PEACOCK D H LIMITED
GST Reg No 97918708 email: dave2mar@gmail.com Phone 021 02465899

WAIORONGOMAI RIVER BED LEVEL TRENDS; 1979 to 2014

Introduction:

This is the second in a series of reports on river bed level trends in the Waiapu catchment, Ruatoria, commissioned by the Environmental section of the Gisborne District Council.

The following trends in mean bed levels have been derived from cross section surveys by the former East Cape Catchment Board and the Gisborne District Council, commencing in 1979. Trends have been assessed starting at the most upstream cross section approximately 3.8 km upstream of the confluence with the Tapuaeroa River.

The Waiorongomai River catchment:

The Waiorongomai River is a major tributary of the Tapuaeroa River, and has a catchment area of 36.84 square kilometres. It has its headwaters in the Raukumara ranges on the opposite side of the ridge where the Raparapariiki river has its headwaters. While the Raparapariiki flows generally from north to south, the Waiorongomai flows more in an east-south-easterly direction, turning south about five to six kilometres upstream of the confluence with the Tapuaeroa River; see Fig. 1. The main channel length is approximately 14km.

Fig 1. Waiorongomai River Catchment

Executive Summary:

The three most upstream cross sections in the Waiorongomai River, (2.2 to 3.8 km from the confluence with the Tapuaeroa River), show an almost linear increase in mean bed levels between 1979 and 2014, averaging a rapid 89 to 114 mm/yr, with lesser rates downstream of this. Over the first 300 metres of the river bed from the confluence, the aggradation rate has been a gradual 21 to 31 mm/yr, over the same period.

Volumetric plots show a lessening of the rate of bed load deposition at the most upstream surveyed reach over the past ten years, and virtually no change in mean bed level over the first 500 metres of the river bed from the confluence with the Tapuaeroa River.

It may have been expected that the debris from Barton's gully would have made a major impact on the volume of bed load in the lower Waiorongomai but this is not the case as eroded material from Barton's gully consists of a relatively soft mudstone lithology, which produces a much higher proportion of suspended sediment compared to material from gullies in the eroded headwaters region.

A comparison with the Raparapaririki River shows that since 1987 the deposition of bed load over the first three kilometres in the Waiorogomai upstream of the Tapuaeroa, has been an order of magnitude less than in the Raparapaririki. While the volume of bedload *transported* is not necessarily proportional to volumes deposited, this does suggest that the Waiorongomai has made a relatively minor contribution to the aggradation of the Tapuaeroa River compared to the contribution from the Raparapaririki.

There has been little if any shingle extraction from the Waiorongomai, and because of the input of poor quality material from Barton's gully there is no prospect in the future of the bed material being used for anything other than local farm tracks.

Although the bedload material from the Waiorongomai is unlikely to be used as a resource in the future it is still an important tributary of the Tapuaeroa River to monitor, hence it is recommended that the cross section surveys continue, at least until other techniques, ie; DEM's are assessed.

Mean Bed Level Plots:

Mean bed level plots have been prepared for each of the seven cross sections surveyed. These show fairly rapid aggradation rates at the three most upstream cross sections (at 3843, 2870 and 2192m); with average aggradation rates of 89, 95 and 114 mm/yr respectively over the 35 year period (1979 to 2014). Fig. 2 shows the mean bed level changes at the most upstream section at 3843m. This cross section is a short distance upstream of the confluence with the stream from (the infamous) Barton's gully.

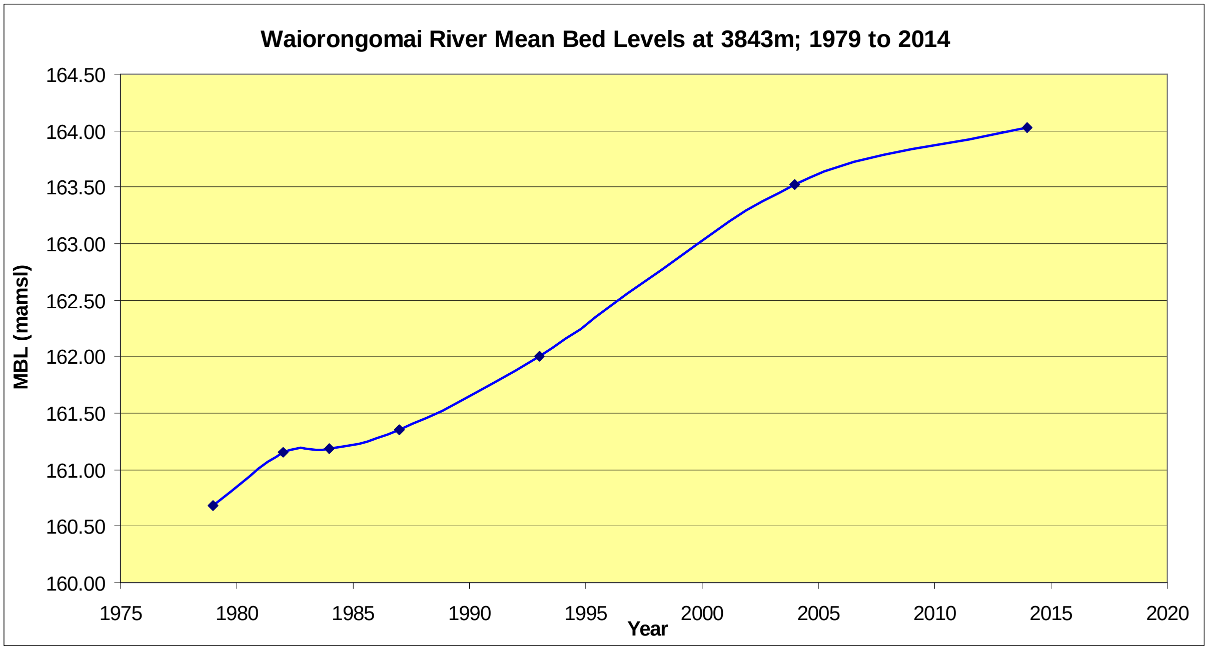

Fig. 2

Figure 3 shows the increase in mean bed levels at 2192m, which has the fastest aggradation rate of the three most upstream cross sections.

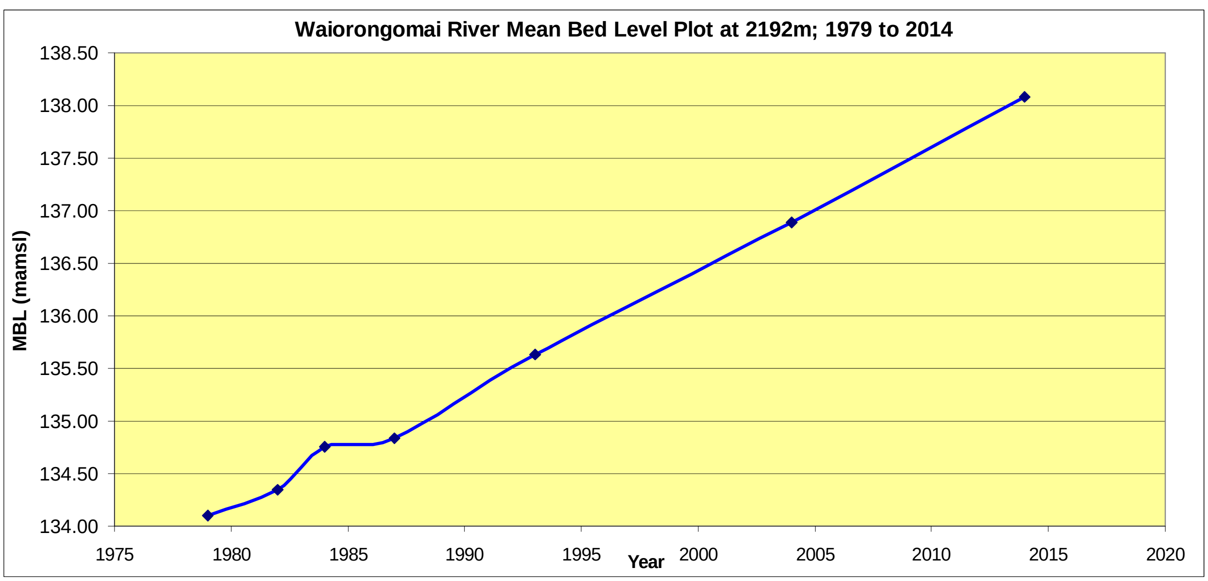

Fig. 3

The aggradation rate shown in Fig. 3 is very linear, except for a small upward "blip" in the rate of aggradation between 1982 and 1984. This same blip is also shown at 3843m (Fig. 2), but occurs earlier, between 1979 and 1982. This may be the result of increased gully erosion and input of bed load material into the river following the major storms in 1980 and 1982 (Cyclone Bernie).

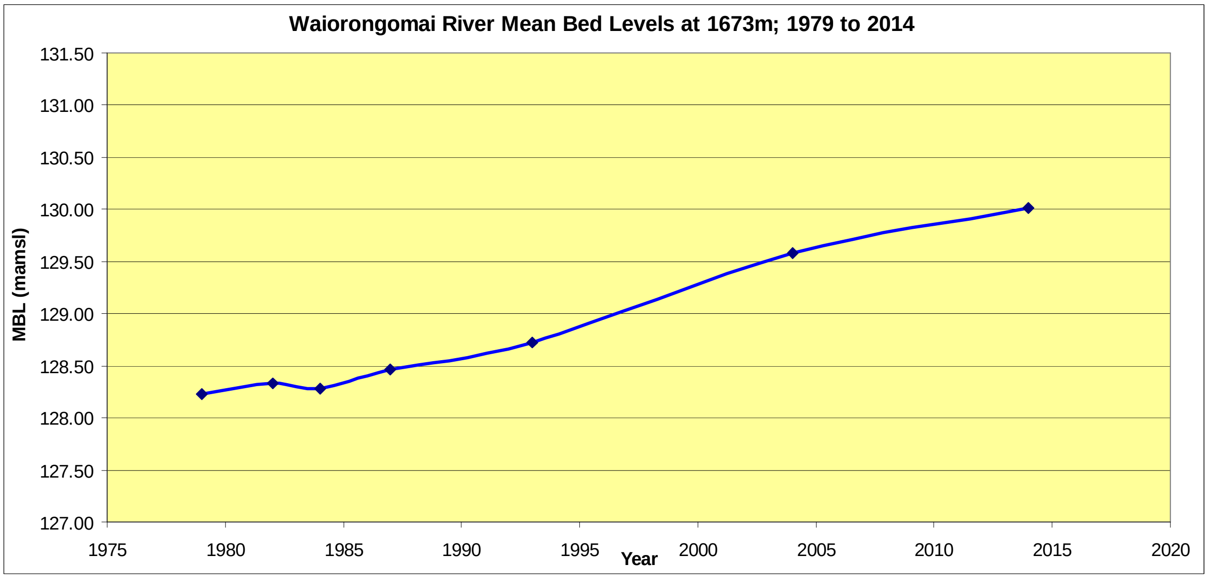

Fig. 4

Some 500 metres further downstream, at 1673m, the aggradation rate has reduced to an average 51mm/yr (Fig. 4); and at 763m the aggradation rate is 50 mm/yr. The aggradation rate also appears to be reducing over the last two surveys; viz; between 2004 and 2014.

Note that the “blip” in the aggradation rate apparent at the three most upstream cross sections is hardly discernable further downstream at 1673m.

At the two most downstream cross sections, at 278m and 108m, the average aggradation rate has dropped to 31 mm and 21 mm/yr respectively. At 108m the mean bed level has risen only about 100mm over the ten years 2004 to 2014, or 10 mm/yr average. In the Tapuaeroa River just upstream of the Waiorongomai confluence, mean bed levels over the same ten year period have increased by about the same amount viz; 100 mm. This may indicate that (the much larger) Tapuaeroa River could be having a major influence on mean bed levels in the Waiorongomai, in much the same way as the “backwater effect’ has on river flood levels.

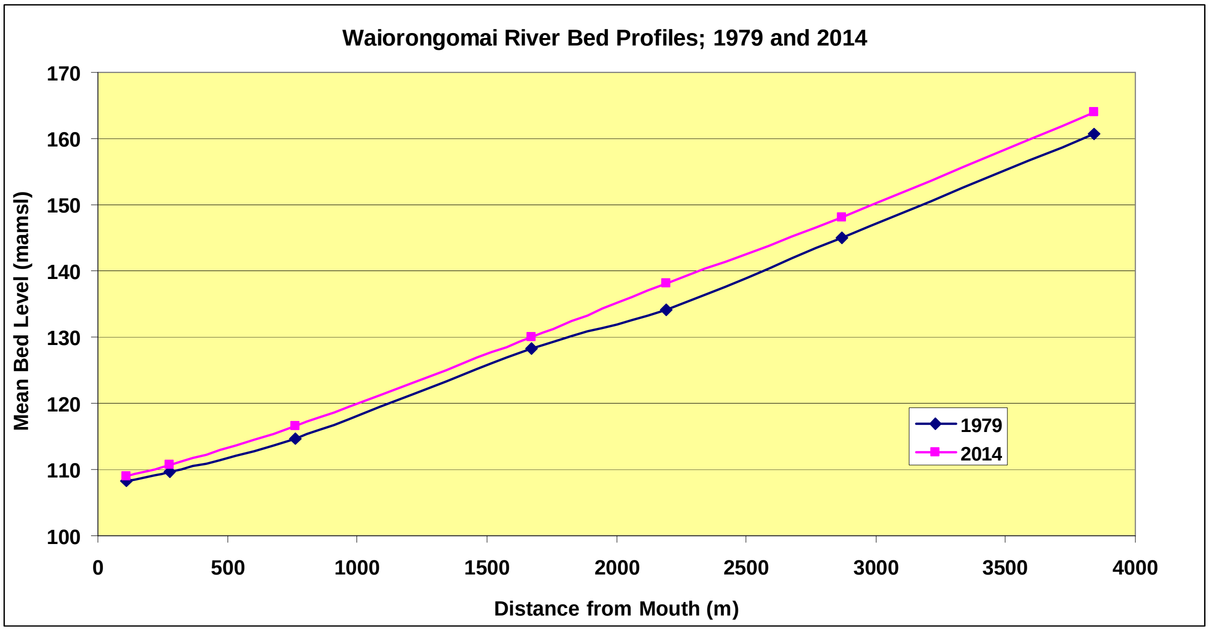

Fig. 5

Figure 5 shows the mean bed level profiles for the years 1979 and 2014. The 2014 bed gradient for the first reach is 10.59 m/km, and steepens to a maximum 16.37 m/km in the most upstream reach. Upstream of the cross section at 1673m the 1979 profile is low compared to the 2014 profile, but this has been filled in by the deposited bed load from subsequent floods, as can be seen by the 2014 profile.

This steepening of the river bed is not expected to have any significant effect on the river hydraulics, and is expected to reduce in time provided there is no major input of bedload material from upstream. The rate of aggradation at the most upstream reach (2870m to 3843m) has slowed over the past 10 years; see figure 7.

Comparison with the Raparapaririki River mean bed levels:

The Raparapaririki and Waiorongomai rivers have their headwaters on either side of the same ridge and are of similar size (35.13 and 36.84 km2 respectively), yet there appears to be a wide disparity in the amount of bed load being deposited in the two rivers. It has been suggested by the author that a comparison should be made so that an explanation can be posited for this apparent disparity. This may help with understanding how the major bed load inputs from the two tributaries impact on bed levels in the Tapuaeroa River.

Volumes of bed load deposited in rivers and streams may be compared from “normalised” graphs in terms of the same units, these being in cubic metres of deposited material per lineal metre length of river per year; (m3/m/yr). These graphs show a comparison of the first three kilometres of the Raparapaririki and Waiorongomai rivers over three time periods, these being 1987 to 1994, 1994 to 2003 (or 2004), and 2003 (or 2004) to 2013 (or 2014). The first period starts the year before the Cyclone Bola storm in March 1988, so it should show the immediate response from the Bola flood on bed load deposition in the surveyed sections of the two rivers.

In the Raparapaririki graph (Fig. 6), massive volumes of bed load material have been deposited during the first period, 1987 to 1994, viz; some 350 m3/m/yr has been deposited in the most upstream reach, (between the cross sections at 2915m and 3379m). However subsequent periods show that the volume deposited upstream of about 2 kms has slowed substantially to about 80 m3/m/yr during the second period (1994 to 2003); and during the last period (2003 to 2013) upstream of 2747m there has been net *degradation*.

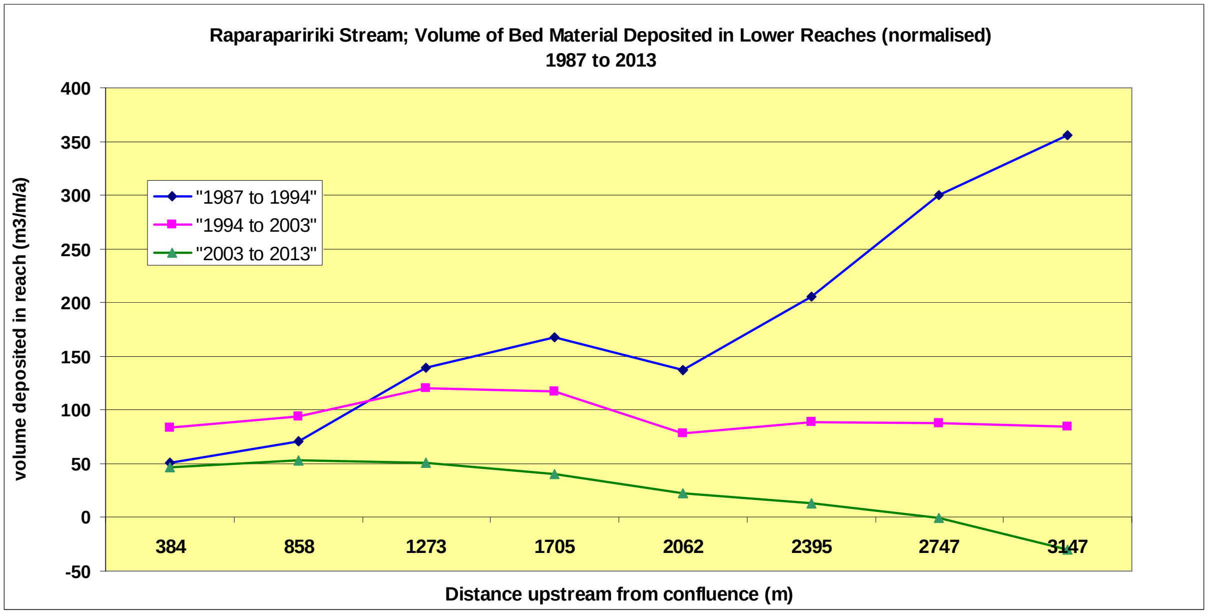

Fig. 6

In the Waiorongomai River volumetric graph, Fig. 7, the volumes of bed load have not exceeded 25 m3/m/yr; which is (more than) one order of magnitude less than in the Raparapaririki, although the two catchments are of similar size. In the most upstream reach the plot shows a sudden drop in the volume of bed load material deposited over the last 10 year period, from about 25 m3/m/yr in 1994 to 2004, to only 15m3/m/yr in 2004 to 2014. This would appear to indicate that, all other factors being equal, the current aggradation at the most upstream cross section (see Fig. 2), may soon turn to become a net degradation, and volumes of deposited bedload will decrease substantially further downstream over the next 10 year period.

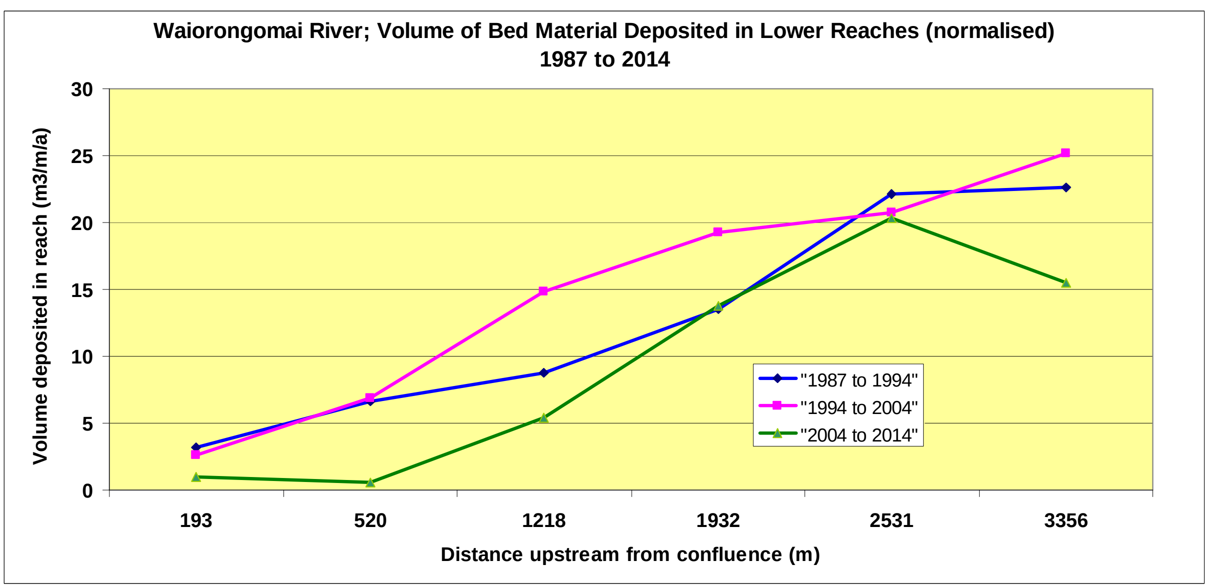

Fig. 7

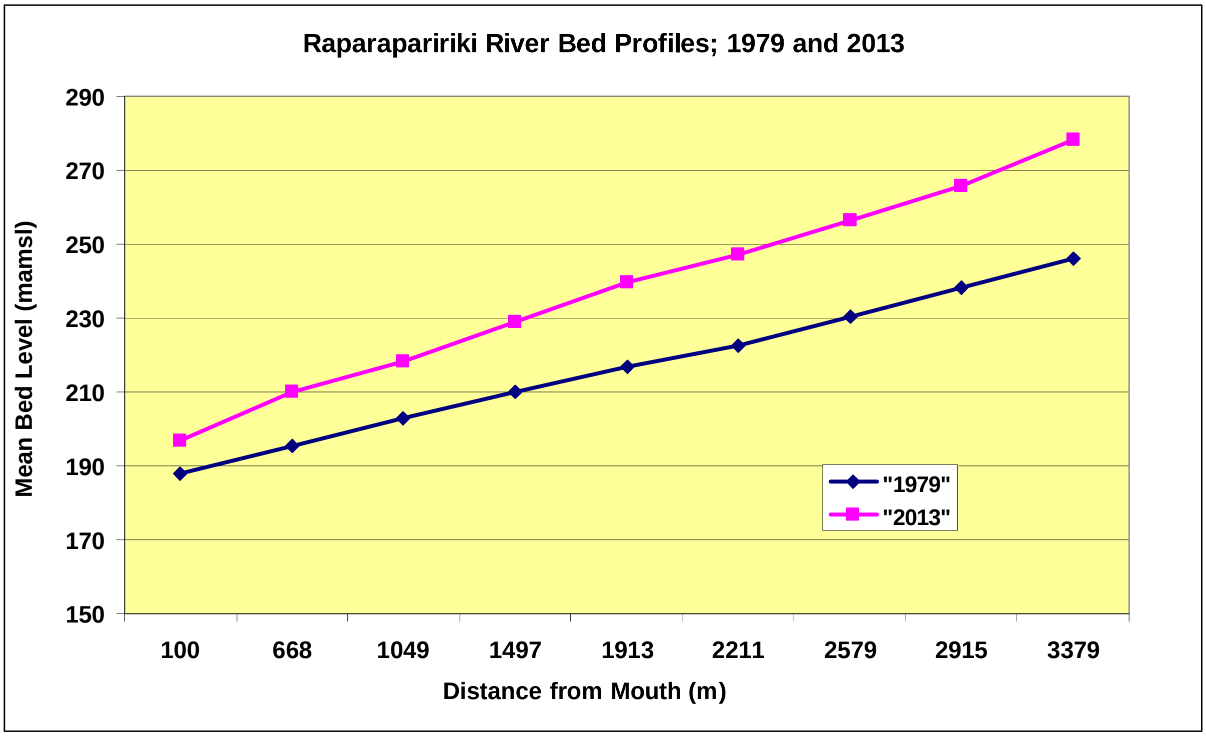

Fig. 8

Figure 8 shows the increase in mean bed levels over the first 3.3 kms of the Raparapaririki River between 1979 and 2013. The difference in mean bed level increases from 8.8m at the 100m cross section to a massive 31.9m at 3379m. The average gradient in 2013 was 24.8m/km and maximum gradient 27.6m/km; much steeper than it was in 1979.

Compare this with the Waiorongomai River bed profiles in Figure 5. The 2014 average gradient was 14.7 m/km and maximum 16.4 m/km. Over the first 3 kilometres of the two rivers, the Raparapaririki is almost twice as steep as the Waiorongomai. The average gradient in the Raparapaririki in 1979, prior to the two floods in the early 1980's and (particularly) the Cyclone Bola flood in 1988; was 17.8 m/km, which is not much steeper than the Waiorongomai was in 2014. Hence not only has the volume of bed load deposited in the Raparapaririki since 1979 been an order of magnitude greater than that deposited in the Waiorongomai, it has also substantially steepened the first 3 kilometres (at least) of the Raparapaririki river bed.

The influence of Barton's gully:

A study of aerial photography by Dr M Marden (*Landcare Research*) has shown a much greater extent and size of gullies on the Raparapaririki side of the ridge since the Cyclone Bola storm in 1988 than on the Waiorongomai side of the ridge. This may have been because on the Raparapaririki side of the ridge the material had already been disaggregated by an earlier storm and was suddenly reamed out during Cyclone Bola (*pers com; M Marden*). Hence the upstream end of the Raparapaririki has had a much greater input of potential bed load material from the Cyclone Bola storm than the upstream end of the Waiorongomai. (Note that the upstream ends of both rivers are about 10 kilometres upstream of the most upstream cross sections). Although a tributary stream from (the infamous) Barton's gully; Fig 9, joins the Waiorongomai about 3 kms from the confluence with the Tapuaeroa, it does not appear to have added major volumes of bed load material into the Waiorongomai compared to the volumes of material being deposited in the Raparapaririki. This is no doubt because the mudstone lithology of Barton's gully produces a much greater proportion of suspended sediment load than does the harder material derived from the headwater gullies; (*pers com; M Marden*).

Fig. 9: *Barton's gully (top right); the Waiorongomai river centre, and Tapuaeroa River at bottom left. (Google Earth photo; dated October 2014.*

Note the lighter grey colour of the bed load material originating from Barton's gully compared to the material in the Waiorongomai river channel upstream of Barton's gully.

Fig. 10: *Gravel and silt spewing out from Barton's gully into the Waiorongomai River (foreground). The red roofed whare shown in Fig.11 can be seen behind the dead trees, left foreground. Photo: Courtesy of Dr. M Marden; photo date: 2009.*

Fig. 11: *The whare, partially buried by gravel and silt from Barton's gully.*
Photo: Courtesy of Dr. M Marden; photo date: 2009.

Discussion and conclusions:

The mean bed level plots in this report only cover the first 3.8 kilometres of the Waiorongomai River channel, which has a length of some 14 kilometres. Volumes of bed load material deposited since cyclone Bola (measured in m3/m/yr) are likely to be much higher further upstream, and this would also apply to the Raparapaririki River. The survey data does however provide a useful insight into the rates of aggradation and degradation in the lower reaches of the two rivers; which in turn provides insights into how the Tapuaeroa River is responding, and will respond in future, to the massive input of bed load material from storms since 1979.

To the author's knowledge there has not been any shingle extraction, at least in commercial quantities, from the Waiorongomai. This is no doubt because of the input of poor quality bed load material into the river from Barton's gully, and the absence of any road up the valley. It is possible however that shingle excavated from this river could be used for local farm tracks, but unlikely when better quality material can be excavated from the nearby Tapuaeroa River bed.

While bed load deposits in the Waiorongomai are only a fraction of those deposited in the Raparapaririki, this may not necessarily be the case following future major storm events. For this and other reasons it would be advisable to continue the surveys.

Recommendations:

It is recommended that cross section surveys are carried out in the future at the same sites, at an interval of about five years**.**

NB: This recommendation should be subject to further review when survey methods using the latest available technology; ie drone surveys and DEM's, have been appraised for use on all of the Waiapu catchment rivers.

Appendix 1:

This appendix, which is available on request from the environmental section of the GDC, comprises all mean bed level, volumetric and profile plots prepared for this report in electronic form.

Acknowledgements:

- Ian Hughes and Brian Currie; for providing a continuous high quality survey record for the past 35 years;
- Dr Mike Marden (Landcare Research), for his valuable insights into the lithology and geology of the Waiorongomai catchment.

Prepared by:
D H Peacock;
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