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Subsidence Rates Of Peat Since 1925 In The Moanatuatua Swamp Area

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Acknowledgements

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1 Introduction

Moanatuatua swamp is one of many peat bogs in the Waikato Region that has been drained and converted to agriculture or horticulture. As a result of conversion, subsidence occurs from consolidation and losses of organic matter, due to peat mineralization (Schipper & McLeod 2002). Obtaining information on subsidence rates is important for future land-use management and the developing of mitigation strategies to reduce subsidence rates and CO_2 emissions.

2 Background

Moanatuatua peat bog covers an area of about 8500 ha south of Hamilton, North Island, New Zealand (latitude 37˚55′25′, longitude 175˚22′34′) (Schipper & McLeod 2002) and was formed approximately 14 000 years ago (Clarkson et al. 1999). In 1925, an extensive drainage plan was drawn up of the majority of the Moanatuatua swamp area (J.B. Thompson, Land Drainage Engineer), showing intended drains. Along these intended drains, the plan shows peat thickness, usually at 20 chain intervals (402.34 m). The location of these points is shown in **Fig. 2**. Since 1925, most of the area has been drained and converted to agriculture or horticulture.

The 1925 Thompson land drainage map is held by Waipa District Council (Te Awamutu). It is a blue map with white writing kept in a set of horizontal steel map draws in a basement storage room. (Contact Stephen Cornelius, Drainage Engineer).

3 Objectives

To obtain a comprehensive dataset of subsidence rates in the Moanatuatua swamp, by remeasuring peat thickness at the 1925 sites.

4 Methods

Peat thickness sites on the 1925 plan were transferred to a topographic map of the area (NZMS 260 Sheet 15) by locating an obvious start point, e.g., drain intersect, then electronically setting out the distance measured off the 1925 map. Grid coordinates were then generated for each point. This procedure was accomplished using ArcView GIS. These points were then located in the field using a handheld GPS (Garmin 'Etrex'), with a nominal accuracy of ±5 m. Because drains have since been dug along the 1925 points, the actual point of remeasure was located at right angles to the drain, but maintaining the same 1925 distance between the points. Local topography was also taken into account as drains cause the land in close proximity to slope towards the drain. The point of remeasure was chosen where the height of the land is most representative of the surrounding area. Usually, this was approximately 10 m in from the drain.

Once the point was established, the thickness was measured using a steel probe 12 mm in diameter with a 20-mm diameter drill bit attached to the end. A sample of the subsurface material was obtained to ensure the bottom of the bog had been struck. The subsurface material comprised either blue-grey mud or alluvial sands and silts. When possible, three thicknesses were measured at each point to obtain an average thickness. The additional thicknesses were measured approximately 5 m either side of the point, parallel to the drain. Where there was hump and hollow drainage (which usually ran perpendicular the main drain), one thickness was measured on the crest, and one on the mid-slope on either side. In some circumstances, three thicknesses were unable to be measured because tree fragments in the bog made conditions impenetrable for the probe.

A total of 61 sites were measured, during May and June 2002. Average thickness for each point measured was calculated, and then subtracted from the matching 1925 thickness. This was then divided by 77 (years) to obtain a rate of subsidence per year.

5 Results

Mean subsidence over the 77-year period was 2.53 m, giving an annual rate of subsidence of 3.3 cm y^{-1} with a 95% confidence interval of ±0.34 cm. This rate of subsidence is similar to earlier work in a nearby area, where the annual average rate was calculated to be 3.4 cm y^{-1} (Schipper & McLeod 2002). Appendix 1 shows the full table of results. Subsidence rates tend to increase with increasing peat thickness, as can be seen in **Fig. 1**. As different parts of the bog have been converted at various times since 1925, we would expect a range of rates of subsidence. There will also be interproperty and intraproperty differences in management, such as the method of drainage used for each paddock and land use.

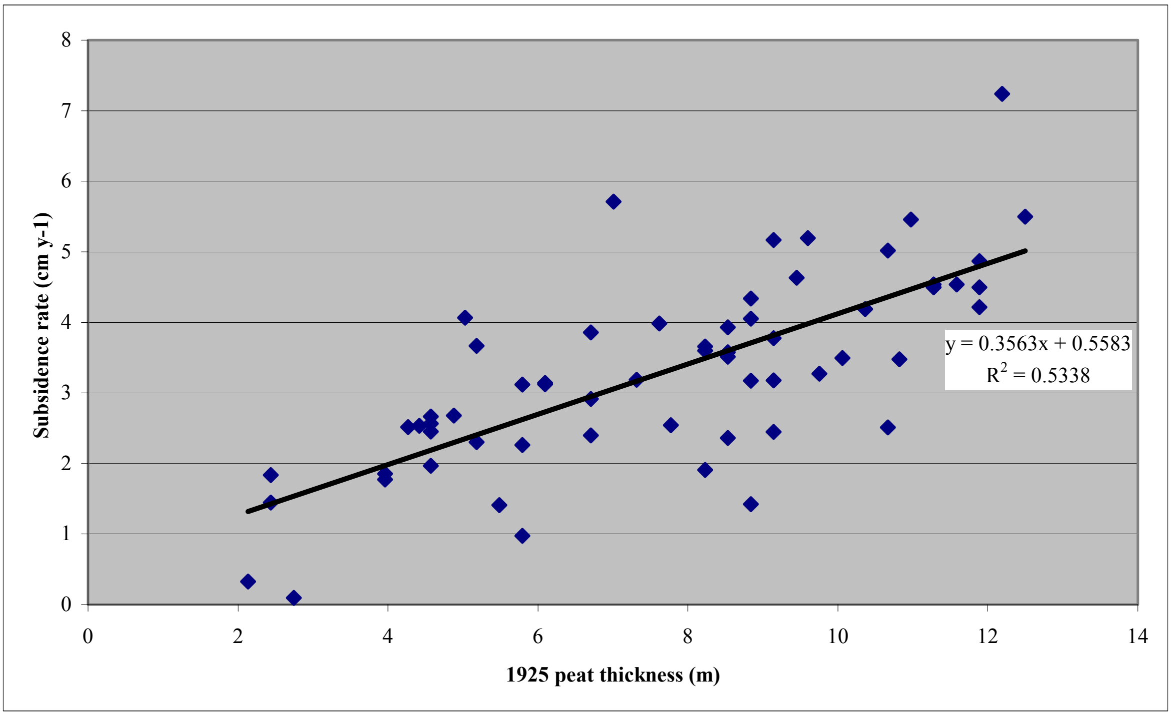

Figure 20: Graph showing the relationship between subsidence rate and thickness of peat in 1925

Conclusions

Since 1925 the thickness of peat at Moanatuatua has decreased 3.3 cm y^{-1} on average but subsidence rates vary throughout the area. A trend exists between 1925 thickness and annual subsidence rate where rate of subsidence increases with increasing peat thickness. However, peat thickness only accounts for about 50% of the variation. Some variation would also be due to management history.

References

Clarkson, B.R.; Thompson, K.; McLeod, M.; Schipper, L. 1999: Moanatuatua Bog proposed restoration of a New Zealand restiad peat bog ecosystem. *In:* Streever, W. *ed.* An International Perspective on Wetland Rehabilitation, ed, Dordrecht, Kluwer Academic Publishers. Pp.127–137.

Schipper, L.A; McLeod, M. 2002: Subsidence rates and carbon loss in peat soils following conversion to pasture in the Waikato Region, New Zealand. *Soil Use and Management 18(2)*: 91–93.

Append ix 1 Table of results showing NZMS coordinates

Point I.D.	Easting	Northing	2002 thickness(es)(m)			2002 mean thickness (m)	1925 thickness (m)	Total change (m)	Rate of change (cm/yr)	% decrease w.r.t 1925 thickness
001A	2718553	6356497	1.9			1.90	5.03	3.13	4.1	62
002A	2718660	6356801	5.85	5.78		5.82	7.77	1.96	2.5	25
003A	2718805	6357178	6.73	6.76	6.92	6.80	10.67	3.86	5.0	36
004A	2718939	6357556	7.28	7.08	7.06	7.14	10.36	3.22	4.2	31
005A	2719085	6357932	6.61	6.75	6.95	6.77	10.97	4.20	5.5	38
006A	2719203	6358311	8.11	8.17		8.14	11.89	3.75	4.9	32
007A	2719365	6358712	8.26	8.1	8.43	8.26	12.50	4.23	5.5	34
008A	2719489	6359076	6.62			6.62	12.19	5.57	7.2	46
009A	2719613	6359454	7.4	7.89	6.81	7.37	10.06	2.69	3.5	27
010A	2720946	6355105	2.67	2.59	2.58	2.61	7.01	4.40	5.7	63
012A	2721051	6355492	5.32	5.39	5.53	5.41	8.23	2.82	3.7	34
013A	2721152	6355882	5.57	5.45		5.51	8.53	3.02	3.9	35
014A	2721250	6356291	6.46	6.33		6.40	8.84	2.44	3.2	28
015A	2721355	6356662	5.2	5.13		5.17	9.14	3.98	5.2	44
016A	2721456	6357051	5.79	5.65		5.72	8.84	3.12	4.1	35
017A	2721529	6357440	6.76			6.76	8.23	1.47	1.9	18
018A	2721631	6357829	7.02	5.76	5.93	6.24	9.14	2.91	3.8	32
019A	2721724	6358223	5.93	5.83	5.89	5.88	9.45	3.57	4.6	38
020A	2721835	6358611	5.78			5.78	8.53	2.75	3.6	32
021A	2721934	6359000	5.5			5.50	8.84	3.34	4.3	38
022A	2722055	6359735	5.04			5.04	5.79	0.75	1.0	13
023A	2722012	6360133	2.67	2.33	2.6	2.53	3.96	1.43	1.9	36
024A	2721986	6360534	1.86	1.8	1.99	1.88	2.13	0.25	0.3	12
025A	2723016	6359209	2.21	1.5	3.36	2.36	5.18	2.82	3.7	55
026A	2722711	6359278	4.7	3.43	2.9	3.68	6.10	2.42	3.1	40
027A	2722392	6359336	3.17	3.5	3.5	3.39	5.79	2.40	3.1	41
028A	2722163	6359366	3.8	3.67		3.74	6.71	2.97	3.9	44
029A	2721786	6359442	4.86			4.86	6.71	1.85	2.4	28
030A	2721390	6359520	5.83			5.83	8.53	2.70	3.5	32
031A	2720999	6359600	5.6			5.60	9.60	4.00	5.2	42
032A	2720601	6359677	7.26			7.26	9.14	1.88	2.4	21
033A	2720190	6359759	7.34	6.81	7.55	7.23	9.75	2.52	3.3	26
034A	2719421	6359959	7.76	7.81		7.79	11.28	3.49	4.5	31
035A	2719029	6360036	8.37	8.48		8.43	11.89	3.46	4.5	29
036A	2718638	6360124	7.7	7.93		7.82	11.28	3.46	4.5	31

Appendix 1. Table of results, showing NZMS coordinates (of points), 2002 peat thickness, 1925 peat thickness, and related analyses

Point I.D.	Easting	Northing	2002 thickness(es)(m)			2002 mean thickness (m)	1925 thickness (m)	Total change (m)	Rate of change (cm/yr)	% decrease w.r.t 1925 depths
037A	2718231	6360177	7.94	8.24		8.09	11.58	3.49	4.5	30
038A	2717847	6360257	8.68	8.6		8.64	11.89	3.25	4.2	27
039A	2717451	6360338	7.92	8.15	8.36	8.14	10.82	2.68	3.5	25
040A	2721173	6354611	2.6	2.64	2.77	2.67	2.74	0.07	0.1	3
041A	2721471	6354480	2.28	2.43	2.28	2.33	4.27	1.94	2.5	45
042A	2720812	6354795	1.06	0.98	1.03	1.02	2.44	1.42	1.8	58
043A	2720454	6355004	2.54	2.43	2.44	2.47	4.42	1.95	2.5	44
044A	2720091	6355177	4.1	3.8	4.25	4.05	5.79	1.74	2.3	30
045A	2719731	6355384	4.4	4.05	4.75	4.40	5.49	1.09	1.4	20
046A	2719574	6355663	7.7	7.66	7.87	7.74	8.84	1.10	1.4	12
047A	2719453	6356059	8.72	8.75		8.74	10.67	1.93	2.5	18
048A	2721843	6354714	2.65	2.54	2.6	2.60	3.96	1.37	1.8	34
049A	2722156	6354975	3.42	3.4		3.41	5.18	1.77	2.3	34
050A	2722468	6355236	2.62	2.57	2.6	2.60	4.57	1.98	2.6	43
051A	2722775	6355491	3.1	3.07	3	3.06	4.57	1.52	2.0	33
052A	2722414	6355235	2.66	2.59	2.8	2.68	4.57	1.89	2.5	41
053A	2722165	6355436	3.72	3.59	3.76	3.69	6.10	2.41	3.1	39
054A	2721859	6355700	4.5	4.5	4.38	4.46	6.71	2.25	2.9	33
055A	2721554	6355963	4.86			4.86	7.32	2.46	3.2	34
056A	2721364	6356119	5.46			5.46	8.23	2.77	3.6	34
057A	2719830	6360075	6.81	6.71	6.57	6.70	9.14	2.45	3.2	27
058A	2719936	6360462	6.8	6.76	6.59	6.72	8.53	1.82	2.4	21
059A	2720068	6360842	4.42	4.57	4.67	4.55	7.62	3.07	4.0	40
060A	2720176	6361225	3.02	2.47	2.95	2.81	4.88	2.06	2.7	42
061A	2720296	6361606	2.44	3.02	2.1	2.52	4.57	2.05	2.7	45
062A	2720409	6361987	1.55	1.2	1.23	1.33	2.44	1.11	1.4	46

Mean	25.14	7.66	2.5
Standard dev.	9.16	2.79	1.0
95% C. I.	2.30	0.70	0.3

Appendix 1 (continued)