crown land. It is, perhaps, of particular interest to conservationists since it abuts the Mount Rescue, Scorpion Springs, and Mount Shaugh conservation parks, and also the Big Desert region of Victoria. Together these parcels of land constitute a wilderness area of national significance.

Such information, and a great deal more, appears in a new publication called 'Environments of South Australia'. Little of it is new, yet it's hard for the layman and many administrators to locate such tit-bits and to get them into perspective. 'Environments of South Australia' may help to solve this difficulty.

The publication is the result of 2 years' work by a team of seven scientists from the CSIRO Division of Land Use Research. The team, led by Dr Peter Laut, carried out its work as an attempt to find a reasonably quick way to conduct the proposed ecological survey of Australia. The problem was to work out a method of surveying the vast area of the continent in not-too-long a time that would nevertheless provide enough detail to make the survey useful for governments and laymen alike.

Quick survey visualized

The idea of an Australian ecological survey first received approval in principle at a meeting of the Council of Nature Conservation Ministers (CONCOM) in mid 1974. (This body consists of conservation ministers from State and federal governments.) The survey was then visualized as a quick task that would indicate areas suitable for declaration as national parks.

Lengthy discussions followed between the then Department of Environment and Conservation and CSIRO. The proposed survey grew in scope and scale. The Department and CSIRO signed the first of three contracts for a pilot survey, which the latter would carry out, in mid 1975. This survey would cover an area of 410 000 sq km in South Australia— about half of the State — and be jointly financed by the two bodies. (In a later contract the study area was extended to cover the whole of the State.)

At that time, the Australian ecological survey was only one of a number of related projects in the pipeline, several of which have since come to fruition. These included a soil degradation survey, a pilot

wetlands study, the Australian Biological Resources Study, and the so-called RAKES study carried out by Professor John Burton at the University of New England.

The work of Dr Laut and his colleagues was itself to be regarded as the precursor for yet another set of land management surveys with the aim of defining the best uses for given areas of land. The South Australian Department of Environment is already carrying out a study, complementing the CSIRO one, aimed at providing a way of making such surveys.

Lake Eyre, as it appeared full in 1976.

A delta spreads out into Lake Eyre.

Time versus detail

Carrying out an ecological survey of a continent the size of Australia presents quite a problem. To cover the area in a reasonable time (say 10 years) conflicts with the need to do it in sufficient detail for the whole exercise to be useful. Obviously some sort of compromise has to be made.

In fact the title 'ecological survey' is a misnomer. What the scientists were able to produce was an inventory of South Australian environments — hence the publication's name.

They used a modification of the land system survey technique pioneered by the Division of Land Use Research. They now think that, with the approach they used in South Australia, a group of eight scientists should be able to cover the rest of the continent in the same way in less than 10 years.

The team doesn't expect its reports to be detailed enough to suit everybody's needs. Only use will finally reveal their value. So far, the seven volumes of 'Environments of South Australia' have been distributed for evaluation to various Commonwealth and South Australian government departments, and also to land planning consultants, some conservation groups, and schools in South Australia.

The original contract drawn up between the Division of Land Use Research and the then Department of Environment and Conservation centred on two tasks:

- to work out and prove a suitable way of mapping and describing major plant communities, wildlife habitats, landscapes, and existing land uses
- to test the usefulness of LANDSAT photographs for this purpose

At that time, using LANDSAT photographs (usually known as images) for surveying purposes was new and untried. The satellites LANDSAT I and II seemed to offer the advantage of providing information about large areas of the continent in moderate detail. Thus if it proved possible to interpret the imagery successfully, perhaps it would be possible to dispense with the more-traditional methods of surveying by observation on the ground. For various reasons this did not prove to be the case (see the box).

Salt pan beside Lake Everard in Province 7 (Western Pastoral).

Problem with wildlife

Mapping wildlife habitats is a problem that has eluded biological surveyors for many years. It's normal to assume that particular animals inhabit specific ecosystems, which contain particular types of vegetation growing on suitable soils. Thus if you make a vegetation map, you should be able to predict where particular species of wildlife can be found. If the relation between the vegetation of the environment and the distribution of the animals and birds holds true, then vegetation maps should be of immense value as a management tool for wildlife conservation.

Unfortunately, the art of wildlife surveying hasn't yet reached this stage. While the distribution of some animals does seem to correlate with vegetation types — red kangaroos live on grassland plains, while grey ones require open woodland — not enough is known about many of the rarer species to be able to predict their whereabouts with confidence.

For this reason, the CSIRO survey group has not produced distribution maps for fauna. Instead it has restricted itself to making notes about fauna that may be of particular interest in any particular habitat. Meanwhile, Dr David Ride, who is Director of the Australian Biological Resources Study, and Dr A. Falconer of the Canadian University of Guelph have explored two possible ways of meshing information about the distribution of animals and birds into land surveys.

Four-tier system

Right from the outset it was understood that the CSIRO researchers would collect their data in forms that could be stored on computer, which meant that they would require standard pieces of information about all the land to be surveyed. The team members came up with a system containing four levels of detail. South Australia is divided into eight 'provinces', each of which corresponds to a commonly accepted geographical region. Each province contains two or more 'environmental regions', which in their turn are subdivided into 'environmental associations' consisting of groups of even smaller units, the 'environmental units'.

The environmental association represents the basic unit of the survey. Dr Laut and his colleagues delineated them by picking out patterns on the LANDSAT imagery that they considered signified changes in the types of environments on the ground. These were the smallest subdivisions that were actually mapped.

To increase the level of detail the team subdivided these associations into as

many as five environmental units, each of which represented a facet of the environment in the associations. For each unit the group compiled lists of information about 50 standard environmental features.

In all, Dr Laut and his colleagues divided South Australia into 1400 environmental units. The lists of information about the 50 standard environmental features make up the bulk of 'Environments of South Australia'.

For each of the 346 environmental associations the environmental units are ranked in order of importance. The most widespread unit appears as the 'dominant' one, and others are termed 'subdominant' or 'minor' ones. Idealized profiles of the piece of land in each association show how the environmental units fit into the landscape.

Wilpena Pound

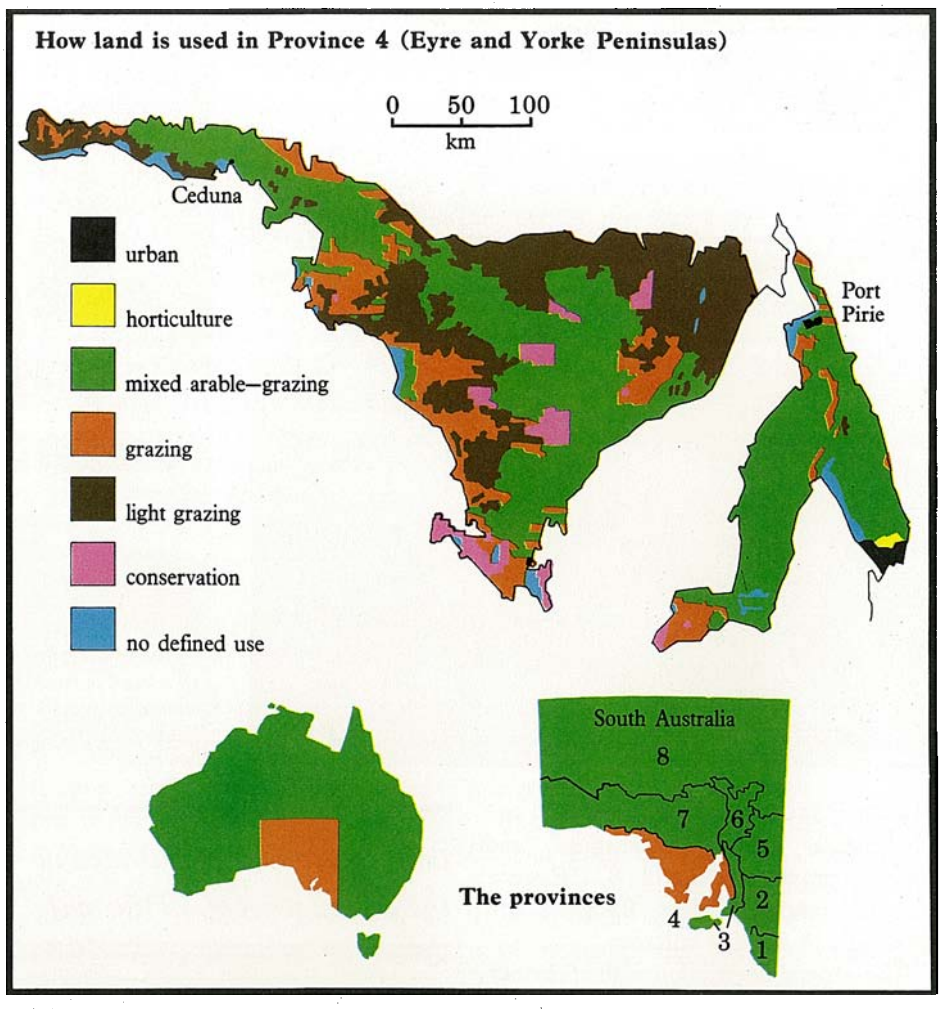
This may all sound hard to understand. Take Wilpena Pound, the well-known tourist attraction in the Flinders Ranges, for example. This feature of the landscape appears in the report as an environmental association, which consists of five environmental units. Each unit represents a landscape type and these are ranked in the following order of importance: hogback ridge, valley floor, intra-montane plain (plain between high ridges), ridge, and footslope.

In the case of Wilpena Pound, the edge of the environmental association could be very easily picked up on a LANDSAT image or on the ground. In other areas, finding environmental association boundaries wasn't so easy, since one type of association of related environments often merged, almost imperceptibly, into another. Consequently, the scientists decided on the location of such boundaries by a process of concensus after discussion. The point to remember about these association boundaries is that they represent transition zones that are not necessarily precisely locatable entities.

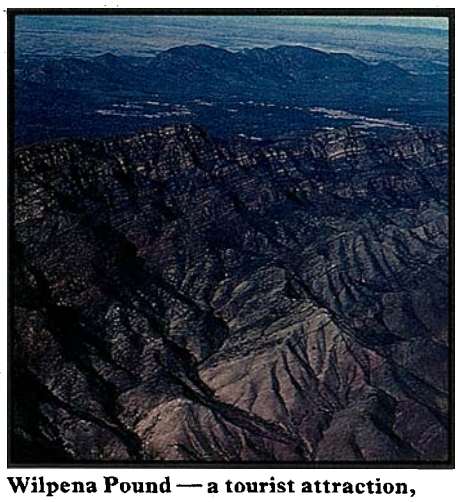
The next step up from the environmental association is the environmental region. Each of these represents a grouping together of the associations into large, roughly related, areas of land. In each, it's possible to describe the dominating land features, and these large units provide a vehicle for making general statements about particular pieces of country.

For example, the 'Mount Gambier Volcanics Environmental Region' is found in the 'South-east Province' of South Australia. All the land within this region is slightly higher than the surrounding country, and it is all located on a slightly uplifted limestone plain, above which rise a number of volcanic cones. The youngest of these (the report tells us) last erupted about 1500 years ago.

In addition, we learn, the environments of the area are poorly conserved — the region contains only two small conservation parks and a natural forest reserve. It has no areas that, in the long term, would constitute ecologically viable reserves.



Hogback ridges make spectacular scenery near Willouran Hill, not far from Maree.

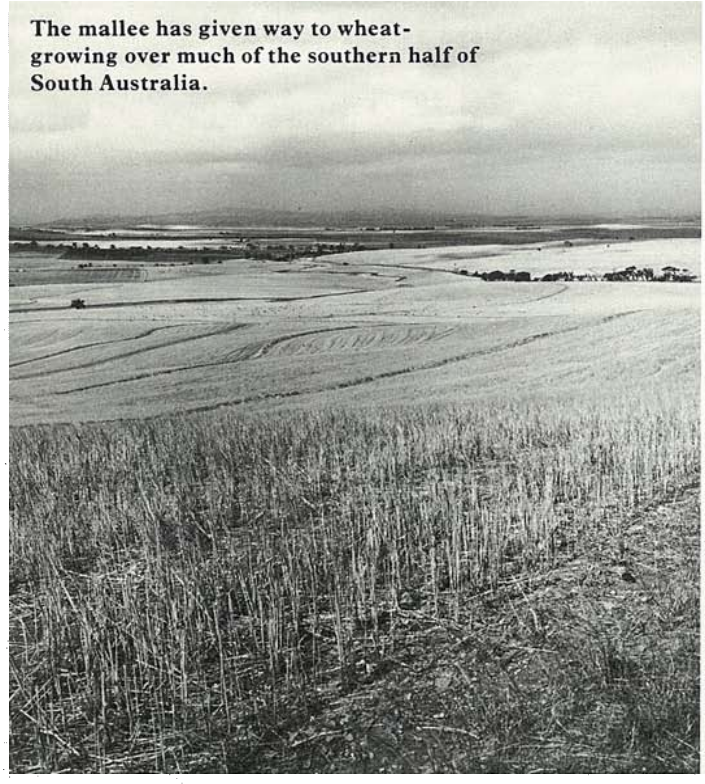


Wilpena Pound — a tourist attraction, and an environmental association in 'Environments of South Australia'.

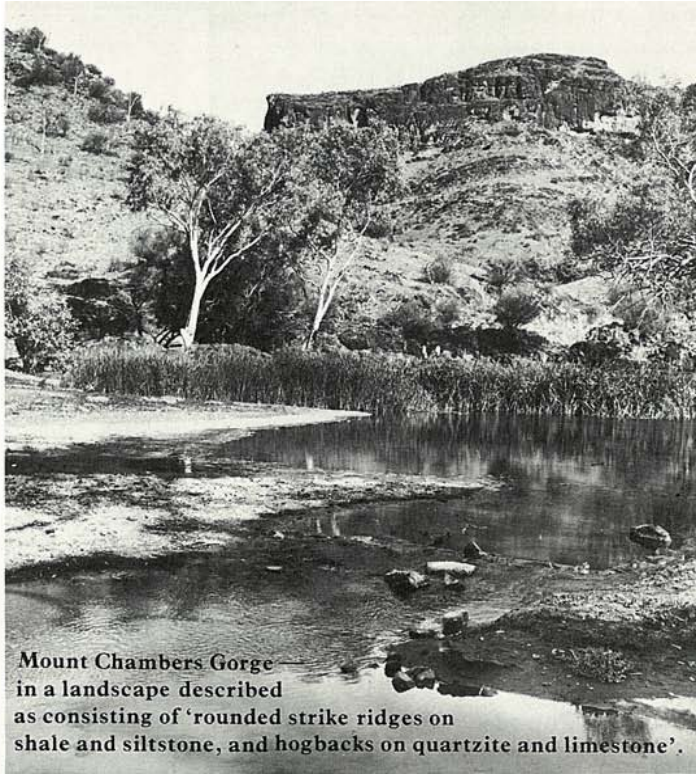
Artificial arrangement

The eight provinces again act as vehicles for making very broad statements. These segments of the State really do little more than provide an artificial arrangement of the information to make it more understandable. While the description of each environmental region contains statements under three standard headings — general description, climate, and conservation — the province contains more-general statements under seven standard headings: climate, land forms, soils, native vegetation, nature conservation, land use, and population and settlement.

Mostly, each volume of 'Environments of South Australia' contains descriptions



The mallee has given way to wheat-growing over much of the southern half of South Australia.



Mount Chambers Gorge — in a landscape described as consisting of 'rounded strike ridges on shale and siltstone, and hogbacks on quartzite and limestone'.

of a single province and its assembled environmental regions, associations, and units — provinces 5 and 6 ('Eastern Pastoral' and 'Flinders Ranges') are combined in a single volume.

The general description of the province comes first, followed by a description of the first environmental region to be considered. Then comes the first of the environmental association descriptions along with a map of the region with the particular association superimposed, and the tables of features of the environmental units.

Also included with each volume is a mosaic of LANDSAT images of each province at a scale of either 1 : 500 000 for populated provinces, or 1 : 1 000 000 for the sparsely inhabited country of the pastoral zone. On these images are superimposed the boundaries of the environmental regions and environmental associations.

As mentioned earlier, there had been hopes when the survey was first mooted that using LANDSAT imagery would eliminate the need for detailed work on the ground. In the event, it didn't turn out that way. Instead, the maps and all the other information compiled in the survey reports came from a mixture of sources, including a great deal of work in the field.

The LANDSAT imagery was used in the compilation of all the maps. In addition, the survey team collected all the existing relevant published information on South Australia.

LANDSAT imagery was used in the compilation of all the maps.

In northern and western parts of the State such information proved hard to come by. So the CSIRO group itself had to collect much of the information in the report for these regions. Even in the best-documented regions, members of the study team drove along at least one transect in each environmental association to check the accuracy of their information in the field. They also checked this accuracy by observation from low-flying aircraft.

Thus the researchers are confident that most of the information contained in the reports is reliable. But, they point out, inaccuracies in earlier work that was used as source material will at times have crept in, so there will be errors. The surveyors don't consider that such errors will greatly reduce the value of what they have achieved — gathering the information into one place in a standardized form.

Likely users

Who will use 'Environments of South Australia'? Perhaps for government administrators the great advantage will be a sound basis for comparing one area with another. How, for example, does one particular property in the pastoral zone compare with another similar one some distance away? Such questions are of great importance to the administrator deciding the best use for a particular piece of land, or the fair rent to be charged to a lessee.

It would be particularly useful to be able to classify all land according to its capability to support a particular type of use, but the ecological survey was not detailed enough to do this. Dr Laut thinks that such a classification could be produced using additional information grafted onto the framework his group used.

Amateur conservation groups know only too well how hard it is to obtain information about the areas in which they are interested. 'Environments of South Australia' is an obvious source. School teachers too may well find the mass of carefully arranged information that it contains most useful. A few initial reactions elicited from teachers on our behalf by the South Australian Department of Environment suggest that teachers and senior secondary students of geography, geology, biology, and the earth sciences in particular should find the publication valuable. (There were criticisms too.)

Broad view, not detail

The survey will not help people who need minute detail. Perhaps an ecological survey of Australia carried out on the same format would help planners to decide where to build new cities, but it would not help them to lay out those cities. And a survey like this won't help the farmer to decide on the best way to manage any one paddock either.

LANDSAT — an evaluation

When compiling 'Environments of South Australia', Dr Laut and his colleagues made extensive use of LANDSAT imagery — indeed their contract with the then Department of Environment and Conservation directed them to evaluate it. The surveyors used it to obtain information on two main features — the vegetation, and the shape of the land (land form). They had somewhat mixed results.

LANDSAT produces its images by scanning the landscape and receiving reflections of the sun's radiation in four separate wavelength bands (see *Ecos* 11). By combining these four bands together it is possible to produce a 'false-colour' image, which the human eye can learn to interpret. Unfortunately, only one band was available to the CSIRO surveyors when they began their work, although a second band did become available later. Consequently they had to work using black and white prints.

These prints came from the CSIRO Division of Mineral Physics, where Dr Andy Green of that Division spent a lot of time producing good-quality pictures from the tapes held there. Dr Laut and his colleagues greatly appreciated this.

The tones on each LANDSAT black and white image are a photographic impression of the radiation reflected in a narrow wavelength band from the land beneath. The intensity of the light in this band will be affected not only by the vegetation, but also by the soil beneath. Consequently the moisture in the soil and the state of the vegetation may greatly affect the intensity of the reflected light and hence the tones on the photograph.

This fact makes interpreting the images very difficult. LANDSAT images taken on different days may be almost unrecognizable as the same area. In addition, unlike normal aerial photographs, LANDSAT images can't be viewed stereoscopically, so the hill and valley slopes cannot be measured. For these reasons it's essential to check the truth of image interpretation on the ground.

The group found that some vegetation boundaries did stand out very clearly — that between dryland and swamp, for instance. Less-extreme boundaries such as those on the northern part of Eyre Peninsula between open scrub and low open woodland also showed up.

However, there were complications. Grazing of natural vegetation by domestic stock could alter its reflectiveness. Thus straight-sided paddocks sometimes appeared on the LANDSAT image like a patchwork quilt. Yet investigation of those paddocks on the ground revealed no difference between them. Such an image may mislead.

Fires also add to the confusion. Fire scars of different ages can be picked out over large areas of open scrub in both the Murray Mallee and the Great Victoria Desert of South Australia. These fire-scar boundaries obscure vegetation boundaries.

In addition, areas recently cleared for agriculture looked deceptively like remnant stands of native vegetation.

The team therefore concluded that different forms of vegetation — woodland, open woodland, and scrub — cannot be identified on black and white prints of LANDSAT imagery without considerable 'ground truthing'. Nevertheless, combining the photographs with other information such as existing vegetation maps does allow a broad interpretation.

The scientists fared a little better when analysing the land forms using the LANDSAT imagery, partly because each image covered a much larger area than can any other form of remote sensing.

When compared with air photomosaics at scales of less than 1 : 100 000 the mosaics seemed the more useful. (There are limits to how much LANDSAT images can be blown up to give greater detail.) At scales of more than 1 : 250 000, LANDSAT imagery proved the better tool for mapping.

In some areas the land form could be mapped from the LANDSAT imagery, but in others the chequerboard-like distribution of the vegetation obscured it.

In general, the team concluded, LANDSAT imagery provides a useful tool for broad-scale environmental mapping, and for mapping distinctive land forms where the pattern of the vegetation does not obscure such features. It is also possible to infer a limited range of land uses from such images.

Certainly combining all four of LANDSAT's spectral bands into 'false-colour' prints aids interpretation, but the team from the Division of Land Use Research wasn't able to use such images when preparing 'Environments of South Australia'.

So if it's detail you want, you should look elsewhere. But if you need a broader view, the 'Environments of South Australia' could well be the place to look.

Dr Laut and his colleagues have shown that it is possible to list the environments of a large State in reasonable detail fairly quickly. It would obviously be possible to carry out a similar exercise for the rest of Australia.

Since the scientists started the South Australian study, the Land Conservation Council of Victoria has brought out a number of its series of reports for Crown lands in Victoria, and similar studies are going on in Queensland and Western Australia. It is now up to the Commonwealth government to decide whether it wants the rest of Australia covered by a CSIRO-style survey.

The title 'ecological survey' is a misnomer.

More about the topic

'Environments of South Australia. 1. Province 1 South-east; 2. Province 2 Murray Mallee; 3. Province 3 Mt Lofty; 4. Province 4 Eyre and Yorke Peninsulas; 5. Province 5 Eastern Pastoral and Province 6 Flinders Ranges; 6. Province 7 Western Pastoral; 7. Province 8 Northern Arid; 8. Handbook.' P. Laut, P.C. Heyligers, G. Keig, E. Loffler, C. Margules, R.M. Scott, and M.E. Sullivan. (CSIRO: Canberra 1977.)

'Final Report of a Feasibility Study for an Ecological Survey of Australia.' (CSIRO: Canberra 1977.)

Report on a feasibility study for an ecological survey of Australia. *CSIRO Division of Land Use Research Technical Memorandum* No. 76/10, 1976.