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RESOURCE APPLICATIONS

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VEGETATION MAPPING ISSUES

Australian vegetation has been variously mapped and such mapping continues. Despite this, the vegetation information is almost invariably deficient when addressing general conservation requirements as well as the environmental impacts of proposed developments. This note briefly addresses some of the fundamental issues in vegetation classification and mapping that produce such deficiencies.

The issues addressed are:

1. The need for mutual exclusion between vegetation categories.
2. The assumption that 'typical' vegetation types exist that can unambiguously recognised.
3. The often implied assumption that the distribution of vegetation is directly related to the environment.
4. The definition of objectives for the vegetation mapping.
5. The usual lack of any performance measure to test of the reliability of outcomes.
6. Limited consideration of spatial and temporal scale.
7. Independent derivation of information.

Mutual Exclusion between Categories

Mutual exclusion requires that a feature can be assigned to only one category. For example, an individual plant can be recognised as being a shrub or a tree but not both. Mutual exclusion is a basic scientific requirement for logical analysis and the production of an unambiguous classification.

Some environmental legislation allows the same area of land to be both grassland and woody vegetation and hence contravenes this basic requirement. This is often exacerbated by a plant community being named by reference to a species considered most important rather than an objective analysis of all plants present. The same area of vegetation can be classified differently depending on the goals and perceptions of the observer.

Another example of the failure to address the requirement for mutual exclusion is the requirement to map both individual trees and woody vegetation in the same map. Woody vegetation is an assemblage of trees hence there is no logical way of differentiating between trees and woody vegetation. This requirement is best addressed using two layers, one discriminating woody from non-woody vegetation, the second mapping individual trees in non-woody areas.

Another common issue in vegetation mapping relates to assigning structural formations to species. Some plant species can have different structural forms depending on their age and/or the environment. Structural and floristic vegetation maps are therefore different entities as structure cannot give floristics and structure cannot be reliably inferred from the floristics.

Assumption of Distinct Communities

Sharp boundaries between vegetation types can often be readily recognised and this has developed the perception that there are distinct vegetation types. Such spatial disjuncts have been used to identify catenary sequences whereby different vegetation types are identified as occurring in different parts of the landscape. However, there has been very limited assessment of the reliability of extrapolating the results for one area to another. Vegetation types that appear distinct locally usually exhibit wide variations across regions.

Local observations indicate that vegetation forms distinct states represented by the climax of Clements. However, regional observations indicate that vegetation is a continuum where this accords with Gleason's continuum theory. The conclusions reached depend on the range of observations, hence the recognition of distinct community types is strongly scale dependent.

The practical outcome of this scale dependency is that the identification of distinct vegetation types / communities depends on the views of the beholder. As identified under mutual exclusion above, the classification of the vegetation reflects the goals and interests of the observer.

Relationship between vegetation / species and environment

At a general level vegetation development is strongly related to the environment. Rainforests and deserts occur in hot wet and dry areas respectively. However, the relationship between environment and vegetation becomes increasing obscure when addressed in more detail. The plant species present in deserts or rainforests depends on their evolutionary history and hence vary with continents.

History can similarly determine the occurrence of species and hence vegetation types within continents, regions and local areas. The history may derive from plant life cycles whereby the growth of one plant prevents colonisation by another, or by episodic impacts such as fire, flood and drought.

While many species cannot grow in a particular environment there will be many species that can. A range of species and vegetation types can occur in a particular environment. The observed outcome by way of the local occurrence of particular species and vegetation types contains a large probabilistic element.

The results of Austin illustrate the limited association between species and environmental factors. Prediction of the distribution of dominant species from environmental factors had a reliability of between10 and 75% (average below 50%). This result is likely as good as can be expected taking account of the limitations of the environmental and vegetation information used in this analysis.

This issue is significant if species distributions are to be modeled from environmental factors as results will generally be poor. There is a limit to the extent to which species distributions can be predicted from environmental factors. The issue is particularly significant where species distributions are identified in relation to habitat as discussions are then almost invariably circular.

The indications are that the occurrence of plant species relates as much to factors such as the interactions between life cycles of organisms as to the physical environment. However, considerably more research has to be done to quantify the magnitude of such effects.

Defined Objectives

The main reasons for undertaking vegetation mapping are:

- Developing understanding of relationships between the biota and the environment.
- Assessing business potential (eg, agriculture, forestry, bee keeping, mineral exploration).
- Addressing community perceptions for conservation.

While now often separated, the development of understanding and business potential were integral in the development of human society. Native vegetation provided the most reliable indication of the development potential of areas and this knowledge was essential for the development of human communities. This use of vegetation mapping to identify development potential is well illustrated by Land Systems mapping.

The requirements for vegetation information to address development have now largely progressed from simply mapping what is there to additionally evaluating the actual and potential impacts of land use. The vegetation descriptions / classifications used in mapping must therefore provide information relevant to the functioning of the community. The information provided by most past surveys is inadequate for this purpose.

The other main change in requirements relates to addressing conservation for other than academic reasons. The main requirements relate to the constituent plant species in vegetation and the value they provide to animals.

Current attempts to address information requirements for conservation have largely been directed at providing increasingly detailed vegetation descriptions. It is assumed that if everything is described then all will be revealed when the reverse almost invariably applies. The key requirement is the same as when addressing development. The vegetation descriptions / classifications used in mapping must provide information relevant to the functioning of the systems.

As the requirements or use for vegetation information have changed the objectives in vegetation mapping must change. The need is to provide information that improves knowledge of how the systems function rather than static descriptions of what is believed to exist. This requirement cannot be achieved by the use of an ill-defined reference such as pre 1770 vegetation.

Performance measure

A lack of clearly defined objectives means there is no yardstick for evaluating performance, hence there is no basis for evaluating success or of improving performance. This is a key deficiency as performance monitoring against defined objectives is the key principle in both the scientific method and environmental management.

Other reasons why the accuracy of vegetation mapping is seldom evaluated relate to cost and the subjective nature of most vegetation classifications. Subjective classification makes assessment of reliability exceedingly difficult. Accuracy can be assessed for objective classifications but few are prepared to pay for the associated costs. The outcome is wide diversity of vegetation maps of uncertain reliability and applicability. The diversity of vegetation maps limits application as considerable experience is required to determine their applicability for different purposes.

Scale

Scale issues with past survey methods were spatial but the requirement to address system function additionally introduces temporal issues.

Measurement

From an ecological viewpoint the relevant scale depends on the size and life form of the plant. From a measurement viewpoint the scale relates to the need to obtain a reliable average measure. The spatial resolution appropriate for characterising vineyards is around 10m, and this is likely applicable to many grasslands. However, the spatial resolution appropriate to native woody vegetation is around 60m.

The scaling issues for measurement can be illustrated by way of grassy woodlands. At high spatial resolution a woodland is composed of discrete areas of grassland and trees. At low spatial resolution the area is composed of a mixture of grasses and trees. As by definition grassy woodlands are mixtures of grasses and trees the scale of measurement must be sufficiently large to encompass this mixture to provide a representative measure.

Such scaling issues were well studied in the 1960s and numerous papers show how the variance in vegetation changes with the spatial scale of the observations. The appropriate scale varies with the community type and can vary depending what is of interest in the community.

Application

The unit area used for description is invariably too small for application. Conservation issues must be addressed regionally while addressing environmental issues requires understanding of the spatial relationships between different elements. Classifications are therefore used to identify equivalent map units. Classification is essential as the human mind cannot comprehend the different characteristics of all individual units of land within a region.

This use of classification raises issues relating to the assumed existence of distinct communities as discussed above. This becomes critical in application due to the limited human ability to comprehend complexity. Detailed classifications can be used for small areas but simplified classifications are required when addressing regions. These scaling differences are reflected in the different levels of detail in information required for planning and management.

Mapping Methods

Traditional air photo interpretation (API) is directed at mapping local patterns. The difficulties lie in identifying relationships between the mapped units and their extension elsewhere due to the subjective interpretation and limitations of photography.

Satellite imagery provides wide coverage and numerical analysis provides objectivity. Issues still arise concerning the similarity of mapped units across large regions but these can usually be resolved due to the objectivity of the methods.

Satellite imagery provides measured information for every pixel across large regions. This provision of a high level of detail consistently across regions provides a high level of scale independence that cannot be achieved by other means.

Temporal Change

A survey used to develop a vegetation map represents information for one point in time. The assumption generally is that, without human intervention, the same vegetation would have existed 200 years ago and should exist in 100 years time. These assumptions are incorrect and this greatly affects conclusions relating to conservation. This is addressed further under point 3 above.

Successive surveys can logically be used to determine the changes in vegetation over time and this has been done for major changes such as land clearing. However it has seldom been done to monitor temporal patterns of change within native vegetation. This mainly arises because of the subjectivity of vegetation classifications and inaccuracies in mapping.

Satellite imagery provides opportunities for monitoring temporal change because of the high spatial accuracy, the spectral resolution, and the capacity for objective analysis. However, its use for this purpose depends on the imagery containing relevant information.

Satellite imagery should not be expected to produce the same information as obtained from aerial photography if only because of the limited information provided by photography. Satellite imagery provides information not previously available. However, it cannot directly provide all the information considered desirable and should be used in an analogous fashion to aerial photography. Image analysis must generally be linked with ground observations.

Independence of measures

Past requirements were for vegetation maps that identified what was there and could be interpreted to indicate the development potential. The map was a stand alone product. Current requirements differ due to the need to examine system function to identify likely changes. The vegetation information is analysed with other information such as terrain and soils to examine system function. Vegetation represents a reference layer analysed with other reference information in GIS

The most basic requirement with such analyses relates to the independent derivation of the data layers. The vegetation information should be derived independently from other information used in analysis such as topography. A failure to maintain such independence produces circular arguments whereby results can arise by definition.

While topographic information is sometimes used in vegetation mapping the main concerns with the independence of observations relates to soils as patterns of soils are often mapped from the patterns of vegetation.

Effective Implementation

The ERIC focus is on delivering required outcomes with methods based around a detailed understanding of ecology. The technology is a means to an end and methods are modified and developed to address particular needs. The most appropriate technology and methods are determined on a case by case basis in consultation with clients.

ERIC develops the capability of clients to address their needs by the provision of information and support in its application. This allows clients to concentrate their efforts in addressing their core issues.

The best outcomes are achieved with close collaboration between ERIC and clients. This includes the provision of training and tools to aid field sampling. This involvement of clients reduces costs and improves application of the information.

The technology allows highly cost effective mapping of vegetation across regions and states. The mapping of woody vegetation clearing illustrates a particular application. The level of detail provided can be tailored to the particular application, as with the use of multi-temporal imagery to improve the mapping of grasslands. The reference vegetation map can be used to address specific requirements, as with the development of a fire hazard map.

The common theme with all methods relates to detailed knowledge and understanding of what is being mapped and the characteristics of the imagery. The quality of the results depends on the ability to select the most appropriate imagery, conduct the most appropriate analysis, and understand client needs.