

RECENT AGGRADATION WITHIN THE WAIKATO RIVER

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Abstract

Since approximately 130 A.D. the bed of the Waikato River, in its lower reaches, has been raised 20 to 30ft — most likely by an amount closer to the latter figure. This represents an average of about 1ft every 60 years. Of the causal factors discussed, it is concluded that man-caused erosion is the main contributory factor but, as sea level may have been 10ft lower during 130 A.D., a rise of this amount would no doubt be another major cause.

INTRODUCTION

River control is complicated by many factors such as determining the means of control and the possible after effects of such control. Causes and effects of silting are, or should be, included in surveys prior to control and although present day observations are invaluable, geological observations are equally necessary to give a complete picture of what has happened in the near-past and what might happen in the near-future.

All observers, engineers, and others, agree that the Waikato River is in the process of raising its bed but little is known about the rates and causes of this aggradation. By employing geological observations an effort is made here at placing the rates and causes into some sort of perspective. Others may perhaps draw different conclusions from the facts presented, one of the puzzling features being why the Waikato should be aggrading at faster rates than its tributaries.

The present sediments being transported by the Waikato River consist of medium to coarse pumiceous sands, containing mainly quartz and ferromagnesian crystals. Besides the usual large scale features of levees, ever-shifting channels and river islets, the bed of the river consists of moving, small-scale, dune-like ridges and hollows. Thus, although no cross section has been cut through these modern sediments, they are almost certainly current bedded.

Discounting minor irregularities the slope of the Waikato River bed must be close to the slope of the river itself. Holderness (1954) reports that "from Cambridge to Ngaruawahia, a distance of $26\frac{3}{4}$ miles, the river has a fall of $26\frac{3}{4}$ feet or a foot per mile. From Ngaruawahia to Mercer, $32\frac{1}{4}$ miles there is a fall of 22.09ft or $8\frac{1}{4}$ inches per mile. From Mercer to Port Waikato, a distance of $22\frac{3}{4}$ miles, the fall from low summer level at Mercer to L.W.S.T. at Port Waikato is about 11ft 6in. or 6 inches per mile, while at H.W.S.T. at Port Waikato this is reduced to about 1 inch per mile."

AMOUNT OF AGGRADATION

The amount of aggradation since about 130 A.D. can be reasonably established through the study of the Taupo Pumice Alluvium of that age. Healy (1964) suggested a mean age of A.D. 131 years for the age of Taupo Pumice eruptions. Although deposition of the Taupo Pumice Alluvium may have post-dated the eruptions slightly, it is not likely to have been significantly younger and thus an age of A.D. 130 is provisionally accepted. There are three lines of evidence that all lead to approximately 25ft for the amount of aggradation since 130 A.D.

(1) Tributaries to Waikato River

The Waikato River has aggraded at a much faster rate than its tributaries resulting in its bed being considerably higher. For example, levels on the bed of the Mangawara Stream, near Taupiri, show a gradual slope from 25ft a.s.l. where it joins the Waikato, to 5ft a.s.l. 30 chains upstream (Lands and Survey plan of 1929). Similarly, whereas the average depth of the Waikato is 10 to 15ft where it joins the Waipa River, the latter deepens upstream from 20-22ft at 15 chains to 30-35ft at 40 chains distant. Thus the amount of aggradation within the Waikato has been 20ft greater than that in both of these tributaries.

The actual amount of aggradation must have been greater than 20ft and has occurred at some time since 130 A.D. for the following reasons. The Taupo Pumice Alluvium of that age was very rapidly deposited within the Waikato River and in the mouths of its tributaries. With cessation of pumice eruptions the Waikato and its tributaries eroded themselves down to their original levels almost as quickly as the soft pumice sands were deposited. As remnants of the Taupo Pumice Alluvium Surface continue upstream from the above recorded depths in the Mangawara Stream and Waipa River the relative amounts of aggradation within the Waikato, just described, must be subsequent to erosion of the Taupo Pumice Alluvium.

(2) Base of the Taupo Pumice Alluvium

Exploratory drillholes, drilled into the bed of the Waikato River at Huntly by the Ministry of Works prior to the building of the new road bridge, show that the base of recent aggradational material extends down to 9ft below sea level and that the amount of aggradation has been 30 to 32ft. As these figures are based on two holes only it may not be a good average. However, drillholes at the Karapiro Dam site led Healy (1946) to a similar conclusion. "At Karapiro the Waikato appears to be flowing at a level which is 20 to 30ft higher than before the Recent [Taupo] pumice invasion. He considered, however, that "the river is still engaged in cutting down to its former level, but that the greywacke bar between the mouths of the Tunakawa and Hauoira streams [exposed because of a change in river position] is retarding the process." This view is not consistent with information downstream (see above) nor, as no drillholes penetrated the bed of the river at this point, is there definite evidence of a bar between the mouths of the Tunakawa and Hauoira streams. This site is now drowned by Lake Karapiro and even if a bar existed it could only affect the river upstream and create rapids at its site which appear to have been absent.

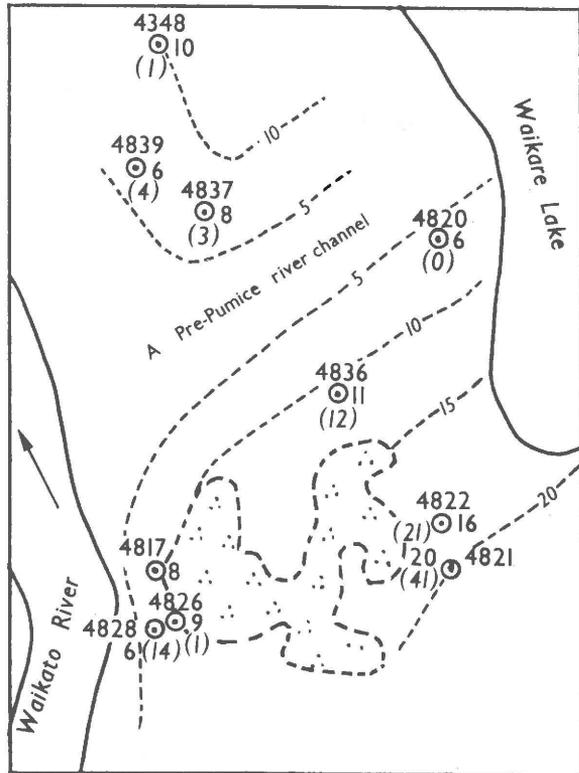
(3) 130 A.D. River Level

Sections (1) and (2) above show the differences in bed level between that of 130 A.D. and the present. Drillhole evidence between Ohinewai and Rangiriri is not sufficient to show bed level but an approximation as to

river level can be determined at the time of the Taupo Pumice eruptions. In this area the Waikato River is confined by pumice levees built by deposition of the Taupo Pumice Alluvium. These levees are bordered on both sides by swamp and lakes. Drillholes on the eastern side show that the 130 A.D. pumice usually rests on peat at levels between 5 to 9ft above m.s.l. This range is recorded in 11 out of 14 holes and could be due to peat compaction for there is some correlation of high and low levels with thin and thick peat respectively. (Note, for example, that where only 1ft to 1ft 6in. of peat underlies the pumice, the top of the peat is at the highest levels of 8 to 9ft above m.s.l.) Assuming a compaction factor of 33 per cent the reconstructed, pre-130 A.D. peat level falls towards the river (Figs. 1 and 2) in a smooth curve similar to a present day peat surface adjoining Waikiekie Stream (Fig. 3). Near the river, the peat is interbedded with sand and mud as would be expected if the present site were the main channel through the pre-130 A.D. swamp. The reconstructed swamp surface and site of the river prior to the pumice flood, suggests that the river level between Ohinewai and Rangiriri was about 0 to 5ft above m.s.l. As the present normal level is 19ft the river has risen 15 to 20ft.

Conclusions

Since 130 A.D. the bed of the Waikato River has risen 20 to 30ft at Huntly, Taupiri, Ngaruawahia and Karapiro, whereas the river level further downstream between Ohinewai and Rangiriri appears to have risen only 15 to 20ft. The apparent shallowing may be due to the limits of accuracy in the above deductions. On the other hand apparent shallowing could be real, due to a combination of several causes including (1) relative position in the river's profile of



0 40 Chains

LEGEND

- 4836 = No of drillhole
- ⊙11 Reconstructed pre-pumice peat level
- (12) Thickness of peat buried by pumice
- ⋯ Hill underlain by Tauranga Sediments and standing above Taupo Pumice Alluvium Surface
- 5-- Contours on reconstructed Pre-Pumice peat surface

Fig. 1: Peat surface between the Waikato River and Lake Waikare, north of Ohinewai, prior to inundation of the area by the Taupo Pumice Alluvium (see also Fig. 2).

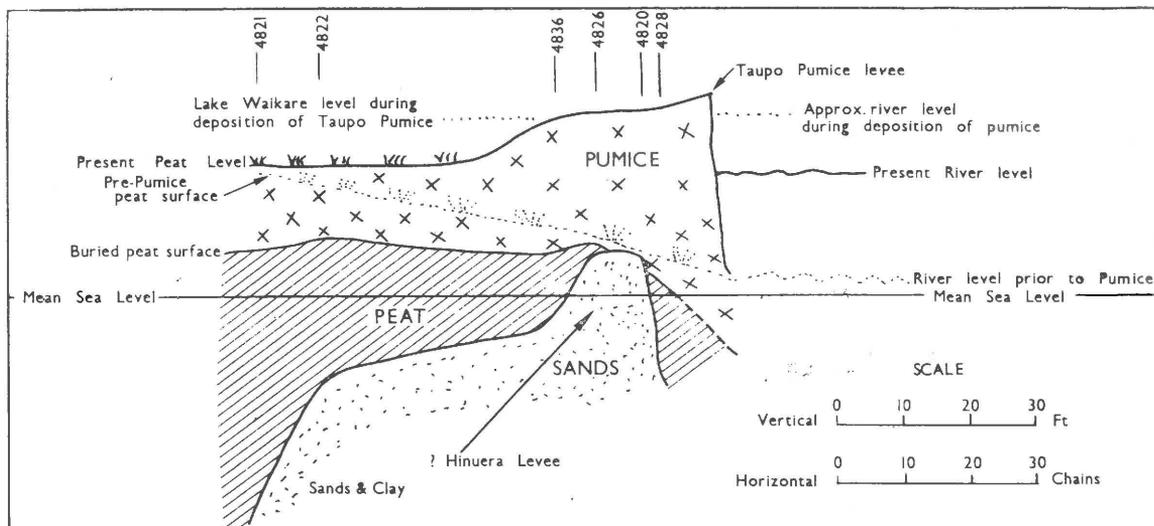


Fig. 2: Composite section through the Taupo Pumice Alluvium, underlying peat and probable Hinuera Formation, constructed from drillholes sited in Fig. 1. Compare the reconstructed slope of the peat surface with a present-day peat slope shown in Fig. 3.

equilibrium; (2) widening of the river through (a) lateral corrasion and (b) its higher level in a V-shaped valley; (3) increased velocity which would have accompanied aggradation, providing sea level has remained constant, and (4) possible decrease in rainfall.

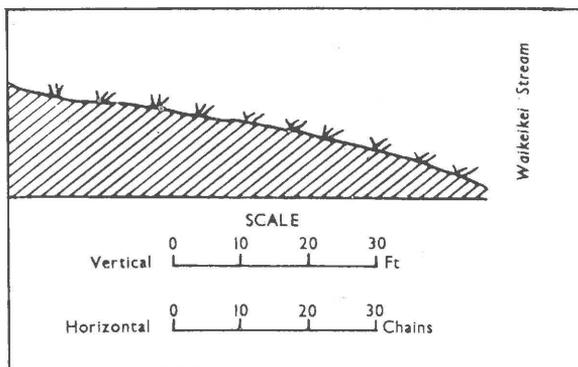


Fig. 3: Present-day peat slope on part of the Whangamarino Swamp near Waikiekie Stream drawn to the same scale as employed in Fig. 2.

RATE OF AGGRADATION

Grant (1954) showed that during 1928-31, silting of 4.6in. per annum occurred within the Waikato River in the Lower Waikato Basin. He was careful to point out that "since 1928 . . . there has been markedly little flooding in the Waikato River and one good flood may rapidly obliterate the result of 3 year's silting."

In the same report Grant concludes that "no greater silting than 1ft to 1ft 6in. has occurred in at least 30 years." Since 130 A.D. the maximum amount of aggradation appears to have been 30ft, a rate of 1ft every 60 years. Although this rate is twice as slow, it is of the same general order as found by Grant. The differences may be due to several factors: (A) measurements over a small interval of time may be misleading, and (B) the rate of erosion, and thus an increase in sedimentary supply, may have been speeded up in later years by other causes (see below).

CAUSES OF AGGRADATION

Several possible causes for 30ft of aggradation since 130 A.D. need to be considered.

Climatic Changes

Denudation of vegetation and a consequent increase in sedimentary supply due to period of severely cold climate can be neglected. There is no evidence for such a period. Similarly, a decrease in rainfall and thus reduction in water volume to load ratio, appears to have been unlikely for in either case it should have affected the Waipa as much as the Waikato and yet the latter is aggrading faster.

Installation of hydro-electric dams

Dams across the Waikato River have reduced the amount of flash flooding and hence less sediment may have been swept out to sea. On the other hand these dams would retain some of the river's load and hence reduce the sedimentary supply downstream. In any case dams have only been constructed within the last half century and can have had little effect on 30ft of aggradation.

Man-made erosion

Man has occupied New Zealand for at least 800 years (see N.Z. 14C No. 50, Fergusson & Rafter, 1957). Forest fires that he started in the Waikato Valley may have sufficiently denuded the land to increase the sedimentary supply (see for example Selby, 1966). Aggradation, at the rate of one foot every 30 years recorded by Grant (1954) would amount to 27ft in 800 years.

Rise of Sea Level

Mean sea level is constantly shifting either up or down. In the early part of this century it was rising at the rate of 4 inches every hundred years, a rate which has since been doubled in the last 30 years (Schofield, 1960). Since 130 A.D. there have been several cycles of sea level rise and fall (Schofield, 1960) the maximum level being about 2ft above the present. More evidence is required before it will be known how low sea level has been since 130 A.D. However, there appears to be some evidence for it having been 10ft below the present, 1,500 to 2,000 years ago (Fairbridge, 1961). The lower river level at Ohinewai immediately prior to the deposition of the Taupo Pumice Alluvium may well have been due to a lower sea level at that time.

Other Factors

Land subsidence, as distinct from a eustatic rise in sea level, may have occurred but cannot be proved at the moment. Volcanic ash showers since 130 A.D. have not been many or great but may have added some extra material over and above the normal load. This may explain why the Waikato River is aggrading at a faster rate than its tributaries. On the other hand the banks of the Waikato River are more often composed of unconsolidated, easily eroded material that could have been disturbed by the Maori communities living there.

A continued, seaward lengthening of the delta which lies inside the heads of the Waikato River must have contributed slightly but this would add only a few inches of aggradation for every mile the delta increased in length.

Conclusions

The most likely causes for aggradation since 130 A.D. are a combination of man-made erosion and rise in sea level.

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