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A HYDROLOGIST'S CONTRIBUTION TO THE DEBATE ON WILD ANIMAL MANAGEMENT

Summary: In the 1950s, increased erosion, flooding and sedimentation was widely observed in New Zealand. The ruling opinion then was that the forests prevented erosion and floods, and browsing mammals were primarily responsible for the increased erosion of mountain lands. It followed that effective control of browsing mammal populations was necessary to prevent erosion and alleviate lowland flooding and alluviation. In the 19608 evidence was found for much severe erosion on the Ruahines in the 1840s -long before browsing mammals were there. Furthermore, four severe periods of erosion had affected the Ruahines, Ureweras and elsewhere, since the 13th century and each had ended regardless of humans, and without their assistance. By 1985 I was able to show that there have been at least seven other periods of accelerated erosion since 180AD, similar to, but greater than, the current one. These were long before even Polynesians and their animals had arrived in New Zealand.

The present period of increased erosion and alluviation is primarily the consequence of atmospheric warming and the bigger rainstorms and floods it brings. Browsing mammals have not contributed significantly but they do reduce the density of the vegetation which minimises normal soil erosion and hence the concentrations of fine sediments in streams. The primary objectives in managing browsing mammals should be to: (a) protect the indigenous vegetation for itself and as habitats of native animals, and (b) enhance the beneficial effects of vegetation on the stability of surface soil and on water quality.

Keywords: Ruahine range; Tukituki and Waipawa rivers; hard-rock mountain lands; alluvial sedimentation; erosion; Holocene erosion periods; timberline; rainstorms; floods; gales; drought; snowfall; atmospheric warming; anthropic vegetation clearance; browsing mammals; earthquakes.

Introduction

Hydrological studies are concerned with, among other things, the supply and transport of the coarse sediments eroded from mountain lands which confer both benefits and problems for humans when deposited down stream. I have worked on these and related subjects since the 19508, and in the process have made many observations and comments on wild animals. Over that time my ideas have evolved as the accumulating facts have jousted with the accepted opinion of the day to form new hypotheses. And from that continuing flux have emerged the successive approximations to reality which form the basis of advice to land managers. Here then, are some of the lessons learned from one person's experience in a complex discipline. My comments apply only to the high-rainfall, hard-rock mountain lands of the North Island. They cannot and should not be applied to other environments such as to the extensive *low*-rainfall, hard-rock mountain lands of the eastern South Island.

History of an Idea

In 1955, with advice and help from Peter Logan, I prepared a report for the Hawke's Bay Catchment Board on wild animal control in the upper Tukituki Basin, on the Ruahine Range (Grant, 1955). At that time I accepted the conventional philosophy when I made statements such as: "Let us not be mistaken . . . and class as natural all of the severe erosion in this region. To do so would automatically label it as inevitable and consequently place it beyond man's powers." Again". . . by far the bulk of the erosion taking place today at the head of the Tukituki River is not natural erosion - it is very definitely accelerated or induced." My conclusion: "It is obvious, if we wish to conserve the vegetation, soil and water resources of the country, and by so doing help to alleviate many lowland problems, that firstly we must gain the necessary control of the animal populations."

The same philosophy appeared on official brochures of the Forest Service and the Soil Conservation and Rivers Control Council, which proclaimed "these forests prevent floods". This concept was simple, intuitive and "scientifically seductive", but hydrological studies have since proved it to be demonstrably false.

However, in that same year, (1955), I began channel geometry measurements of the upper Waipawa River which became the reference standard for subsequent measurements of physical change. I was starting to graduate from making simple visual assessments to the much more demanding process of quantifying physical conditions.

In 1965 I presented a brief historical study of the Tukituki River and in it quoted some of Colenso's previously overlooked observations (Grant, 1965). His vivid descriptions of severe, active erosion in 1845, made inescapable the conclusion that "much of the scarring we see today on the Ruahine Range had its origin *before* the time of extensive European settlement and the introduction of animals" (Grant, 1965: 23). This historical perspective was a surprise to those in wild animal management, but it did not give the reason for the erosion.

By 1969 I was convinced that exotic feral animals do not cause land instability, yet the ruling philosophy of the time was so strongly to the contrary that a blank statement to that effect would not have been acceptable. Hence, I added the rider: "However, because the level of natural erosion is now high it is probably fitting, at least in certain regions, that some measure of animal control be exercised to facilitate the revegetation of damaged areas" (Grant, 1969: 149).

In outlining a research programme for the Ruahine Range, I compared the rata-kamahi forest *(Metrosideros robusta- Weinmannia racemosa)* of the southern area with the beech forest *(Nothofagus fusca,* N. *solandri* var. *cliffortioides)* of the central area (Grant, 1975: 32). Rata and kamahi are both palatable to possums *(Trichosurus vulpecula)* and red deer *(Cervus elaphus),* and the beeches are not. Nevertheless, it appeared that in many basins of the central area the rates of erosion and channel change were greater. "What then are the real influences of animals in different environments of the Ruahine Range?" I asked.

By 1977 I was able to describe the history since 1920 of changes of channel regime of the upper Waipawa River (Grant, 1977a). Since the late 1940s the *rate* of coarse sediment transport had progressively increased, not only in the upper Waipawa but throughout the Ruahine Range.

By 1981 I had enough data to determine that the Range, and elsewhere (e.g. the Ureweras), had been subjected to four severe periods of erosion since the 13th century, and was now experiencing a fifth. Obviously some of these periods were before the arrival of Europeans and their animals: and the indications were that they were associated with heavy rainfalls, major floods and gales (Grant, 1963: 158; 1977b; 1981: 298).

My ideas were crystallised in 1983 by the results of a systematic study in the upper Waipawa River basin (Grant, 1983). It first described the chief basin features: sediment supply areas, relations between geology and erosion, the main erosion processes and channel sedimentation history, both present and past. Then it considered the main sources of energy affecting the basin and how they have changed with time. These were: air temperature, rainstorms and floods, drought, earthquakes, cultural clearance of vegetation, and browsing mammals. Finally, it discussed the probable effects of change with time of each important energy influence on (a) vegetation, (b) erosion processes and (c) channel sedimentation. It concluded by estimating the importance of these changing influences on the vegetation, in relation to erosion processes and channel sedimentation.

Vegetation cover and composition are not constant, but change with time for many reasons. Atmospheric warming since about 1950 (Grant, 1969, 1983; Salinger, 1979) has probably extended the growing season by 25-30%and increased transpiration rates. Both increases must have produced more plant growth and a greater demand for soil water. Less snow fell, and it melted sooner, so high altitude vegetation had less protection from mammals and herbivorous insects. It also means that new growth is exposed for a longer time to damage by frost and wind. Since 1950, rainstorms have removed 2% of the vegetation area in the sediment supply zone. The impact of recurring droughts has probably increased since the 1940s, and the impact of wind may have increased since 1950. Since the 1950s, the density of vegetation within the reach of browsing deer has increased at lower altitudes, but has probably decreased at high altitudes; forest canopies have been damaged by possums (Grant, 1956). By contrast, earthquakes and cultural clearance of vegetation have not influenced overall vegetation condition and trend.

Erosion has accelerated since the 19505 mainly because there have been more and larger, rainfalls and floods, and the atmosphere has warmed. Red deer were responsible for minor fluvial erosion of soil under vegetation in the late 1930s to early 1940s, but by the 1950s much of the affected areas at lower altitudes had become revegetated. All the important areas supplying coarse sediment (e.g. large gullies in exposed bedrock and in screes) looked essentially the same in 1919 as they do today (Figs 1 and 2) – not one large source of sediment has developed since deer entered the basin some time before 1917 and possums in about 1937 (Grant, 1984).

There have been small gains and losses since 1919: some minor eroded areas have revegetated, some older ones have enlarged, and an odd new one has developed as a result of heavy rainstorms (Figs 1 and

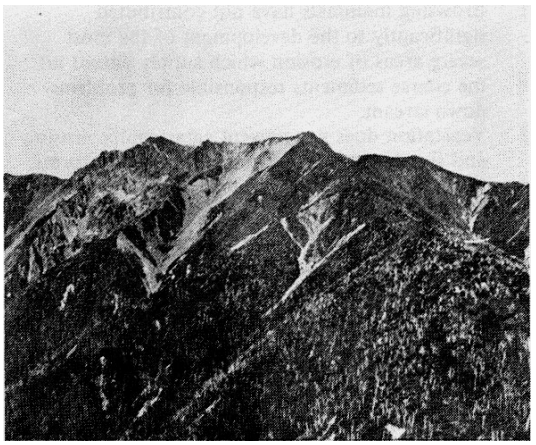

Figure 1: *Taken in 1919 looking towards Te Atuaoparapara, 1689 m, at the head of the upper Waipawa River, Ruahine Range; showing the abnormally high numbers of standing dead tree trunks and heads (in white or grey), resulting from a great drought which culminated in 1914-15. Note the numerous large areas of exposed bedrock and scree which today supply most of the coarse sediment to the upper Waipawa River. Photo: Mr B. Bibby.*

Figure 2: *Taken in 1982 of the same area as in Fig. 1. Note the absence of large numbers of dead trees and the bushy, healthy appearance of the beech forest canopy. The present timberline is c. 90 m lower than it was before the 1914-15 forest dieback in Fig. 1. Since 1919, some minor eroded areas have revegetated; some older ones have enlarged and an odd new one has developed in heavy rainstorms. The major eroded areas, which now yield most of the coarse sediment to the upper Waipawa River, have changed very iiI/Ie in area since 1919.*

2). But minor scars do not often develop into major ones which yield long-term sustained supplies of sediment. Usually after a relatively short period they heal with vegetation. Rather, the large and important sediment supply areas develop on sites determined by local geological and geomorphological characteristics.

I therefore concluded (Grant, 1983): "Of the total complex of change the direction of change of two major elements only, viz., temperature and precipitation (rainfall and snowfall) can explain, processwise and chronologically, the more obvious changes since c. 1950 of the overall erosion and sedimentation regime in the basin of the upper Waipawa River." And, ". . . there is no evidence that the earthquake factor, vegetation history, wild animals or Man have influenced overall environmental history and contributed importantly to the present period of increased erosion and sedimentation since c. 1950".

The historical evidence shows clearly that the earlier periods of accelerated erosion (five counting the present, since 1200AD: Grant, 1981) were more severe than the present one. Their associated sedimentation was greater, yet each terminated regardless of the presence of Polynesians, and was followed by a long tranquil interval when vegetation re-established and soils formed. Furthermore, each erosion period ended, not only regardless of the presence of humans, but also without their assistance. The current erosion period, observable everywhere in New Zealand, is relatively minor in impact, and will follow the same pattern. Therefore management measures such as wild animal control will not alter the present pattern of erosion and sedimentation in high-rainfall, hard-rock mountain lands.

Despite this conclusion, I still consider that animal control is worthwhile, because the various natural factors (mentioned above) of the contemporary erosion period are limiting vigorous, healthy and dense vegetation. Natural though they may be, they are still, in human judgement, undesirable. It is probably wise to take all practicable steps to minimise the impact of wild animals "for the benefit of the vegetation itself. But such a measure would have no beneficial influence on the downstream sedimentation problem" (Grant, 1983: 114).

Photographs of parts of the Ruahine Range (e.g. Figs 1 and 2) demonstrate that the 1914-15 drought affected high-altitude forests more abruptly and severely than the impact of browsing animals (Grant, 1984; 1985a). Yet there was no consequential increase in the extent of the largest areas of erosion, because these had already developed long before browsing

mammals entered the district. The drought was associated with a period of long-term atmospheric warming - not cooling, and one of its results was that the timberline was lowered by about 90 m. The revelation that such dramatic changes in vegetation could arise from climatic factors rather than fire and browsing mammals, explained why these traditional explanations were inadequate.

By 1985 I was able to extend the concept of recurring erosion periods back from prehistorical time into the pre-human past (Grant, 1977b; 1981). My review of late Holocene fluvial history showed that there have been at least seven other periods of accelerated erosion and sedimentation, similar *to* but greater than the current one, since 180AD (Grant, 1985b). These happened long before even Polynesians and their animals arrived in New Zealand. All the data point *to* the conclusion that accelerated erosion is not primarily due *to* forest degradation or the activites of browsing animals (Grant, 1983; 1984; 1985b). Indeed, between 1950 and 1984, the impact of rainstorms, floods, gales, warmer temperatures, etc. of the current erosion period on the vegetation generally increased, even though deer populations were reduced by intensified control measures (see Grant, 1985b: 109).

The Problem

A problem can be loosely defined as any situation in which human interests are threatened. The very early erosion periods in New Zealand were severe but caused no problem because no-one lived here (Grant, 1985b). Today's problem touches human interests only on the downstream riparian land and floodplains where people live and earn their livelihood, even though it originates in the high-rainfall mountains. The main difficulties are when river bed levels rise, and riparian lands erode and get flooded. Secondary effects include diminished water quality because *of* the greater concentrations and durations of fine suspended sediments which are undesirable where water is used for homes and farms. These problems will not be solved by expensive remedial works in the high rainfall headwater zone. Downstream problems must be tackled by engineering works in the downstream area itself.

Conclusions

My conclusions concerning the management of wild animals in the headwater zone *of* high-rainfall, hard-rock mountain lands are as follows:

1. Browsing mammals have not contributed significantly to the development of the most severe areas of erosion which supply almost all the coarse sediments responsible for problems down stream.
2. Vegetation does not prevent catastrophic erosion and flooding caused by unusually severe storms.
3. Vegetation does minimise normal soil erosion and therefore reduces the sustained yield of fine sediments which can impair water quality down stream.
4. Browsing mammals do reduce the density of vegetation.
5. The contemporary vegetation is also being affected adversely by uncontrollable climatic fluctuations.
6. New Zealand's indigenous vegetation is unique and is worth conserving in its own right.
7. Therefore (from 3, 4, 5 and 6), the impact of browsing mammals on the vegetation should be minimised.
8. The primary objectives in managing browsing mammals should be to: (a) protect the indigenous vegetation for itself and as habitats of native animals, and (b) enhance the beneficial effects of vegetation on the stability of surface soil and on water quality.

Finally, all conservation work planned, for high rainfall, hard-rock mountain lands, without seriously considering these conclusions, is a waste *of* time and resources.

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