LAND 2021-2022 and 2020-2021

Over the last 150 years of New Zealand's history, people have made significant changes to our land – particularly in the Waikato region which covers a span of 25,000 km. Native forests have been cleared and wetlands drained to create opportunities for different land use activities. With increased pressure on land, it is imperative to understand the effects of activities on the land, and how these can be managed.

Our soils are considered to be a non-renewable resource, like fossil fuels. It takes thousands of years for rocks to become soil, and further hundred years for the soil to build up organic matter. This organic matter is what allows soil to carry out its various functions. As people we rely on soil, and its organic matter, for survival. Depleting the soil quality and poor soil management can be detrimental. Therefore, making good decisions around our land and soil is very important to our wellbeing.

Various land types in the Waikato region, suit different uses. By using the land in a way that is not suited to the soil, we run a risk of damaging the land and subsequently having flow on effects to other part of our environment.

Soil versatility is a term used to describe what use a soil would be most suited for. Soils with greater versatility are suited to a wider range of land use activities. Soils are classed from 1 (very versatile soils) to 8 (least versatile). In the Matamata-Piako district approximately 75% of our soils are very versatile soils (soil class 1- 3) which makes up an area of over 110,000 hectares. These versatile soils have a large impact on the type of businesses in our district and also to our districts economy.

Land use in our district

Land use activities can place significant pressure on soils. Farming is known to cause increased erosion and also increase soil compaction while repeated cultivation or cropping is known to reduce soil microbial and organic matter. Root systems play an important role in providing stability on soil, however this can be undone during deforestation or harvesting as it causes soil disturbance and erosion into waterways. While this is a flow on effect from land use practices in our district, it is worth noting that efforts are continually being made to improve farming practices and mitigate the adverse effects it has on our soil structure.

According to data collected by the Waikato Regional Council (WRC) sites that were classified as being used for 'dairy farming' or 'dry stock':

- had soil compaction affecting at least 85% of sites;
- approximately 70 percent of sites across the region were considered to have excessive fertility. High fertility in soil refers to soil having excessive nutrients This is usually a result of when nutrient-dense fertilisers are added to soils to increase

nutrient levels to assist with production. There are often secondary effects of this such as excess nutrients which then leach into waterways.

On the other hand ¼ of sites are facing issues related to low fertility. Low soil fertility occurs when land use practices have used up the nutrients in the soil. When soils have reduced fertility, there has been a loss of root system growth and a reduction of bio organisms in the soil. Without strong root systems, there will be an increase in erosion and further soil structure degredation. All bio organisms in soils have a purpose whether it is breaking down biomatter or adding to the soil structure, they are essential for maintaining and replenishing our soils.

The Waikato Regional Council monitors soil quality at 25 sites throughout the district, within a 5 year period. That information feeds into this report around land uses within the Matamata-Piako District, soil quality and soil structure. The main land uses that are monitored by the Waikato Regional Council are dairy farming, beef and sheep farming (also called dry stock farming), horticulture and cropping and plantation forestry.

Soil Quality in our district

Soil quality is incredibly important to our district as it plays a key role in many of our land use classifications. Agriculture and dairy products are considered part of the district's major economic base and is a big contributor to the district's GDP. Therefore, close monitoring and proper management of soils is critical.

Good quality soils have properties that enable multiple land uses. Ideally, soils should be able to hold water and nutrients where it will be made available for plant roots to use, suppress weeds and pests, perform carbon sequestration from the atmosphere, filter water that flows through it before reaching waterways, absorb heavy rainfall which prevents flooding and support biological activity/ organisms.

- Nitrogen levels in our soils

From the data collected by the Waikato Regional Council from testing sites within the Matamata-Piako district, five (5) sites out of 11 recorded low nitrogen content in the soil, as well as soil degradation, which are two main factors in soil quality (Table: see Hot Water Nitrogen data and Hot Water Carbon data). These sites included three (3) sites that had been classified as 'cropping', another as 'dairy' and the remaining site was used for 'maize' growing. This indicates that there was insufficient nitrogen for biological activity and insufficient levels to support organisms at these sites. The nitrogen values for these five sites was below 225mg.

Interestingly, a correlation can be seen between the sites that displayed *inadequate* nitrogen content in the soil, and that of the *inadequate* carbon content in the soil. Hot water carbon is used to identify the amount of biological activity and carbon availability for microorganisms to use as food (sequestration). A value that is less than 1800mg, indicates that there is degradation of the soil structure and quality. The same five (5) sites that were flagged as having insufficient nitrogen levels above also had inadequate levels of carbon. The nature of farming maize and crops, means that the soil structure and deep root systems that would ordinarily sequest carbon from the atmosphere, is being disturbed, hence that these land uses are usually associated with poor soil structure as well. Deep root systems with low

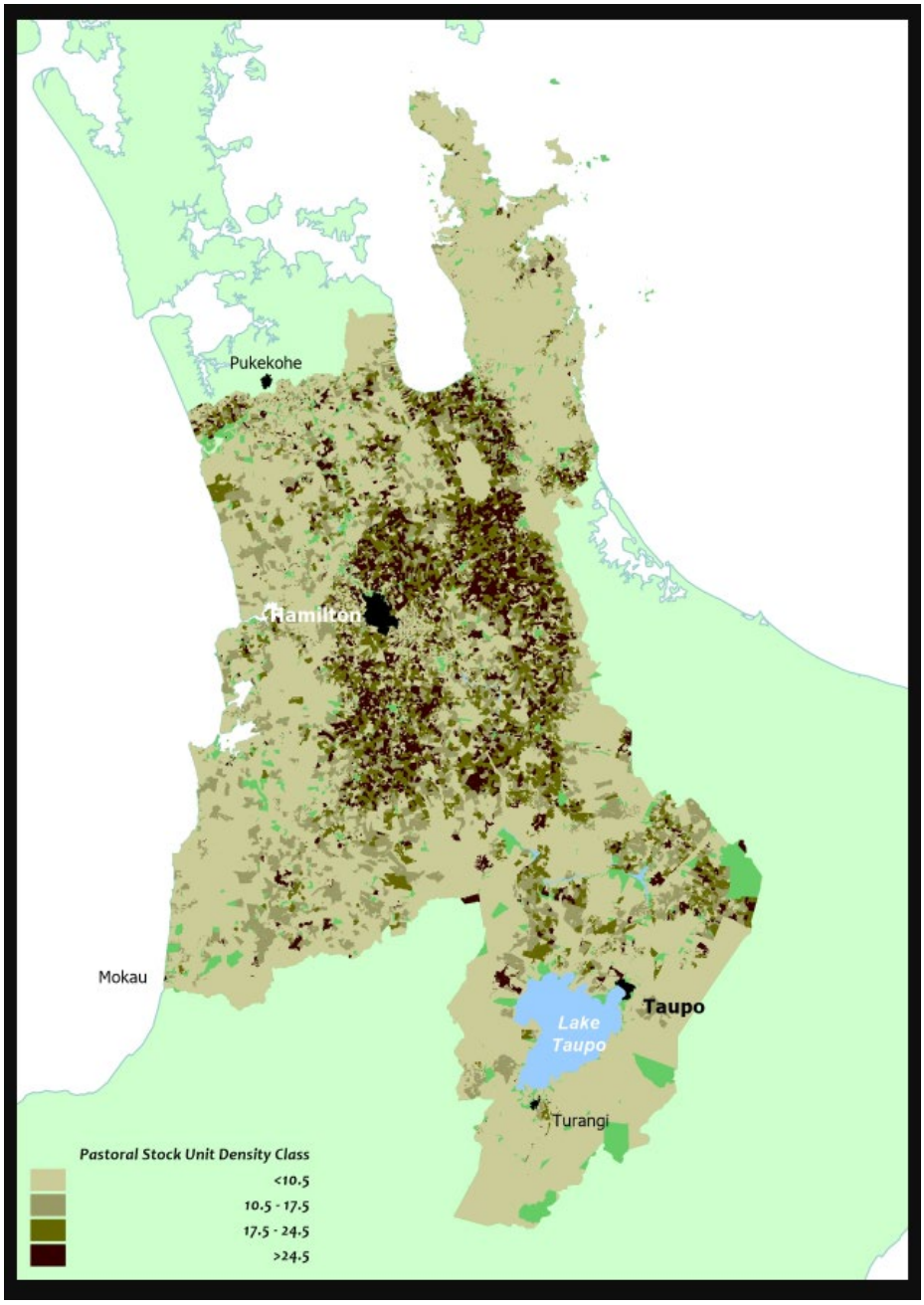
disturbance have been shown to have higher organic carbon present in the soil, therefore have higher levels of microorganism diversity and reduce erosion.

In contrast to having low nitrogen levels detailed above at the five sites, the data concludes that typically beef, dairy and dry stock farming practices have the highest levels of nitrogen and carbon in the soil. This is likely to be due to animal faeces and urine containing high levels of nitrogen entering the soil, as well as less root system disturbance. The Waikato Regional Council identified that about 70% of sites that were tested across the region were affected by excessive nitrogen fertility which leads to nitrogen leaching into waterways causing issues in streams and rivers such as algal blooms and loss of species. This is called eutrophication.

Stock Density of our soils

Stock density is one of the indicators to determine how tightly compacted the soils are as a result of livestock grazing and machinery related techniques. The soil structure becomes compromised when it is compacted, and this tight packing of soil and root systems also reduces the diversity and extent of biomatter. This consequently results in less nutrients being used and the more likely nutrients are leached into the waterways. Therefore, stock density not only has an effect on our soil structure it also has an effect on our water quality.

Matamata-Piako district is unique in that we have diversity in our landscape, with farmland, mountain ranges and rivers that lead into the Hauraki Gulf. We are also a district that is responsible for much of the national gross domestic product related to primary production. Alongside this, our district is also experiencing growth in our population and therefore development. While there is improvements to be made to our current practices, the evidence shows that this trend is typical of other farming areas where similar correlations are seen.



Map of Stock Density in the Waikato Region. Sourced: https://www.waikatoregion.govt.nz/environment/land-and-soil/land-and-soil-monitoring/riv9-report-card/.

The map above portrays classes of pastoral stock class in the Waikato Region. Of note is that there is a significant extent of high class soils and therefore high stock densities within the Matamata-Piako district. This correlates with the levels of nitrogen, E Coli and phosphorus found in our soils and waterways.

The diagram above shows that approximately 68% of farms in the Waihou/Piako catchment zones are higher stocked dairy farms. Sourced: https://www.waikatoregion.govt.nz/environment/land-and-soil/land-and-soil-monitoring/riv9-report-card/

Using the data collected by the Waikato Regional Council, we can identify that 80% of sites tested within the Matamata—Piako District displayed moderate to severe levels of soil compaction which is directly related to stock density. To measure soil compaction, a macropore indicator is used. Macropores are large soil pores, that are generally greater than 0.08 mm in diameter. Macropores drain freely by gravity and allow easy movement of water and air. They provide habitat for soil organisms and accommodate root systems. With diameters less than 0.08 mm, micropores are small soil pores usually found within structural aggregates. Soil structure is important as it related to soil functions like biological productivity, regulating water flow and nutrient storing. Soil structure is characterised by loosely packed, crumbly soil with macropores dispersed throughout the aggregate.

Four of the eight sites tested in our district, showed inadequate levels of macropores, suggesting severe soil compaction. Four sites were classified as dairy farming, two sites were classified as cropping, and the remaining sites were beef and maize. Considering that all sites that were tested are associated with farming practises, it is noted that only 50% have been identified in the 'severe soil compaction category. There is more awareness being raised regarding soil health and how far reaching our land use practices can be. There is an increased community participation to manage or mitigate these measures through changes in business practices, methods and increased support being take up on a national and district level.

Land Use	pH Soil fertility	Total Carbon % Organic matter content. Organic matter helps to store water, nutrients	Hot Water Carbon mg Biological activity and Carbon availability for microorganism to use as food. Soil structure degraded at <1800	Total Nitrogen % Nitrogen reserves in soil. Below 0.2% is deficient for grass and crops	Hot Water Nitrogen mg Biological activity and amount of Nitrogen available for organisms. Less than 225 indicate Nitrogen fertiliser needed	Anaerobically mineralised nitrogen Below 50 is considered deficient for pasture	Olsen Soil fertility using phosphate indicator. Optimal is 30-15. Excessive is >50	Macropores Soil compaction. Needs to have >10 for root growth and water infiltration
Dairy	5.7	8.3	2776	0.85	369	146	45	3
Dairy	5.5	8.6	2116	0.94	330	157	17	6
Cropping	6.2	5.2	1050	0.54	203	60	100	11
Cropping	6.2	5.9	1291	0.59	198	72	30	6
Dry stock	5.9	8.2	2530	0.84	345	181	6	22
Dairy	6.6	5.8	1365	0.57	182	112	46	7
Maize	5.8	4.6	1144	0.50	121	66	53	10
Cropping	6.2	5.2	728	0.53	194	53	81	6
Dairy	6.5	6.4	2327	0.57	292	201	70	9
Beef	6.0	9.3	2353	0.98	373	174	12	3
Maize	5.8	6.3	1242	0.67	187	89	37	4

Table 1: Results of soil testing carried out by Waikato Regional Council across 11 Matamata-Piako District sites

There are patterns that emerged from the soil testing carried out in the Matamata-Piako district. Results suggest deficiencies within the same tested sites, and often correlations can be drawn against sites within the same land use classification. All sites had between one and three results that were outside of the acceptable / suggested parameters for good soil structure and soil quality.