Session 1
Paper (a)

EARTH SCIENCE INFORMATION FOR LOGGING PLANNING - WHAT, WHERE, WHO?

ANDREW J. PEARCE
Scientist
Forest Research Institute
Ilam

INTRODUCTION

Earth science data that are potentially useful in the planning of logging operations are gathered, collated, or mapped by several organisations in New Zealand that are concerned with geology, geomorphology, soils and hydrology. Often the available data are not presented in a form or at a scale suitable for direct use by logging planners, and these data must be interpreted by trained earth scientists who can also speak the logging planner's language and who understand at least some of the planner's needs. Regrettably, such intermediaries seem few and far between, and the earth science profession in New Zealand has not been to the forefront in training people for this important applied science role. In this paper I attempt to give an outline of the types of earth science data that are available, how they might be interpreted to make them useful to planners, their limitations, and where suitable interpretation might be obtainable.

At the outset, however, I want to make a distinction between two aspects of land-use planning. One of these I will call <u>indicative planning</u>. This is concerned with medium and long time scales, is usually done at rather small scales of mapping and principally identifies sets of constraints and sets of options to produce a coherent and optimum pattern of land use for an area. Most regional planning and some aspects of district scheme planning are of this type. The second aspect I will call <u>operational planning</u>, which is concerned with decisions, rather than sets of options. The operational planner has to bite the bullet and decide whether or not, for example, a road will follow a particular route, or whether a particular compartment will be tractor logged. These decisions apply to the immediate future, and operations are planned on a detailed (large) scale. These two types of planning are at the ends of a spectrum of planning processes and the boundary between them is neither clear nor very important; logging planning, however, is definitely at the operational end of the spectrum and is concerned with hard decisions, short time scales and fine subdivisions in space. These characteristics in themselves place some constraints on earth science involvement in logging planning, since only data that are readily available and which can quickly be interpreted can be used. Professional earth scientists are too often not prepared to commit themselves to advice when data are few and time is short, thus by default, they may force planners to make decisions that are less soundly-based than they could be.

WHAT SHOULD THE LOGGING PLANNER HAVE?

Ideally, the logging planner should have access to a terrain zoning map of the area to be logged. Such a map should be on a topographic base of about 1:10 000 to 1:15 000 with a contour interval of about 10 m; it should identify specific erosion hazards such as old landslides, zones of particular instability because of slope steepness, soil water conditions, or rock type; it should identify routes, at least for major roads, that avoid or minimise contact with such hazards; it should specify the need for streamside protection zones on particular rivers and/or streams; and it should subdivide the total area into zones that are suitable for particular types of management, e.g. clearfelling, summer-only logging, selection logging, protection zones, etc. The basis of the zoning system should be made explicit as far as possible in a legend of supporting information, e.g. rock formation X zoned for no logging because of extreme landslide hazard; streams draining >100 ha have perennial flow and support trout populations, thus streamside protection is required.

Engineering geologists or geomorphologists using stereoscopic viewing of large-scale aerial photographs can characterise particular landscape types which may have differing erosion hazards, can identify particular rock and or soil types with specific problems, and can identify specific hazard areas. This interpretation should be undertaken jointly with the logging planner, who can specify options for road and track layout, logging system, coup size, seasonal logging patterns, etc. Local field staff's road construction experience, if available, should be drawn on while field checking of the photo interpretation is being done. Rainfall intensity/ frequency data should be reviewed to assess the probability of large storm damage during various seasons, and the areal extent of very intense storms may be important in determining coup sizes in some regions. Hydrologic data on floods and low flows should be reviewed to assess the need for streamside protection zones for various catchment sizes. The finished terrain zoning should be presented on a large scale topographic map or orthophoto map. The role of the earth scientist should be to interpret the raw data into a zoning map for the planner, and to help the planner to assess the likely consequences of his various options for roading, logging system, logging pattern and timing etc., so that a suitable compromise can be achieved between undesirable effects of the logging on slope stability, streams etc., and the efficiency of the logging operation.

WHERE ARE THE DATA?

The data needed to produce a terrain zoning map are widely scattered across organisations. Topographic maps at a suitable scale will be available for many State Forest areas, but may have to be prepared from large-scale aerial photographs where maps are not already available. Map scales smaller than about 1:20 000 will not be very useful in most areas, because of the probable need to identify and separate out areas as small as a few hectares. Geological data for the whole country are mapped at a scale of 1:250 000 but for various reasons the data presented are often not useful for the sort of zoning map that logging planners need. Many areas are mapped at scales of 1:63 360 or larger but, except for specific engineering geology maps, are unlikely to be directly useful to the logging planner without additional interpretation by an engineering geologist or geomorphologist. Even where no large-scale geological map is available, aerial photograph interpretation and some field work can produce suitable maps in a short time, provided trained staff are available. Topographic maps, and aerial photographs and photogrammetry are largely the responsibility of Lands and Survey (although the Forest Service does some photogrammetric work, and MWD has a research group in photo interpretation at the Palmerston North Science Centre). Large-scale orthophoto maps, which are ideal for presenting the terrain zoning, are beginning to be produced for some State Forest areas. Geological mapping, especially engineering geology and special-purpose mapping, is mainly done by Geological Survey (although FRI does some geological mapping for terrain zoning). Hydrologic data for determining the need for riparian protection, and rainfall data for storm rainfall intensities and frequencies are variously held by Water and Soil Division of MWD, the Meteorological Service, and by Catchment Authorities. Storm rainfall intensity-frequency data are probably best obtained from the maps of Tomlinson (1979). Data on the areal extent of intense storms are probably most important in the Northland, Coromandel and Bay of Plenty areas, which can receive intense subtropical storms that affect only small areas in any one storm. Such data are probably available from Catchment Authorities and the Meteorological Service.

The National Land Resource Inventory Worksheets and the derivative single-factor maps (e.g. erosion) produced by NWASCO will in general not be useful for the detailed planning of logging operations, simply because they are at too small a scale. The Worksheets were not intended for such purposes but were to "... provide land resource information ..... at a scale detailed enough for use at regional and district levels (1:63 360)." (Hawley and Leamy, 1980, p.20). An additional complicating factor with the worksheets for the North Island is the lack of a single coordinated legend for all the sheets.

I believe that the wide variety of sources of earth science data, the range of scales and styles of mapping and presentation of data, and the general need for digestion and interpretation of the raw data into special purpose maps for the logging planner, make it imperative that earth science skills be incorporated into the workforce that plans logging operations of any consequence.

WHO CAN INTERPRET THE DATA FOR PLANNERS?

At present there are few applied earth scientists in New Zealand who are involved in interpreting data for land use planners at the operational level. The Palmerston North Science Centre of MWD has developed considerable expertise at smaller mapping scales suitable for what I have called indicative planning. The Engineering Geology section of Geological Survey has considerable expertise in assessing slope stability and road construction problems and has produced some special purpose engineering geology maps. The skills resident in the staff of these and similar organisations could be used in logging planning, but a period of familiarisation with logging practices and needs would be needed for most staff before they would become really useful to logging planners. The Geohydrology Section of FRI has a small group of earth scientists who have developed some methods of mapping and zoning for forest management, including logging, but this group is far too small to tackle the whole of the forest estate of New Zealand. Indeed I imagine that the resources of the Water and Soil Division of MWD, the Geological Survey, FRI and the Catchment Authorities would be taxed to keep up with producing terrain zoning maps of all areas to be logged within the next decade.

In my view, if terrain zoning is to become a routine part of forest management planning in general and logging planning in particular, there are two possible routes to obtaining the necessary earth science inputs to planning. The first is for all Forest Service Conservancies (and probably all large districts) and for large private forestry concerns to recruit their own earth scientists. There is no shortage of graduates with the necessary background training, but most recent graduates will need some training and familiarisation with forest management practices and needs. Such a development within the Forest Service alone would enable the small FRI earth science group to concentrate more on developing zoning and assessment techniques for particular problems, and to spend less time on what is essentially a servicing task (but a very important one). The second alternative is to make use of private consulting organisations to prepare zoning maps from available data to a standard specification of scale, etc. The actual zoning scheme could not be too tightly specified as it will be very much area- and operation-specific. A small number of engineering consulting firms have geotechnical and engineering geology groups who could undertake such a task. This alternative has a number of attractions to both large and small forestry organisations since it avoids difficulties of recruiting and training staff to develop and use a consistent zoning system, and it permits small organisations to have the same quality of earth science input to their planning as larger organisations have. Inevitably, some combination of these two alternatives will have to be used if terrain zoning maps are to be prepared to any large extent in the near future. Even if consulting firms are used to carry out the bulk of the routine map preparation, some earth science staff will be needed by forestry organisations to set specifications, maintain some quality checking on the consultant's products, and to refine the zoning systems used. If we are serious about using terrain zoning to help logging planning there is an urgent need for recruitment and training of staff by both forestry and consultant organisations so that a start can be made on terrain zoning of the vast areas planted since 1960, which will be coming due for logging in the next and following decades.

SOME EXAMPLES

Two examples of terrain zoning carried out by FRI earth scientists will give some idea of the range of approaches and outcomesthat are possible. In 1977 Westland Conservancy requested a zoning of the production forests of Central and Northern Districts of the conservancy to aid in preparation of Regional Management Plans. Their request stemmed partly from some earlier work done in relation to the West Coast Beech Forest Utilisation Proposals, which had recognised high erosion hazards on particular rock types, and lower hazards on similar terrain underlain by other rock types (O'Loughlin and Gage, 1975; O'Loughlin and Pearce, 1976). Discussions with Conservancy staff indicated that they would be happy with a three-class system of zoning for their immediate purposes:

- a class where there were no erosion or water and soil conservation constraints on clearfelling, if that was desirable,

- a class where selection logging would be acceptable, but where clearfelling was likely to cause erosion problems,

- a protection zone class, where logging should not be permitted.

Geological and soil maps were obtained at the largest available scale, topographic maps at 1:10 000 and 10 m contours had already been prepared and a recent uniform 1:15 000 aerial photograph coverage was available. The geological data were briefly checked in the field where possible and by photo interpretation, then photo-interpretation of slope steepness and existing erosion was combined with the geology data, with Soil Bureau erosion hazard ratings for the soils as mapped by them, and with data on the behaviour of recently-logged areas on particular rock types and soils, to place particular areas into one of the three classes. Zoning into the three classes was presented on 1:10 000 topographic maps. The zoning was briefly checked in the field again, with particular attention to slope steepness and existing erosion. This reconnaissance-level zoning exercise enabled mapping of Nemona, Hohonu, Waimea and Kaniere Forests to be completed, in conjunction with other work, in one year (Pearce, 1978 a,b,c). O'Loughlin and Gage (1975) had previously zoned much of Mawhera, Omoto and Hochstetter Forests in about 1 year, and Pierson (1980) has since zoned Granville Forest using the same system.

The Westland zoning example is one where the geology was reasonably well known and relatively simple; certain rock units were known from past logging experience to have high erosion hazards on steeper slopes, and other rock and soil combinations that have similar erosion hazards were relatively easy to recognise. In practice, the zoning exercise tended to identify those areas where clearfelling was acceptable and those areas where no logging should be permitted, with the residual area being zoned as where partial or selective logging would be acceptable. Those involved in the zoning probably tended to err slightly on the safe side, especially in decisions whether to place areas in the protection category or in the selection logging category.

The second example is the terrain stability classification developed at Mangatu State Forest (Gage and Black, 1979), an extended form of which is currently being developed for the other state forests of the Gisborne District. The geology of Mangatu Forest was not well known and is rather complex, and the same is true for most of the other areas of afforestation in which the extended classification is being mapped. The first requirement in all these areas is to produce geological maps at scales of about 1:10 000 to 1:25 000. At Mangatu Forest a classification of eight terrain types was developed based on the rock type, the type of erosion processes that were active now and had been active in the past, and the age, or duration since the last active erosion period, of the present land surface. The age or duration of stability for various areas could be determined by the presence or absence of various well-dated volcanic ash layers in the soil profile. A clear scale of decreasing relative stability was established for six of the eight types of terrain. This system could not be applied in an unmodified form to other State Forests because of differences in the rock units present, in the geological structures, and the lack of the crucial volcanic ash layers in some areas. By working gradually away from the Mangatu area, through regions that are closely similar in geology towards those that are less similar, we have tried to redefine each of the stability types to include terrain of similar relative stability. The development and extension of this terrain stability system is still underway, and we may yet have to abandon the ideal of having the same classification system for the whole region, and have a set of classifications each of which applies to a smaller area. From the viewpoint of the forest manager and logging planner, having several different schemes would be much less desirable than the one system covering the whole region. The great strength of the system developed at Mangatu is that it is based largely on objective criteria; unfortunately the further it is extended into other areas where some of the criteria can not be used, the more the zoning of a particular piece of terrain depends on subjective geological interpretation.

The system developed at Mangatu Forest certainly cannot be applied to most areas outside the East Cape region because of differences in rock units, geological structures, erosion processes and topography. Systems based on the same principles could, however, be developed for much of the northern half of the North Island, where volcanic ash layers can be used to date the land surface. Elsewhere, systems like that used in Westland but with more objective criteria, where possible, can undoubtedly be developed. Collating the information on the response of various rock and soil units to past logging would be the most important and time consuming part of developing such a system in any region.

SUMMARY

Applied earth scientists can greatly aid logging planners by preparing terrain zoning maps that will help planners to identify hazards and constraints, and by helping planners to assess the consequences of various options for roading, logging system, etc. Many of the basic data needed to prepare such maps are already in existence, but they require compilation and interpretation into a form that is useful to planners. The existing pool of earth science skills within state and private forestry organisations is far too small to undertake such a task. If terrain zoning is to become a routine part of the logging planning process for the large areas that will be harvested in the 1980s and 1990s, both state and private forestry organisations, and private consulting organisations will have to recruit and train a substantial number of applied earth scientists from the ample supply of earth science graduates being produced within New Zealand.

Terrain zoning systems will have to vary from one region to another because of differences in geology, topography, erosion processes, the forest resource, and the logging planner's needs. Objective criteria for assigning pieces of terrain to categories of the zoning system need to be developed where possible, to minimise the degree of subjective geological interpretation used in the mapping of areas. It will not be possible to eliminate subjective interpretation entirely, but by developing systems that are based on sound earth science principles and objective criteria, it will be possible to assess the responses of clearly-defined terrain types to logging and other disturbances of various kinds. These

responses can then be used as input to modify and continuously improve the basis for terrain zoning.

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