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TAPUAEROA RIVER MEAN BED LEVEL TRENDS; 1958 TO 2016.

Introduction:

This is one of a series of reports on river bed level trends in the Waiapu catchment, Ruatoria, commissioned by the Environmental section and the (former) Roading 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 1958. Trends have been assessed starting at the most upstream cross section, a short distance upstream of the confluence with the Raparapaririki River.

The Tapuaeroa River catchment:

Figure 1 shows the extent of the 330 square kilometre Tapuaeroa catchment. The Tapuaeroa and the Mata rivers join to form the Waiapu River, at the far right of the figure.

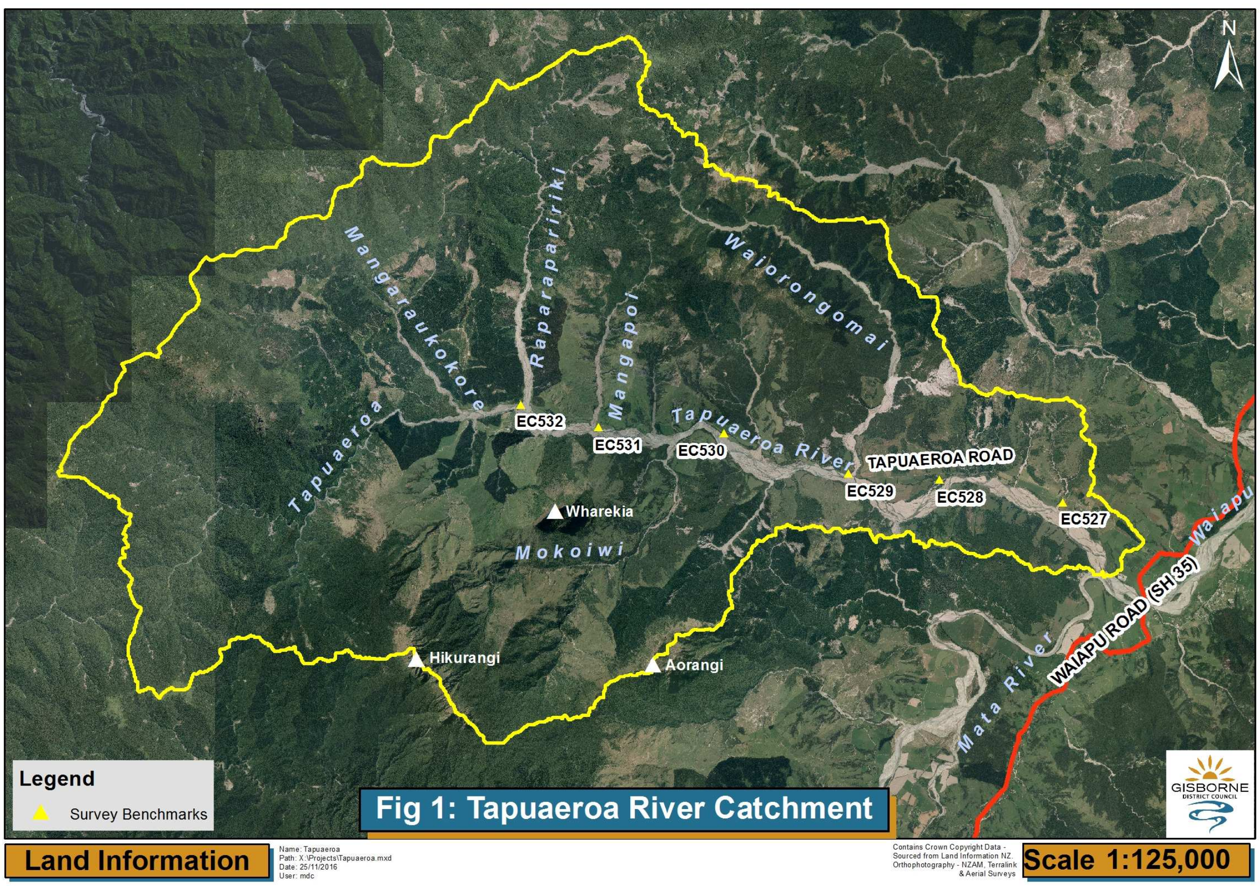

Fig 1: Tapuaeroa River Catchment

Major tributaries which are considered by the author to provide the bulk of the bed load to the Tapuaeroa are the Mangaraukokore, the Raparapaririki and the Waiorongomai. These three rivers are all on the true left bank of the Tapuaeroa. The only tributary of any size on the right bank is the Mokoiwi stream, but since it arises from a harder rock lithology it is not considered to contribute a significant volume of bed load material to the Tapuaeroa.

Executive Summary:

There are six cross sections on the Tapuaeroa River between the Mata River confluence at the downstream end and the Raparapaririki stream some 19.5 km upstream; see Figure 1. For the (post-Bola) period 1986 to 2007, mean bed level plots show a decreasing rate of mean bed level rise from a very rapid rate of 287 mm/yr at the most upstream cross section (EC 532), to a gradual 49 mm/yr at EC 529). Since 2007 the cross section at EC 532 has degraded by some 730 mm, which is considered to be due, at least in part, to shingle extraction operations in the vicinity of the cross section. The next three cross section plots show little change in mean bed level, except at EC 530 where there is an (unexpected) increase in mean bed level between 2013 and 2016.

MBL plots for the two most downstream cross sections (at EC 527 & EC 528), do not appear to follow the above trend, although it is unknown at one of them, EC 528, the last survey being in 1993. At the most downstream cross section, EC 527, mean bed levels have been fairly steady between 1958 and 1998, followed by a sudden increase averaging 79 mm/yr until 2007, then steady again. It is suggested that the sudden increase in mean bed level from 1998 may be a delayed response to the input of material from the Bola flood in 1988.

Because of the wide spacing between cross sections, extracting volumetric data from the cross section surveys is not considered to be a reliable method, however highly accurate DEMs have been produced from drone data by Dr Tunnicliffe et al; of the University of Auckland. These DEMs have produced very accurate volumetric data “differenced” between 2015 and 2016 for this reach of the Tapuaeroa River, and could potentially be used to assess the volumetric changes in bed load material going back to the first survey in 1958. It is most likely that DEM’s based on drone survey data will revolutionise the monitoring of wide braided river beds in the future, and the Gisborne District Council should take full advantage of the work in this respect being undertaken by the University of Auckland.

Because of the number of tributaries, the complex hydraulics of bed load transport in a braided river channel, and the many gaps in the data, to make a logical explanations for river bed aggradation or degradation is well beyond the scope of this report. Even with bed load transport modelling, this would be a daunting task indeed.

Mean bed level plots:

Bench mark EC 532; 19,500m

The cross section at EC 532, which is 19.5 kms from the confluence with the Waiapu and Mata rivers, used to be the most upstream cross section on the Tapuaeroa; but has since been superceded by the cross section at EC 532A.

Figure 2 shows little variation in mean bed levels between 1968 to 1986, until a sudden increase of 6.02m between the 1986 and 2007 surveys (in the post-Bola period). This represents an average annual river bed aggradation over this 21 year period of a very rapid 287 mm/yr. The river bed has then degraded by 730 mm in the nine years to 2016.

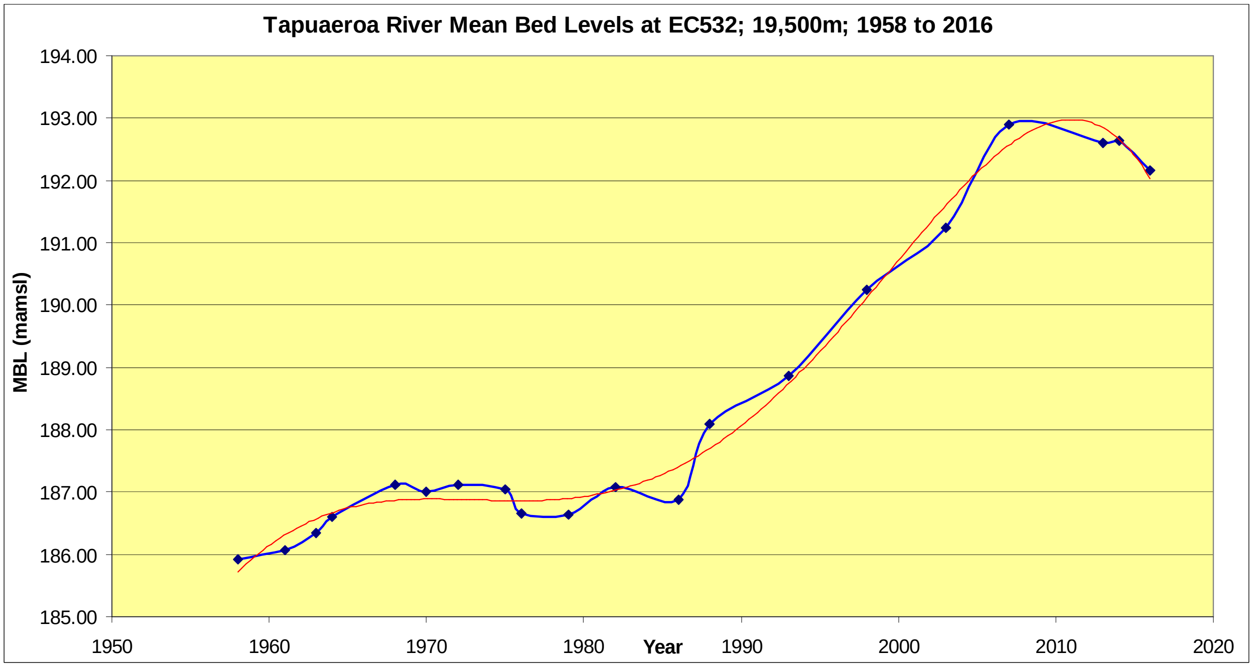

Fig. 2

Bedload inputs to the upper Tapuaeroa River which would have an impact on mean bed levels at EC532 are from the Mangaraukokore River and Raparapaririki Stream. The Mangaraukokore River has been surveyed but unfortunately the last cross section survey was in 1993. Shingle extractions since 2007 in the Mangaraukokore, and particularly from the Tapuaeroa in 2008, are suspected to have caused, or exacerbated, the apparent decline in mean bed levels at this cross section since 2007, (see the chapter on shingle extractions).

The Raparapaririki has obviously been a major bed load contributor to the Tapuaeroa since cyclone Bola and from earlier storms, viz; 1980 and 1982. A shingle fan from the Raparapaririki has forced the Tapuaeroa river towards the right of the photo (Figure 3), and bed load material from the Tapuaeroa and the Raparapaririki has spread over a former terrace just downstream of the Pakihiroa station bridge, burying the old Pakihiroa Station woolshed.

Fig. 3: *Confluence of the Raparapaririki Stream (upper left) and the Tapuaeroa River.*
Photo: G Swain; P F Olsen Ltd; 30th May 2011.

Data from the most recent Raparapaririki survey (2015), shows that bed levels near the confluence with the Tapuaeroa River are still rising, albeit at lesser rate than before, and the shingle fan is perched above the Tapuaeroa river bed. The Raparapaririki River bed some 2 km upstream of the confluence is now degrading, but it is expected that this degrade may take a number of years, if not a decade or more before it reaches the confluence.

Bench mark EC 532A; 19,665m

In recent years it was noticed that the fan of bed load material from the Raparapaririki River had intruded across the line of the cross section at EC 532, so in 2007 a new cross section (EC 532A), was established a further 165m upstream. Mean bed levels from later surveys at EC532 may have been influenced by shingle fan material from the Raparapaririki, but now there is sufficient overlap in the data record from both EC 532 and EC 532A surveys at EC 532 can be discontinued.
The cross section surveys at EC 532A show degradation (of 330mm) only over the past three years.

Bench mark EC 531; 16,760m
The overall trend line for the mean bed level plot is almost linear, but as for the bed levels at EC 532, steepens after 1986. The average bed aggradation rate over the 27 year period 1986 to 2013, is a rapid 127 mm/yr. Unlike the sharp drop at EC 532, over the last three years mean bed levels at EC 531 have been steady, see figure 4.

The Mangapoi stream discharges into the Tapuaeroa River a short distance upstream of bench mark EC 531. While the Mangapoi stream has a relatively small catchment it has been aggrading at the rapid rate of 210 mm/yr at the Tapuaeroa Road bridge between 1984 and 2004, but slower since then, resulting in a perched fan of shingle above the Tapuaeroa river bed.

The Tapuaeroa River just upstream of the Raparapaririki confluence, has been degrading since 2007 (see Fig. 2), but with the input of bed load from the Raparapaririki and to a lesser extent from the Mangapoi, it is perhaps not surprising that some 2.7 km downstream at EC 531 (see Fig. 4), mean bed levels have been steady over the past three years.

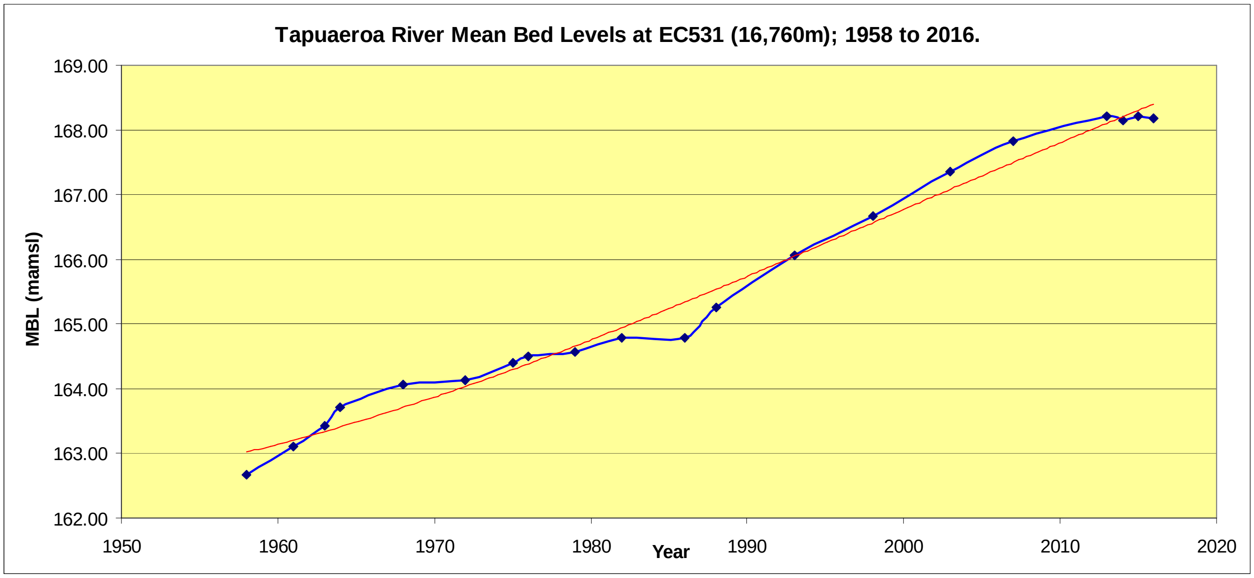

Fig. 4

Bench mark EC 530; 13,290m

Figure 5 shows there is a fairly linear increase in the post-Bola (1986 to 2007) river bed aggradation, averaging 89 mm/yr. From 2007 to 2013 there is virtually no change, then (contrary to the trend upstream), there is an increased rate of aggradation of 110 mm/yr over the three year period to 2016.

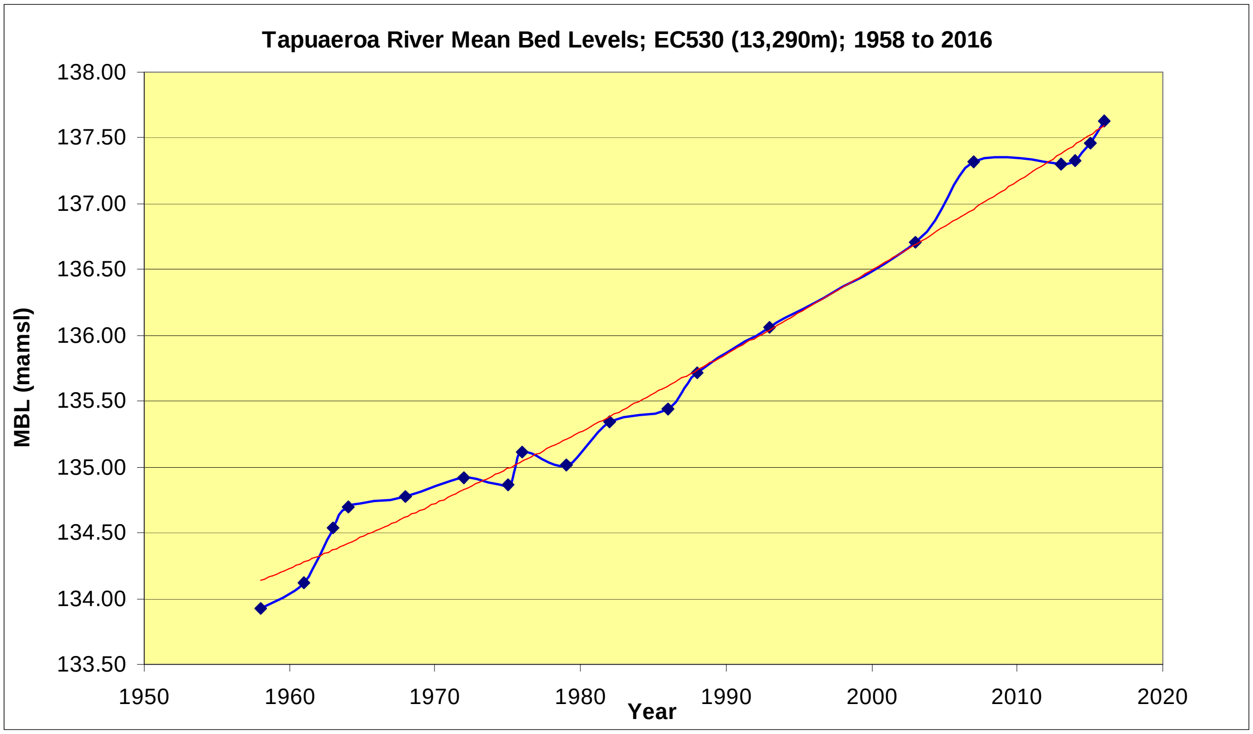

Fig. 5

It is difficult to suggest any one reason for this sudden increased rate of aggradation. The only other streams entering the Tapuaeroa downstream of EC 531 are the Mangawhairiki and the Mokoiwi, both considered to be only minor contributors of bed load. It could be a delayed reaction to bed load input from the Mangapoi or even the Raparapaririki stream, or it could be unrelated to that as well.

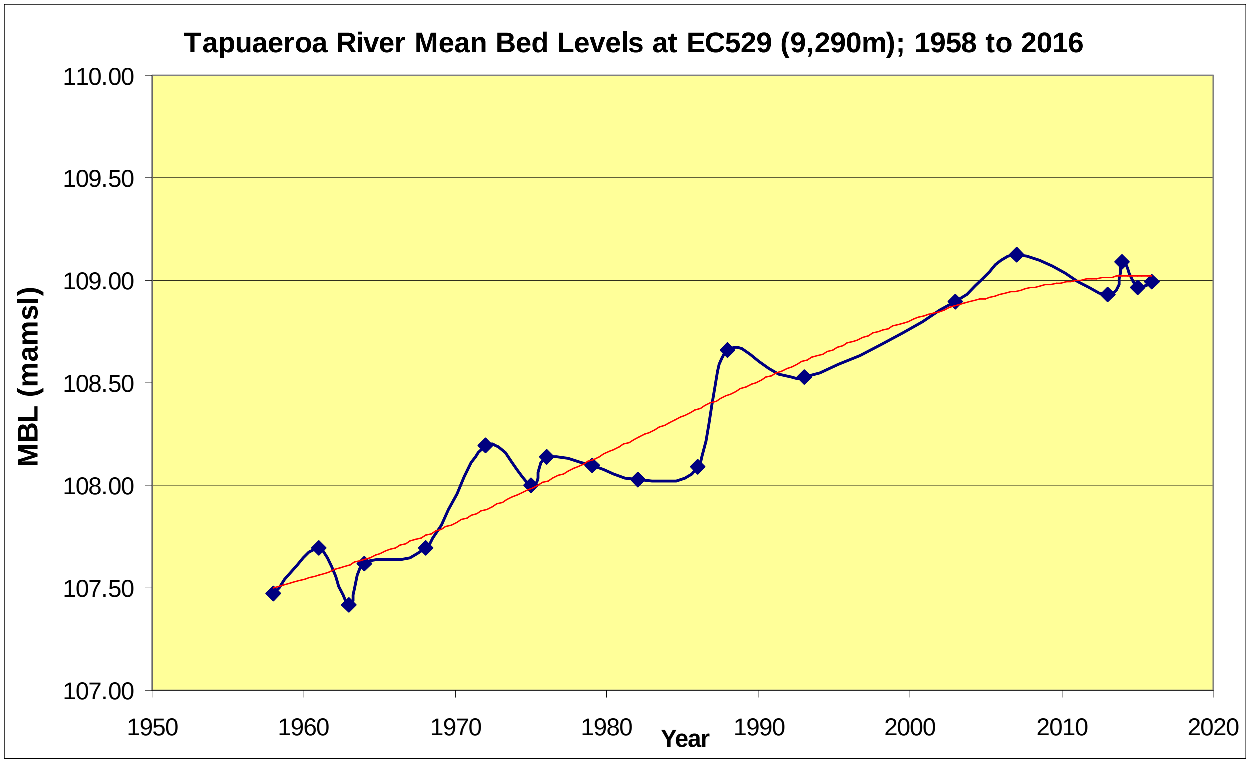

Fig. 6

Bench mark EC 529; 9,290m

Cross section EC 529 is a short distance upstream of the confluence with the Waiorongomai. Figure 6 shows that mean bed levels vary substantially from survey to survey, however the river bed has been aggrading at an average rate of 35 mm/yr since 1964 but that aggradation rate has levelled off since 2007. There does appear to be a sudden upward “blip’ in the aggradation rate between 1986 and 1998 which could be related to the input of bed load material from the cyclone Bola flood.

The Waiorongomai is not considered to be a major source of bed load material compared to the Raparapaririki, and at a cross section 108m from the Tapuaeroa confluence, the mean bed level has risen only about 100 mm over the ten years 2004 to 2014. 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. It is more likely that the Tapuaeroa influences river bed levels in the lower Waiorongomai rather than the other way around.

There are two other smaller tributaries which appear to be discharging bed load material into the Tapuaeroa River upstream of EC 529; one being the Mangahoanga, on the left bank approximately 2.9 kms upstream of the Waiorongomai, and the other an unnamed tributary on the right bank some 2.5 kms upstream of the Waiorongomai. Both are much smaller streams however and are only likely to have had a localised impact on the Tapuaeroa in terms of its overall bed load budget.

Bench mark EC 528; 5830m

Unfortunately the bench mark at this cross section was destroyed and the last survey was in 1993. As for the upstream cross section at EC 529, the river bed at this site has been aggrading since 1964 (until 1993) at a similar average rate (45 mm/yr).

Bench mark EC 527; 2270m

Over the 30 year period, 1958 to 1988, the river bed levels at this cross section have been quite steady, varying by +/- 100 mm from the trendline, then dropping by about 300 mm from 1988 to 1998, see Fig. 7.
River bed levels then increased by 700 mm between 1998 and 2007, and remained at about that level until 2016. If this sudden increase in mean bed level is related to additional bed load from the Bola flood in 1988, then the response has been delayed by some 10 years, since further upstream (at 9290m, see Fig. 6), the river bed had an upward surge after 1986, which may be the signature of the Bola event.

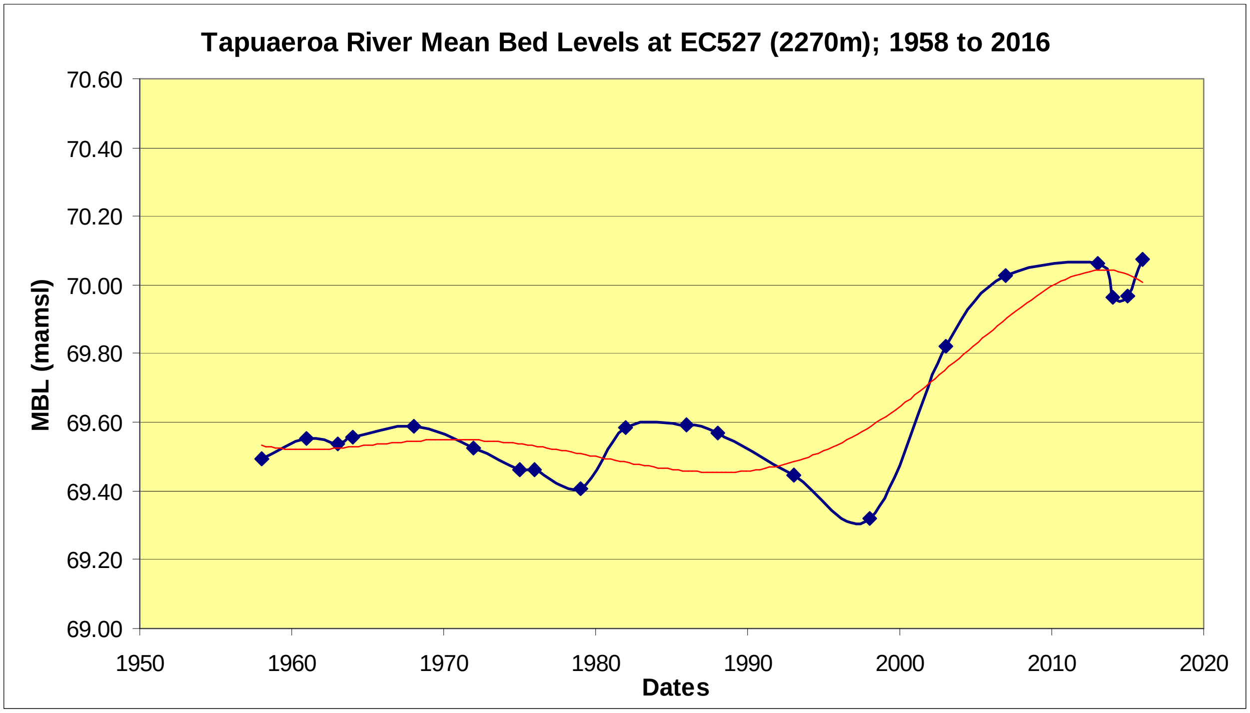

Fig. 7

Shingle Extraction:

Shingle extraction records from the GDC show that between 2005 and 2010 there has been a total of some 22,400 m3 of shingle excavated from the Tapuaeroa River and tributaries. This is made up from extractions of 7800 m3 from the Mangaraukokore (2005, 2007 & 2010); 8,600 m3 from the Raparapaririki, (2006); and 6000 m3 from the Tapuaeroa (2008). Since 2010 there have been no recorded shingle extractions from any of these three rivers.

The average quantity of shingle excavated over this six year period has been 3,730 m3 per annum. By comparison, for the first 3.3 kms of the Raparapaririki river alone, some 104,000 m3 per annum has been deposited over the same period. In the opinion of the author, shingle extractions at the rate carried out between 2005 and 2010 would have negligible impact on overall bedload volumes deposited or eroded in the Tapuaeroa River, however may have had a localised effect on mean bed levels. This could be the case at EC 532. The excavation of some 6000 m3 in 2008 from the immediate vicinity of EC 532, as well as excavations from the Mangaraukokore, could have been the cause of, or exacerbated, the recorded decline in mean bed levels at EC 532 since 2007.

Discussion:

Without the benefit of mean bed level data from the upper Tapuaeroa and Mangaurokokore rivers it is impossible to assess what proportion of bed load material is coming from each of those sources.

However, the Raparapaririki is likely to be the major contributor of bed load material as evidenced by the shingle fan which is perched above the surface of the river bed at the confluence with the Tapuaeroa River.

Mean bed levels have however decreased just upstream of the Raparapaririki shingle fan over the past nine years, but this is considered to be, at least in part, due to the effects of shingle extraction. The trend is reversed some 2.7 kms downstream.

The Waiorongomai River, which enters the Tapuaeroa just downstream of the cross section at EC 529 (9290m), is not considered to have had a major impact on mean bed levels downstream of this point, at least compared to the impact of the Raparapaririki.

Unfortunately the only cross section still surveyed in the lower Tapuaeroa River is at EC 527 (2270m), some 7 kms further downstream again. The data from this site displays a sudden aggradation of 700 mm between 1998 and 2007. If this sudden increase in mean bed level is related to additional bed load from the Bola flood in 1988, then the response has been delayed by some 10 years.

It is not possible from the cross section data to calculate reliable volumetric data for the various reaches (as has been done for the Raparapaririki and the Waiorongomai) as the cross sections are too far apart and there is a large variation in river bed width between sections. However, drone surveys carried out in 2015 and 2016 by Dr John Tunnicliffe et al; from the University of Auckland, have produced DEM's of the Tapuaeroa River bed between the Raparapaririki confluence and the Waiorongomai confluence. (Note: An unpublished poster "Tapuaeroa River Differences Map 2015 – 2016" by Dr Tunnicliffe shows very graphically the detailed topography of the river bed derived from the drone aerial survey data).

These DEMs can provide very accurate volumetric data "differenced" between 2015 and 2016 for this reach of the Tapuaeroa River, and could potentially assess the volumetric changes in bed load material going back to the first survey in 1958. Another survey this coming summer at the same time as another drone survey could be most useful to compare the merits or shortcomings of the two survey methods.

Recommendations:

It is recommended that:

1. A further survey of all Tapuaeroa River cross sections (with the new cross section at EC 532A substituted for EC 532), be carried out at the same time as the proposed University of Auckland drone survey in February 2017.

2. The Gisborne District Council commission a further report to compare the merits or shortcomings of the two survey methods, and to assess the most viable and cost effective method for the future monitoring of the Tapuaeroa and other district rivers.

3. Any decision on any further cross section surveys be delayed until after the conclusions of the report (as in recommendation 2), are known.

Acknowledgements:

- Ian Hughes and Brian Currie; for providing a continuous high quality survey record for the past 58 years;
- Dr John Tunnicliffe for helpful comments on the use of DEM's for river surveying.

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