ANDYSEZ 23

VEGETATION AND KARST PROCESSES

As usual Kent's deadline has come around a) too quickly; b) when I am snowed under by other writing pressures and c) when I am totally bereft of any ideas whatsoever. I have recently rediscovered the file regarding the leasing of Yarrangobilly Caves House in the 1920s which has many amusing bits in it - nothing has changed in government administration - but there is not enough to generate an ANDYSEZ.

One issue that came up on a number of occasions in New Zealand was that of the influence of different vegetation types on karst processes at the surface, in the soil and within the rock. Perhaps it is worthwhile repeating some of the usually qualitative, and sometimes anecdotal, Australian experiences in this regard.

However, before embarking on any examples we should (very) briefly review what vegetation might be doing in the soil. Firstly, plants influence the amount of precipitation reaching the soil through interception and subsequent evaporation. Secondly, the vegetation draws upon soil moisture to carry nutrients into the growing parts of the plant through the process termed transpiration. Plant roots live a complex ecosystem made up of bacteria, fungi and other lower plants which carry out a variety of functions. In doing this most produce carbon dioxide which, as we well know, is a vitally important part of the karst process and elevated levels in the soil markedly drive the rate at which limestone is dissolved (presuming water is available).

As one would expect different plant types and vegetation communities have differing effects. Large trees, for example, will intercept and re-evaporate more water than smooth pastures. Their roots reach deeper and thus will tap a greater reservoir of soil water. More and larger roots = more surface area = more carbon dioxide production etc etc.

Without delving too deeply into the literature lets look at a few "facts":

- "Homes and Colville (cited in Jennings 1985) showed that, with the same limestone and soil in south-eastern South Australia, pine forest causes twice as much [water] loss to the atmosphere as grassland, reducing [net] input into the limestone to nil."

- Wimbush (unpublished data cited in NPWS 1983) found that exotic pines averaged 7 times as much surface area as the roots of native eucalypts in the top 50 cm of soil. Total root weights were only 25% higher reflecting the grater bulk of fine roots. The pines were about 20% more efficient in removing the soil water through the growth period (which was longer for the pines as well). During drought and during the winter the effects of the two species were much the same. The pines also intercepted and re-evaporated more water than the native species.

- Jakucs (1977) presents a table which shows that carbon dioxide production in the soil by cultivated plants varies from 0.3 mg to 275 mg CO_2 per day for each gm dry matter. For bacteria the values ranged from 500 to 13,000.

- Atkinson and Smith (1976) present a table which shows a range of carbon dioxide concentrations in soil air from eleven papers which discuss some thirty-odd vegetation type/soil depth situations. The values vary from 0.1 to 10.8 % CO_2 by volume. All the high range values (above, say 2%) are either in forests or orchards or are under very deep-rooted vegetation types such as bamboo forests or one "manured sandy soil" at 9.7%. This latter value dates to 1852 and the vegetation type is not specified.

Clearly, then, vegetation types do differ in the way they use and generate water and carbon dioxide fluxes. Presumably if one wishes to keep one's karst systems as natural as possible one would maintain the vegetation in its natural state - this seems axiomatic. Reafforestation is best done with native species in a fashion so as to reflect the pre-existing ecosystems - if possible. In Australia, and perhaps New Zealand, the natural climatic variability over decades, centuries or longer may overwhelm the effects of the vegetation change - but we may be playing god here.

Lets look at a few Australian examples of the affects of pines on caves and karst. I haven't reviewed the literature nor checked all of the statements below and therefore may well generate some well-deserved criticism. However:

- Replacing the native vegetation on the Swan Plain, north of Perth, Western Australia, with exotic pines has very markedly lowered the watertable in the Gnangara groundwater mound. Effects attributable to the lowered watertable can be seen in many caves at Yanchep including the subsidence in the Silver Stocking Cabaret Cave (and in the transpirative loss of a groundwater resource essential to the well-being of Perth).

- Conversion of the native eucalypt, ti tree and other communities in Mount Gambier region of South Australia to exotic pines forests, together with the effects of broadscale agricultural drainage, has markedly lowered the watertable (by 2-4 metres over an area of many hundreds of square kilometres) and much reduced the available high quality, groundwater resource. The effects on the karst systems are more problematic but stromatolites are now exposed and dead in the walls of many of the cenotes and at least some caves are now terrestrial rather than aquatic environments. Mount Burr Cave was an intermittently active streamsink cave (sometimes referred to in the past as Mount Burr River Cave). Pines dried this cave out completely until the Black Wednesday bushfires in 1985 removed the plantation. The former stream cave conditions were restored - although as the plantation has been replanted the cave has become progressively drier.

- There were three very large mature pines over Blanche Cave, Naracoorte. No active calcite deposition had been observed for many years. Within three weeks of the removal of the pines calcite was again being deposited (Brian Clarke pers. comm.).

- There is a suite of small caves underlying the Jounama Pine Plantation at Yarrangobilly. The caves have distinctly different environments to similar caves outside the plantation area. Those under pines are drier, have a much changed seasonal carbon dioxide regime (including much higher absolute CO_2 levels). Most tellingly, there is a virtual complete absence of the normal Yarrangobilly invertebrate fauna under the plantation in spite of an apparently far richer cave environment as a result of the very large quantities of fine roots, fungal hyphae and so on. I must write up the results of my quantitative research from these caves!

These are a few examples which might generate some interest in rehabilitation of karst terrains. There is a definite paucity of information about the influence of different vegetation types and regimes on karst and karst processes but there are some guiding philosophies backed by first principles and anecdotal evidence such as outlined above.

REFERENCES

Atkinson TC and Smith DI 1976 The Erosion of Limestones, Chapter 5 in Ford TD and Cullingford CHD (eds) The Science of Speleology, Academic Press, London

Jakucs l 1977 Morphogenetics of Karst Regions, Adam Hilger, Bristol

Jennings JN 1985 Karst Geomorphology, Blackwell, Oxford

NPWS 1983 Harvesting and Rehabilitation of Jounama Pine Plantation, Kosciusko National Park - Environmental Impact Statement, NPWS and Forestry Commission, Sydney