SESSION 5
Paper (b)

MANGATU FOREST, CASE STUDY

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INTRODUCTION:

Mangatu Forest is 65km by road northwest of Gisborne, the last 20km of road are narrow, winding and unsealed. The forest covers approximately 11,000ha of the Mangatu and Waipaoa catchments, on the eastern flank of the Raukumara Ranges. The elevation varies from 200m a.s.l. at the forest headquarters up to 1,000m a.s.l. on the Tarndale Road, the watershed boundary between the Waipaoa and Motu Rivers. This range in elevation has a marked effect on climate; August is the wettest month with 284mm average rainfall at Tarndale Station and a minimum of 147mm rainfall recorded at Waipaoa Station. Snow can also lie on the ground for up to a week at a time on the ridge areas. Although August is usually the wettest month, flash floods are likely in almost any other month.

The hillcountry on which Mangatu Forest is planted is the southernmost section of what has been called the "Critical Headwaters" of the East Coast. This zone of highly erodible rock extends from Mangatu, northeastward along the foothills of the Raukumara Range to Te Araroa. The reason for this severe erosion potential is the normal strength of the bedrock has been destroyed by the actions of folding, overturning, faulting and crushing, grouped together and labelled as "tectonic activity". Under normal forest cover the landform developed by the activity of normal erosion and at Mangatu this was earthflow (mass wasting), gullying and slumping. Following the pastoral development phase of 1890 - 1910 that rate of erosion changed dramatically and it was apparent within 20 years of clearence that erosion was serious. Reports in 1910 and 1920 indicated that reafforestation was the best landuse in the area but it was not until 1960 that large scale afforestation started.

LANDFORM:

The landform of the Mangatu and Waipaoa valleys is typical of many tectonically disturbed valley systems throughout the East Coast region. Mangatu Forest can be divided into four distinct landform units, each of which indicates the difference in the underlying geology. The landform zones and major erosion features are:

(1) Tikehore - Waimatau; bedding plane earthflow.
(2) Eastern Waipaoa; shallow slipping and slumping.
(3) Te Weraroa; gullying and slumping.
(4) Crush zones; large scale earthflow.

THE TIKEHORE - WAIMATAU CATCHMENT is an area of approximately 3,400ha on the western side of the Waipaoa River. It is an area of moderately high rainfall but there are few incised creeks, run-off is spread across the surface in many superficial channels. The bedrock is composed of an alternating sequence of sandstone and carbonaceous mudstone; the dip of the bedrock produces the characteristic assymetric valley landform of a long, dip-slope and a steep back-slope. The earthflow movement in these catchments is therefore structurally controlled with preferential movement down the bedding plane. A modification of this earthflow surface is the deposit of volcanic ash; on the upper slopes there are Waiohau ash deposits and on the lower slope there is only a thin deposit of Taupo Pumice. The difference in age and characteristic of the ash and pumice have been used to produce a stability map.

THE EASTERN WAIPAOA area extends eastward from the Waipaoa Fault. It comprises all the Miocene mudstone and sandstone sequence that forms the distinctive Tutamoe Plateau. This area is geologically, undeformed and its erosion is primarily caused by the collapse of the weaker underlying argillites. Normal erosion is surface slipping and minor slumping but at the crush zone contact with the argillite, earthflow movement is common.

TE WERAROA CATCHMENT lies immediately south of the Tikehore catchment on the western side of the Waipaoa River. The bedrock is composed of well bedded marls and siltstones, commonly called the Mangatu argillite. It is in this rock unit that the most well known erosion features of the Mangatu area occur in; these are the two large erosion scars of "Tarndale and Mangatu Slips". Both features have existed for thousands of years as eroding gullies with slumped headwalls but removal of forest cover has accelerated them to such an extent that planting trees has had no effect on reducing the rate of erosion. Within Te Weraroa catchment the usual landforms are steep V-shaped gullies with well defined ridges and a pronounced dendritic drainage pattern. As seen in Tikehore-Waimatau catchment there is similarly a range of volcanic deposits on the hillslopes, from a complete Waiohau sequences on the ridge to no Taupo pumice at the river edge. This range in type and thickness gives an indication of the length of time a soil has existed on any slope and conversely it indicates the rate of erosion or degree of stability of a slope.

CRUSH ZONE The most pronounced crush zone occurs along the eastern side of the Waipaoa River. The bentonitic crush-zone associated with the Waipaoa Fault varies from 500 - 1,000m wide and this is an area of severe earthflow and gully erosion at the contact with the overlying mudstone units. The crush zone of the Wheturau Fault in the catchment of Homestead Creek was the area first planted in Mangatu Forest. A major access road from the headquaters to the Tarndale Road passes through the bentonitic section of the crush zone and there is still evidence of slope movement along the margins of Homestead Creek even after 20 years growth of trees. The other fault system is the Te Weraroa-Te Waka Fault system that extends across the forest in a north-west direction. This is not a bentonitic zone but the crushed argillite and sandstone have a consistency of porridge and this means that very active earthflows and gully erosion are common.

THE EFFECT OF LANDFORM ON LOGGING:

TIKEHORE-WAIMATAU

The broad open catchment is best suited for skidder operations because the shallow earthflow is most effectively controlled by trees. It has been stated that disruption of the Waiohau Ash is not allowed but practically this will occur but it must be minimised. The drainage of roads and the maintenance of full vegetation cover in the small streams is essential because of the higher rainfall in this catchment. The steep back-slopes can be hauled effectively or additional roads may be necessary; the geology will allow additional roads.

EFFECTS OF AFFORESTATION:

Because of the advanced stage of erosion existing when afforestation commenced in 1960, the results have been slow in appearing. Homestead Creek is usually shown to visitors as the best example of what afforestation can achieve. The former area of raw, grey argillite debris fan now has a channel, which was entrenched 5m deep prior to the placing of an Armco culvert in the bed. The natural degrade back to bedrock situation has produced an armoured, bouldery creek bed which is now on-grade. This channel has therefore removed most of the stored sediment from the channel and there are only minor amounts now removed from the few active earthflows. In Matakonekone Stream similar channel degrade of 3m in four years has resulted in large volumes of material removed from the stream bed and deposited in the main Waipaoa channel. This means that within a few more years stabilised crossings and installation of culverts will be possible. Other tributaries of Te Weraroa Stream have also undergone this aggradation-degradation cycle and there are examples of large debris fans, now planted in trees and drained by an incised, single-thread channel. The stabilisation effect has been to reduce debris movement on the slopes and to remove stored sediment and discharge it into the main channel. In time this process will occur throughout the larger channels but this is a much longer-term process.

Associated with the improvement of the channels is the increased slope-stability such that roads can now be maintained where previously it was thought impossible due to the activity of the wet, moving ground. The overall result is to reduce the rate of erosion back to the natural state such that any sediment removed from the slope can be accomodated within the normal sediment transport system.

There are however areas that have not responded to afforestation, Mangatu and Tarndale Slips, Gully 117, Island Creek and Matau Creek. These areas are apparently producing as much debris as they did 20 years ago in-spite of all efforts to control them. At present it would appear that these large individual features will have to undergo their natural cycle and reach a stage at which man's efforts will be most effective.

CONSTRAINTS ON LOGGING:

The major constraint is the distribution and number of logging roads and landings. Present formation costs of $10,000/km without metal and the cost of $23/m^3$ for high quality greywacke make the roading costs very high both within the forest and on County roads. The only alternative source of moderate quality rock is from Mt. Arowhana, near the northwest boundary of the forest, but this area because of environmental and historical reasons is unavailable at the moment. The highly dissected Te Weraroa catchment suggests numerous ridge roads and small mobile hauling rigs whereas the rolling terrain of the Tikehore-Waimatau catchment suggests wheeled or tracked ground hauling methods. The slope of the ground however is not always the best indicator for deciding logging method, the steeper slopes are usually solid bedrock, the rolling areas are active, moving crush-zone earthflows. The geological nature of the hillcountry and the broad expanses of riverbed indicates that the riverbeds have to be main roads. This will mean there has to be summer and winter logging plans, working the lower slopes, down into the stream beds during the period of low stream-flow (November - May) and working uphill to the ridge roads in the "wet" months. At present the Waipaoa River bed is negotiable from the headquarters up to at least the mouth of Tikehore Stream. Assuming a continuing improvement in channel stability, all of the large branches such as Matakonekore, Tikehore, Te Weraroa, Matau and Island Stream will be important roadways.

The lack of suitable, stable road metal may be overcome by the use of lime stabilisation of the sub-grade. Experimental work on No. 15 Road has shown that these crush-zone situations can be stabilised by the lime method.

The landform will also govern the size and distribution of the areas to be logged, this will be further modified by the condition of the actual stream channel of the catchment or sub-catchment being logged. For example, in Homestead Creek there are areas of bedrock and areas of earthflow. Where-ever possible existing tracks must be used and the area must not be logged such that several active earthflows are cleared in the one operation. The argillite areas are very susceptible to gullying and full protection of these channels must be maintained. Where-ever possible the deep volcanic ash deposits must not be removed by skid tracks or haulage ways because this will allow the percolation of groundwater and cause further instability.

An unknown factor is the quality of timber from the first rotation. Because of the period of ground movement over much of the trees life (10-15 years) the apparently straight trees may only be of pulp grade. For this reason it may be better to fell the trees earlier than planned and start the second rotation for a better quality crop. This problem does not occur in all parts of the forest however and normal rotation length can be expected. The removal of this timber from the forest to Gisborne may be achieved by way of the County road or possibly downriver to Whatatutu. The river-road is at present a short-term alternative depending on the rate of upgrading of the County Road and the rate of degrade in the main channel required to produce stable terraces.

CONCLUSIONS:

Mangatu Forest will be a difficult forest to log; public pressure to see that the present "stable" situation is maintained and the practical need to remove the trees to ensure a better quality second crop will make the logging fraternity think hard about the economics of this type of logging venture. To maintain the present conditions existing in the forest the following are the basic requirements.

(1) Where-ever possible existing roads and tracks should be used but if new construction is essential it must be done well in advance of being used. Lime-stabilisation and use of river-run material must be investigated as road construction materials, both to minimise cost but also to aid the degrade of the main channel.

(2) Some small-scale logging operation is required before the major contract work to determine the quality and size of material in the first rotation. This exercise may indicate that the rotation-length can be increased or decreased on certain sites if quality is not improved by time.

(3) To satisfy the water and soil conservation requirements, a two-tier logging plan for winter and summer logging is required to make best use of the riverbeds as roadways and to reduce the damage caused by vehicles moving across wet, erodable slopes. This type of planning approach would neccessitate several logging methods within one logging area and this may also be a reason for having a small scale logging operation to try the various methods available.

Finally it is hoped that the ideas put forward by the participants in this planning seminar will enable the formulation of logging plans that combine the best elements of soil conservation and practical logging.