Environment Waikato Technical Report 2004/20

Subsidence Rates of Peat Since 1924 in the Rukuhia Swamp

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Executive Summary

Project and Client

In July 2004 Landcare Research, Hamilton, measured peat thickness in the Rukuhia area and calculated subsidence rate over the past 80 years for Environment Waikato.

Objective

- Obtain a comprehensive dataset of subsidence rates in the Rukuhia Swamp, by remeasuring peat thickness at sites previously measured in 1924.

Methods

- Peat thickness was measured with a steel probe as close as possible to sample sites measured in1924. Differences in peat thickness and subsidence rates were then calculated.

Results

- Mean subsidence during the 80-year period was 2.05 m, which equates to a rate of 2.56 cm y^{-1} of peat surface subsidence.
- There was no statistically significant relationship between peat thickness and subsidence rate.

Conclusions

- Subsidence rates at Rukuhia are similar to those recently measured at other Waikato peat bogs following conversion.

1 Introduction

Rukuhia Swamp is one of a number of peat bogs in the Waikato Region that have been drained and converted to agriculture and horticulture. Conversion results in subsidence of the peat due to consolidation and loss of organic matter through peat mineralisation (Schipper & McLeod 2002).

Obtaining information on subsidence rates is important for future land-use management and the development of mitigation strategies to reduce subsidence rates and CO_2 emissions.

2 Background

Rukuhia Swamp covers approximately 6400 hectares south of Hamilton, North Island, New Zealand (latitude S37° 52', longitude E175° 16') (Davoren, 1978). A map of the Rukuhia area, assumed to have been produced in 1924, shows elevation of the peat and underlying mineral surfaces along a number of transects (intended drains). Elevation measurements are usually at 10 chain (201.17 m) intervals along the transects. Since 1924 practically all the peat bog has been converted to agriculture or horticulture.

The 1924 map is held by Landcare Research, Hamilton.

3 Objectives

To obtain a comprehensive dataset of subsidence rates in the Rukuhia Swamp, by remeasuring peat thickness at the 1924 sites.

4 Methods

The original peat thickness map is difficult to read in places due to fading and smudging. It was scanned, and digital sharpening and contrast adjustment techniques were used to improve readability. The map is assumed to have been produced in 1924, based on a note indicating the water level of Lake Maratoto "W.L. 193.0 3/11/1924". At many sample points on the map there are three numbers, and it was assumed the highest and lowest represented the elevation of the peat and underlying mineral surfaces, respectively. The third number, typically around 4 feet less than the highest number, may represent drain depth.

The scanned 1924 map was georeferenced in ESRI® ArcMap™ 8.3 based on road intersections on the map that are unlikely to have changed position significantly. Sample transects were measured from obvious start points, such as road, rail and drain intersections, and sample points measured electronically 201.17 m apart on the transect bearing. Coordinates (New Zealand Map Grid, Geodetic Datum 1949) were generated for each sample point and transferred to a handheld GPS (Garmin® eTrex™), which was used to locate sample sites in the field in July 2004.

Drains have been dug along many of the transects since 1924, resulting in increased subsidence of the surrounding peat relative to areas further from the drains. In such situations, remeasurements were made nearby, where the peat surface was most representative of the surrounding area. In general this was approximately 10 m from the drain.

Once sample points were located, peat thickness was measured using a 12-mm-diameter sectional steel probe with a 20-mm drill bit attached. The probe was inserted by hand until solid material was struck. A sample of the subsurface material was taken with the drill bit to confirm that the bottom of the bog had been reached. The subsurface material comprised either blue-grey mud or alluvial sands and silts. When impenetrable buried wood was struck, three further attempts to insert the probe were made approximately 2 m apart before abandoning that site.

The thickness of peat at each point in 2004 was subtracted from the matching 1924 thickness and divided by 80 (years) to give subsidence rate.

5 Errors

The largest source of error is in replotting the 1924 sample sites to NZMG coordinates. The original paper map is poorly controlled, and even after georeferencing significant discrepancies are apparent between the marked location of many roads, lakes and other features, and their actual current positions. Sample sites appear to be at 10 chain (201.17 m) intervals along transects but there is some variation. It is not known whether this is due to the accuracy of the original map or the actual distances between sites varied. When replotting, it was assumed that sites were at 10-chain intervals except where there was obvious significant discrepancy, in which case the site was not remeasured. The size of the positional error is unknown.

Using the steel probe, existing peat thickness could be measured to within about 5 cm. The accuracy of the original measurements is unknown.

Where drainage has resulted in a sloping peat surface it was necessary to estimate where the surface was representative of the surrounding area. It is assumed the effect of any errors induced by this would be reduced as sample size increases.

Obviously erroneous measurements (e.g., apparent increases in peat thickness) were omitted.

6 Results

Peat thickness observations were made at 66 sites in the Rukuhia area (Fig. 1, Appendix 1) in July 2004. At two sites, the peat had decomposed fully resulting in a dark, essentially mineral topsoil. These sites were not included in subsidence rate calculations, as it is not known when the peat became fully mineralised.

For the remaining sites, mean subsidence over the 80-year period was 2.05 m, or 2.56 cm y^{-1} with a 95% confidence interval of ±0.28 cm. This rate of subsidence is similar but less than that reported for Moanatuatua bog, where the average rate was calculated to be 3.3 and 3.4 cm y^{-1} (McKenzie & McLeod, 2002; Schipper & McLeod, 2002), and greater than the 1.85 cm y^{-1} reported for Hauraki peatland by McLeod et.al (2003).

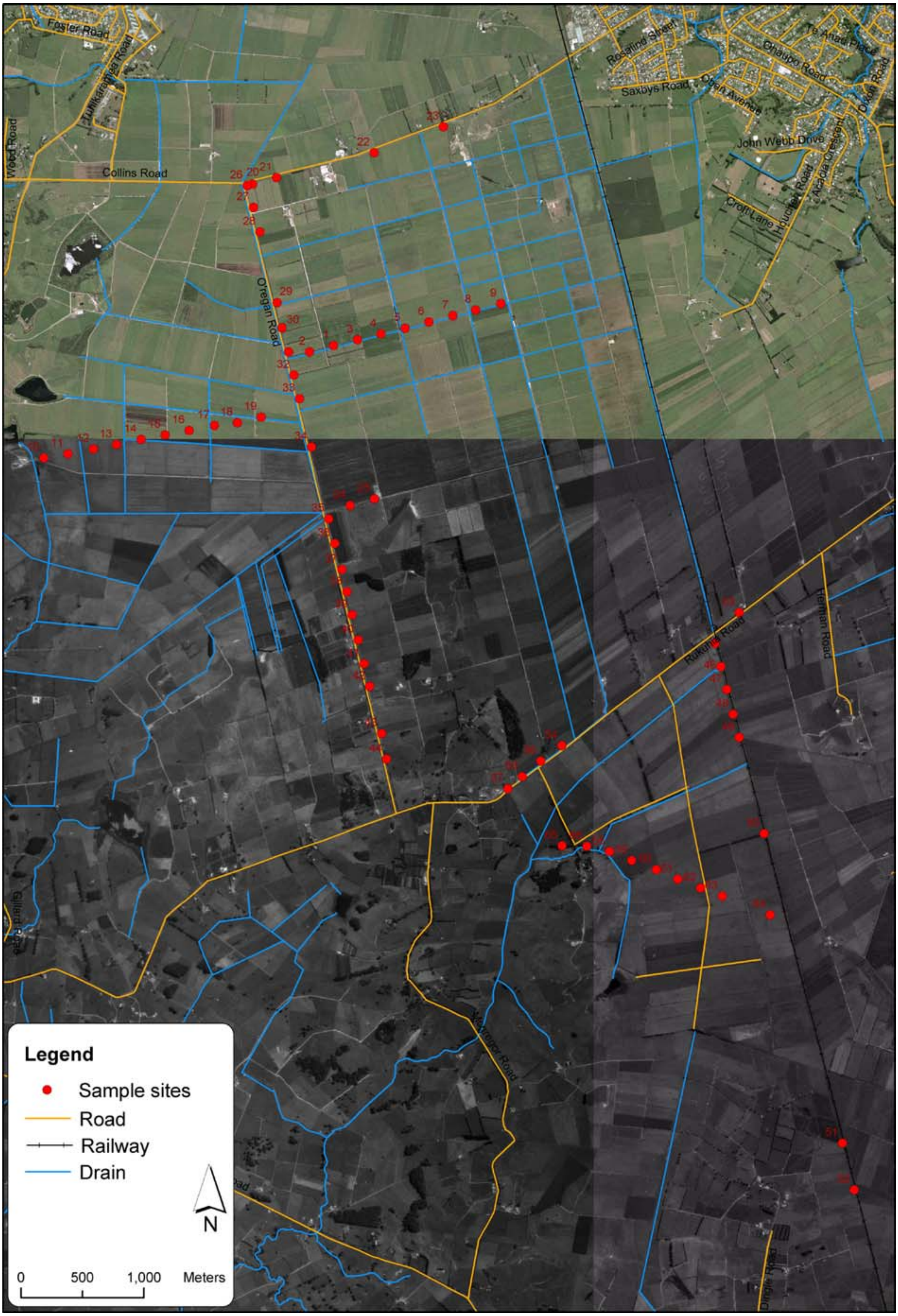

Figure 1: Location of peat thickness measurements made in July 2004. See Appendix 1 for details of peat thickness at each numbered site.

There was no relationship between peat thickness and subsidence rate (Fig. 2) in this study, unlike that found at Moanatuatua (McKenzie & McLeod, 2002). The combination of data from this study, Moanatuatua and Hauraki also does not suggest such a relationship (Fig. 3). Any relationship between peat depth and subsidence rate is complicated by unknown variables relating to the timing of conversion of different parts of the bogs, inter- and intra-property differences in land management (e.g., drainage and cultivation), and localised fires related to land clearing activities and, in former times, sparks from steam trains.

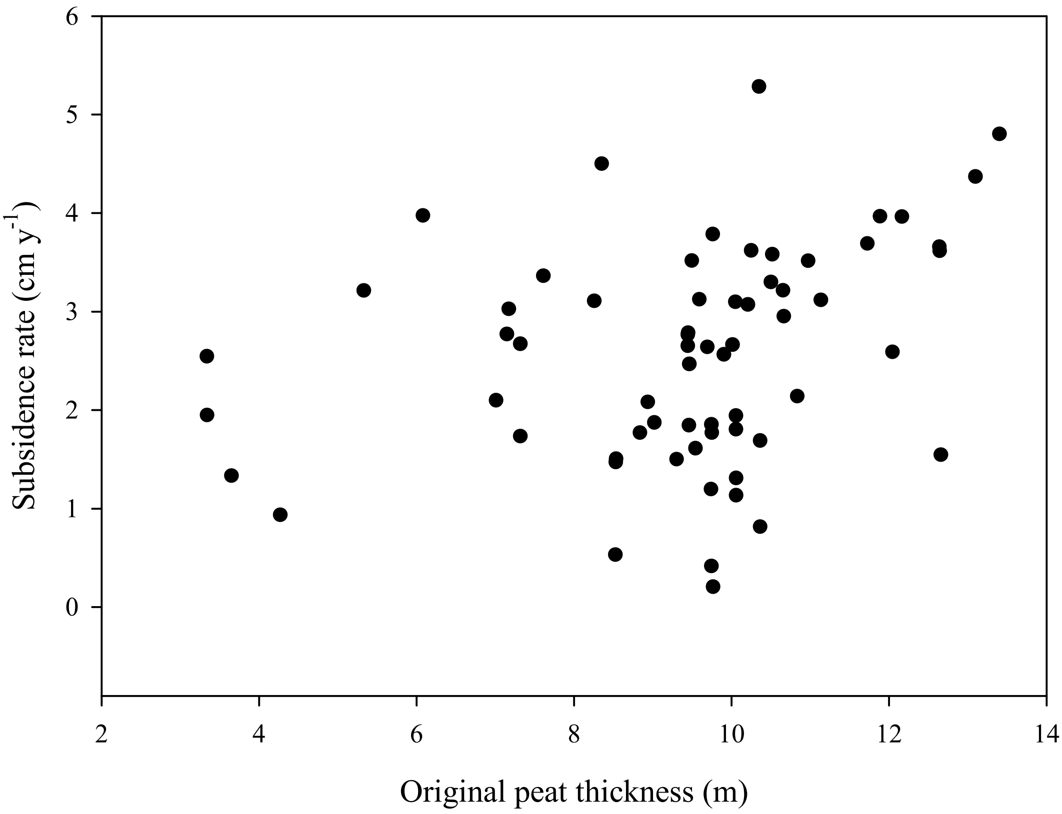

Figure 2: Subsidence rate of converted peat at Rukuhia in relation to original peat thickness.

There is no significant statistical relationship between subsidence rate and original peat thickness.

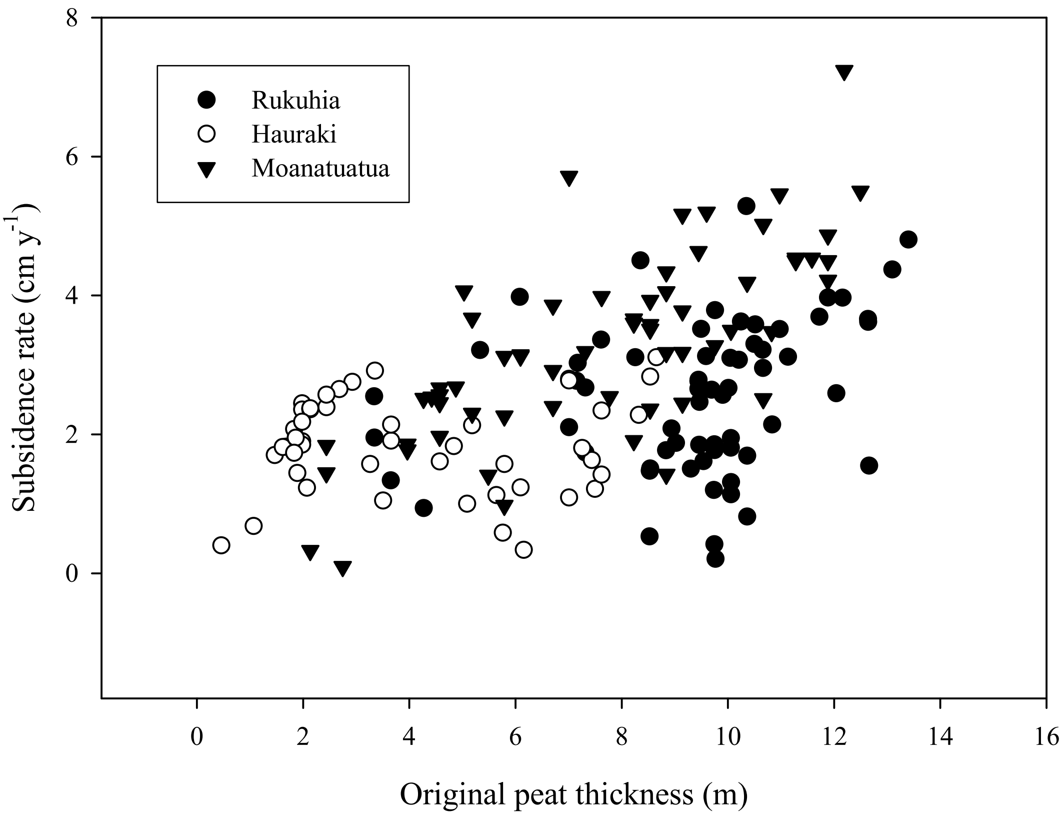

Figure 3: Subsidence rate of peat following conversion at Rukuhia, Hauraki (data from McLeod et al. 2003), and Moanatuatua (data from McKenzie and McLeod, 2002) in relation to original peat thickness.

There is no significant statistical relationship between subsidence rate and original peat thickness.

7 Conclusions

In the 80 years from 1924 to 2004 the thickness of peat in the Rukuhia area decreased an average of 2.56 cm y^{-1}. This is a similar rate to that recently measured in other Waikato peat bogs following conversion.

No relationship was observed between the thickness of peat in 1924 and subsequent annual subsidence rate at the measured sites.

References

Davoren, A. 1978: A survey of New Zealand peat resources. *Water and Soil Technical Publication No. 14.*

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Appendix 1: Sample point locations and peat thickness

Point #	NZMG Easting	NZMG Northing	1924 thickness (m)	2004 thickness (m)	Change in thickness (m)	Rate of change (cm y^{-1})
1	2707923	6370763	10.24	7.35	2.89	3.62
2	2707728	6370712	9.54	8.25	1.29	1.61
3	2708118	6370811	9.9	7.85	2.05	2.56
4	2708311	6370857	10.2	7.75	2.45	3.07
5	2708507	6370904	10.97	8.16	2.81	3.51
6	2708701	6370956	10.65	8.08	2.57	3.21
7	2708898	6371007	10.83	9.12	1.71	2.14
8	2709083	6371054	10.51	7.65	2.86	3.58
9	2709290	6371105	10.5	7.86	2.64	3.3
10	2705556	6369844	8.35	4.75	3.6	4.5
11	2705753	6369877	9.49	6.68	2.81	3.51
12	2705962	6369918	10.01	7.88	2.13	2.66
13	2706150	6369952	11.72	8.77	2.95	3.69
14	2706351	6369994	12.16	8.99	3.17	3.96
15	2706547	6370031	13.4	9.56	3.84	4.8
16	2706744	6370069	13.09	9.6	3.49	4.37
17	2706949	6370109	12.63	9.71	2.92	3.65
18	2707138	6370131	11.88	8.71	3.17	3.96
19	2707332	6370177	11.13	8.64	2.49	3.11
20	2707261	6372083	9.45	7.98	1.47	1.84
21	2707457	6372135	10.05	8.61	1.44	1.8
22	2708255	6372340	10.36	9.01	1.35	1.69
23	2708820	6372552	7.61	4.92	2.69	3.36
24	2708058	6369454	8.83	7.42	1.41	1.77
25	2708257	6369509	9.58	7.09	2.49	3.12
26	2707218	6372071	8.93	7.27	1.66	2.08
27	2707270	6371892	8.52	8.1	0.42	0.53
28	2707323	6371691	9.73	8.78	0.95	1.19
29	2707462	6371113	9.74	8.26	1.48	1.85
30	2707502	6370908	9.74	9.41	0.33	0.41
31	2707555	6370711	9.74	8.33	1.41	1.77
32	2707599	6370521	10.04	7.57	2.47	3.09
33	2707645	6370329	9.44	7.23	2.21	2.76
34	2707744	6369934	10.66	8.3	2.36	2.95
35	2707883	6369346	9.01	7.52	1.49	1.87
36	2707933	6369145	9.46	7.49	1.97	2.46
37	2707993	6368932	9.44	7.22	2.22	2.78

Point #	NZMG Easting	NZMG Northing	1924 thickness (m)	2004 thickness (m)	Change in thickness (m)	Rate of change (cm y^{-1})
38	2708032	6368749	9.69	7.58	2.11	2.64
39	2708074	6368561	9.76	9.6	0.16	0.2
40	2708124	6368356	10.05	8.5	1.55	1.94
41	2708172	6368161	9.44	7.32	2.12	2.65
42	2708218	6367976	8.52	7.35	1.17	1.47
43	2708315	6367590	8.53	7.33	1.2	1.5
44	2708355	6367381	6.08	2.9	3.18	3.97
45	2711038	6368326	9.75	6.73	3.02	3.78
46	2711086	6368139	7.01	5.33	1.68	2.1
47	2711134	6367950	7.31	5.18	2.13	2.67
48	2711186	6367747	7.17	4.75	2.42	3.02
49	2711235	6367558	7.14	4.93	2.21	2.77
50	2711440	6366772	10.36	9.71	0.65	0.81
51	2712079	6364241	12.04	9.97	2.07	2.59
52	2712176	6363858	12.64	9.75	2.89	3.61
53	2711236	6368579	10.34	6.12	4.22	5.28
54	2709787	6367492	4.27	3.52	0.75	0.93
55	2709464	6367239	3.33	1.3	2.03	2.54
56	2709616	6367365	3.64	2.58	1.06	1.33
57	2709348	6367139	3.34	1.78	1.56	1.95
58	2710176	6366625	5.33	2.76	2.57	3.21
59	2710359	6366552	7.31	5.93	1.38	1.73
60	2710557	6366477	8.25	5.77	2.48	3.1
61	2710734	6366400	12.65	11.42	1.23	1.54
62	2710920	6366327	10.05	9.15	0.9	1.13
63	2711097	6366261	9.3	8.1	1.2	1.5
64	2711489	6366107	10.05	9.01	1.04	1.31
65	2709790	6366673	0.61	Fully mineralised, peaty topsoil only.		
66	2709992	6366668	1.05	Fully mineralised, peaty topsoil only.		