Hawke's Bay State of the Environment 2018 - 2021

Regional braided river management

5. Braided river management

Braided rivers are a globally rare habitat. They occur only under a very particular set of climatic and geological conditions where there is a large supply of gravel, and large variations in rainfall and flow. There also needs to be a relatively flat landscape that does not constrain the river the way narrow canyons or valleys do.

Large parts of east coast New Zealand meet all these conditions because of:

- New Zealand's dynamic geology and active uplift which leads to young mountain ranges that actively erode. The axial mountain ranges are made of shattered greywacke, which is a hard rock that produces large quantities of gravel as it erodes.
- Many parts of New Zealand being characterised by sporadic, high intensity rainfall. The east coasts of both islands have typically drier conditions, but ex-tropical cyclones or strong southerlies occasionally produce extreme downpours.
- Sea level change over time which has generated wide terraces around higher coastal landforms in New Zealand. Wave action and sediment deposition 'flattens' the land submerged by shallow seas.

In Hawke's Bay, the Kaweka and Ruahine Ranges provide the gravel which the Tukituki, Waipawa, Ngaruroro, and Tūtaekurī Rivers deliver to the Ruataniwha and Heretaunga Plains. During periods of heavy rainfall, the rivers repeatedly burst out and form new channels and banks where gravels, sands and silt and clay get deposited.

When gravel accumulation starts to constrict flow, the chance of the river bursting out increases. Over the last 250,000 years, sediment deposition from the braided pattern of overlapping ancient river channels has gradually built up the plains (Figure 5-1).

Figure 5-1. Waipawa River at State Highway 50 with the Ruahines in the distance. Water moving large volumes of mobile gravels forms an ever-changing braided pattern. Relict river channels underneath the pasture can still be seen outside the current willow-lined active channel. Photo by Peter Scott, Above Hawke's Bay.

Figure 5-2. An excerpt from the Weekly News about the 1939 Esk Valley flood. Buildings were half buried by silt (top) and the force of water damaged infrastructure (bottom).

Matauranga Māori conveys the danger of braided rivers by conceptualising them as taniwha with flicking or lashing tails, which over time form the braided river patterns. The taniwha references convey a sense of warning, and the risk from volatile river channels. Māori settlements tended to be built on the hills, outside of harm's way when the rivers flooded.

However, when Europeans colonised New Zealand, settlements were concentrated on the flatter areas. The fertile plains were more suited to their forms of farming, and it was easier to construct buildings and roads on flatter ground. However, building on the plains also meant people and infrastructure were now in the path of the wandering rivers and, as a result, susceptible to frequent floods (Figure 5-2).

With people's lives and livelihoods at risk, engineers were brought in to manage the rivers. They diverted reaches to avoid populated areas, and constructed stopbanks to confine rivers. This management approach attempts to balance; the needs of the river to retain flows within braids during lower flows; the need to provide the river with larger flood areas during peak flows; and the need to manage flood risk to surrounding land (Figure 5-3).

Figure 5-3. Braided river channels are characterised by wide expanses of unconsolidated gravel. This provides habitat for a number of threatened and at-risk native species, such as banded dotterels.

Current stopbanks are designed to accommodate 1-in-100-year floods, and works are underway to lift the level of protection to a 1-in-500-year flood. Climate change is expected to increase the frequency of large magnitude events, so higher protection is needed to ensure that people and assets are safe during high flow events.

Ongoing protection by stopbanks relies on the flow staying in the centre of the channel. Riverbanks and stopbanks will erode when the full force of a river is directed at them. If the riverbanks or stopbanks erode, the flood protection is removed, and the river may carve out a new path through the farms and towns across the plains. The willow edge protection is the main tool for breaking up the force of the water thereby maintaining stopbanks (see Figure 5-5). However, two major threats may compromise the integrity of the flood protection; weed colonisation and sedimentation of the active river channel, and the accumulation of gravels which can reduce the amount of water that can fit within the river channel.

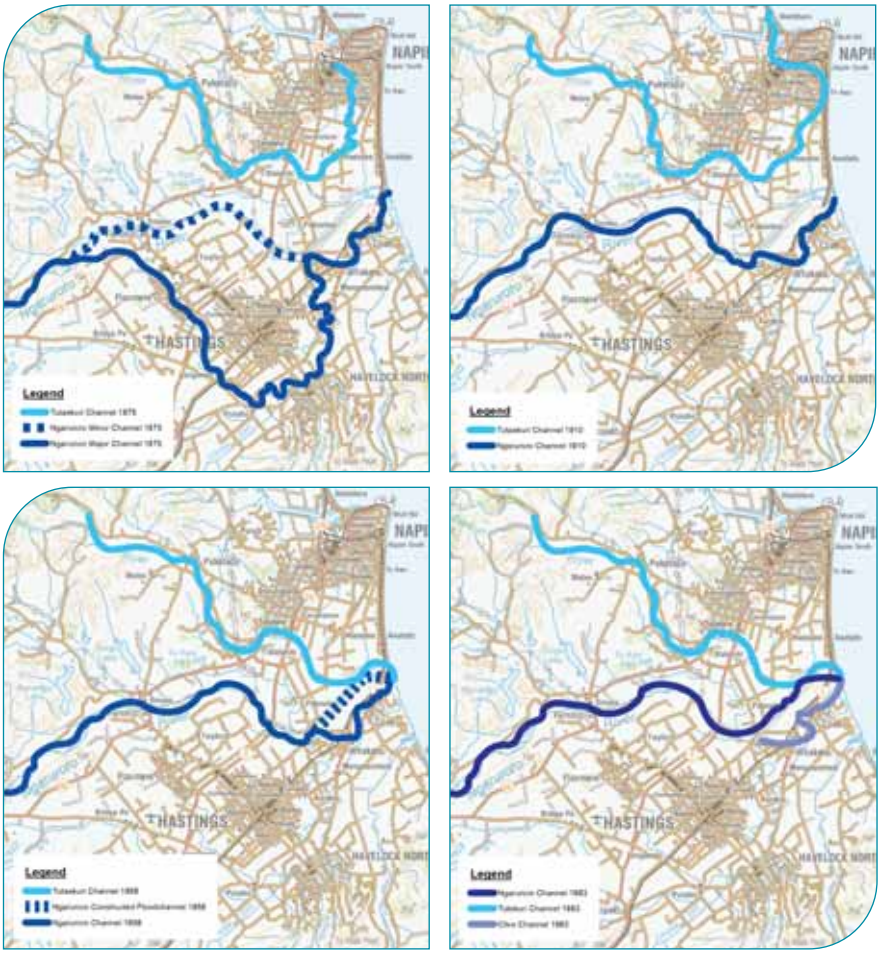

Figure 5-4. The position of Hawke's Bay's braided rivers since 1875. Over the last 250,000 years, the river channels have at some point occupied most of the flatter parts of the Heretaunga Plains (areas in lightest grey). Major changes to river courses, both natural and unnatural, have occurred since European settlement. In 1875, most of the Ngaruroro flowed through the area now occupied by Flaxmere and then swept around the southern side of Hastings (top left). Subsequent floods altered the river form, such that in 1910, most of the Ngaruroro flowed around the north of Hastings (top right). The Napier earthquake in 1931 shifted the Tūtaekurī River to flow into the Ngaruroro (bottom left). Engineering works in 1969 shifted the flow of the lower Ngaruroro away from Clive to help reduce the risk from floods (bottom right).

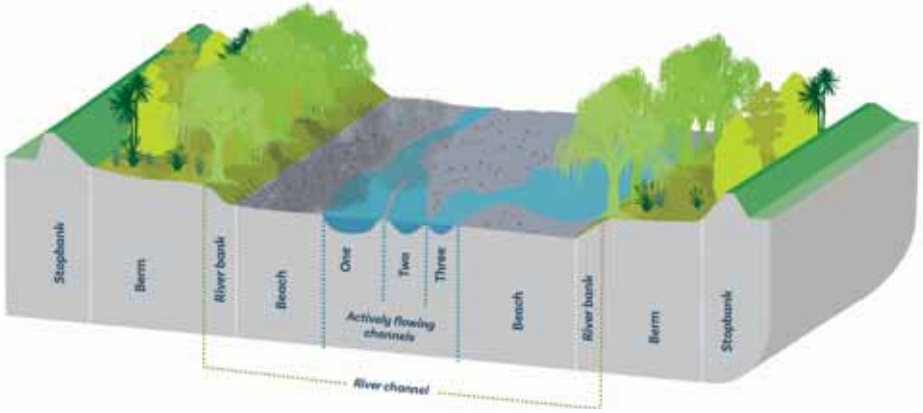

Figure 5-5. Channel design of an engineered braided river.

Weed colonisation and sedimentation of the active river channel

During a flood, the movement of loose gravels cushions some of the force of the flow, because energy is spent moving the gravel around. On the other hand, when water flows into a fixed barrier like a concrete wall, the energy rebounds and the water keeps moving. Mobile gravels, being carried downstream with the flow, are a way to take some of the energy or power out of a flood event.

Increased erosion and the introduction of invasive weeds are two major changes that can compromise the natural behaviour of braided rivers. Increased erosion in upstream catchments generates more fine sediment, which gets interspersed with the riverbed gravels and binds the gravels together in a process called 'armouring'. Weeds colonising the gravel beaches compound this effect by sending roots deeper into the gravel layers and stabilising them even further.

The growth of weeds along braided rivers is often accelerated due to high levels of silt and nutrients that are washed downstream from modified catchments. Without intervention, armouring and weed growth turns the gravel beaches and islands into permanent barriers rather than constantly moving features. When high flows hit these barriers, the water is diverted, and if the flow is directed towards a riverbank, the energy can undermine the integrity of the bank.

HBRC undertakes gravel raking on the beaches and islands of our braided rivers to loosen the gravels to avoid armouring of the riverbed.

A win-win

Mobile gravels provide better habitat for the animals that have evolved to live in braided rivers, including threatened species such as the banded dotterel (Figure 5 6). These birds lay their eggs out in the open among the loose gravels. Exotic weeds provide cover for introduced mammalian predators such as rats and stoats, which means they can sneak up more easily on breeding birds. The survival of eggs and chicks is lower in weed-infested areas.

Beach raking reduces this problem, and HBRC follows carefully developed ecological management and enhancement plans to ensure the raking is undertaken in a manner and at a time of year that does not damage or disturb breeding colonies.

Monitoring results suggests the efforts have been worthwhile. The latest bird survey counted 2564 adult banded dotterels on the Tukituki, Ngaruroro, and Tūtaekurī Rivers. This is the largest number of banded dotterels counted since records began in 1962.

Banded dotterels appear to be declining in other parts of New Zealand, so it is promising that the braided river management programme in Hawke's Bay appears to be providing both good flood protection and better biodiversity outcomes.

Figure 5-6 Clean and unconsolidated gravels provide good habitat for river birds. Banded dotterels and their eggs can be hard to spot amongst the grey gravels.

Gravel accumulation

Gravels carried downstream from the steep mountain channels accumulate in lower gradient reaches of the river network, where the slower flows have less energy and cannot carry the gravel any further downstream.

These depositional processes are one of the major reasons that braided rivers wander. The flow is blocked by gravels that have been deposited in the lower energy reaches, and when the water level is high, the flow gets directed along a new path. This has been a major issue in the upper Tukituki River in Central Hawke's Bay, where the accumulation of gravels has compromised the flood protection scheme. Physically removing gravels is the most cost-effective way to maintain channel capacity.

Gravel from braided rivers is used in aggregate for roading and construction, and so commercial gravel extraction from braided rivers occurs. For the last ten years, about 450,000m^3 of gravel has been extracted from local rivers each year (Figure 5-7).

Although gravel extraction can help restore flood protection, too much extraction can be detrimental to river health and reduce the supply of gravels to downstream reaches and the coast. Balance is required between extraction where it is needed to maintain channel capacity, and extraction in other areas which may have adverse effects such as reducing the amount of gravel reaching the coast.

The Tukituki, Esk and Mohaka rivers are the main rivers supplying gravel to the Hawke's Bay coast and play an important role in maintaining the balance of sediments along the coastal areas.

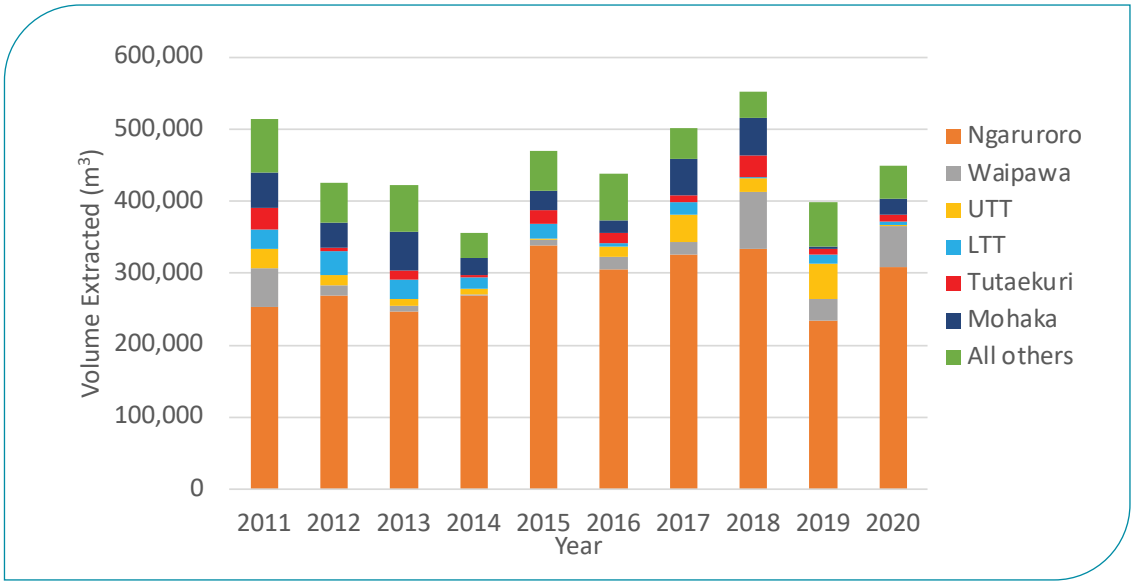

Figure 5-7. Gravel extraction volumes from Hawke's Bay rivers. UTT and LTT are the Upper Tukituki River and lower Tukituki River, respectively.