Investigation of cracking soils: Heddon Bush, January 2018.
Michael Killick, Technical Specialist (Soils and Groundwater Quantity)

On January 30, 2018, I visited dairy farms of the Woldwide group with the owner, Abe de Wolde, in the area of Heddon Bush, to see if we could observe soil cracking as is described for the Central Plains physiographic unit. We looked at a paddock ('Site 1') on the corner of Hundred Line Road and Drummond Heddon Bush Road which in the Topoclimate survey is mapped as Braxton + Pukemutu soils. There were noticeable cracks in the soil at this site, 3-10mm wide, less than 150mm long, 5-10m apart. It was not clear how many cracks might be hidden by pasture, but there were areas of sparse pasture which had no cracks.

A shallow hole (~15cm deep) at the site showed the soil was friable with many small to medium well-formed peds. A creek on the west side of the paddock which is a small tributary of Middle Creek was dry at the culvert where the bed was a metre or so below ground level. Site 1 was described by Abe as wet in winter with areas of standing water, the effects of which could still be observed in the dry conditions of our visit (re-sowing with new pasture had been prevented in one place due to previous muddy conditions). See figures 1-5.

Figure 1. Cracked soil at Site 1.

Figure 2. Uncracked soil at Site 1.

Figure 3. Creek bed at Site 1.

Figure 4. Site 1 locations.


Figure 5. Soil at Site 1.

We also looked at a site ('Site 2') on the north side of Hundred Line Rd mapped as Glenelg soils. This soil did not appear cracked although the soil surface was disrupted by the remains of past pugging so it was not easy to observe. A hole dug to about 15cm depth at this site brought up a number of stones supporting the mapped classification as Glenelg soil.

We walked a transect of approximately 50m at a third site ('Site 3', Figure 7) mapped as Glenelg + Drummond soils (close to the boundary of Braxton + Pukemutu soils). Cracks in this soil were observed at a density of at least one in the region of each stride i.e. $1/m^2$. The cracks were smaller than at Site 1, 2-4mm wide and less than 100mm long (see Figure 6). A hole dug to about 15cm depth at this site brought up two large stones (~90mm) and a number of small stones. A steel ruler was inserted easily into a crack to a depth of ~20cm, but could be inserted with similar ease to similar depth in soil without cracks at the site. (The depth of the cracks could not otherwise be ascertained as it was not visible from the surface and the soil structure and cracks collapsed easily with digging.)

Figure 6. Cracking at Site 3. These cracks do not show up well in the photo because of their smaller size and the high contrast shadows but were easily visible at the time.

A fourth site ('Site 4') on Braxton + Pukemutu soils with heavier pasture cover than sites 1 and 3 showed no cracking although the soil surface was difficult to see beneath the pasture. Large cracks would have been visible if a reasonable number had been there, but possibly smaller cracks such as those at Site 3 might have been present but not seen.

A site mapped as Tuatapere soils on Bayswater Road showed cracking at similar or somewhat greater density than Site 3 and the cracks were a similar or somewhat smaller size. There were frequent small stones on the surface of this soil. Tuatapere soil is described

Figure 7. Site 3 location.

as having stones at greater than 45cm depth, but it is contiguous in this area with stonier soils (Waiau and Glenelg) and may also have been modified by cultivation at some point.

Following the field observations on 30 January, sustained rainfall occurred on the properties and across the region beginning late January 31 and continuing through February 1. At Site 1 further observations were made by Abe to see how it responded to rainfall. At the location described above which was muddy in winter (i.e. where re-sowing had been prevented) no surface ponding occurred after 30mm rainfall or after 60mm rainfall. As this location was a slight depression, prone to ponding in winter, it is not thought that the rainfall was shed in runoff.

At the Environment Southland site, Central Plains Aquifer at Heddon Bush, about 2.7 km from Site 1, rise in the groundwater level in the 6m deep bore occurred within 12 hours of the onset of rainfall. The location of this site is mapped as Braxton and Pukemutu soils but it was found at installation to be stony, so the site description was changed to Glenelg soils. Earlier, lesser rainfall events in January had little effect on groundwater level. See Figure 8.

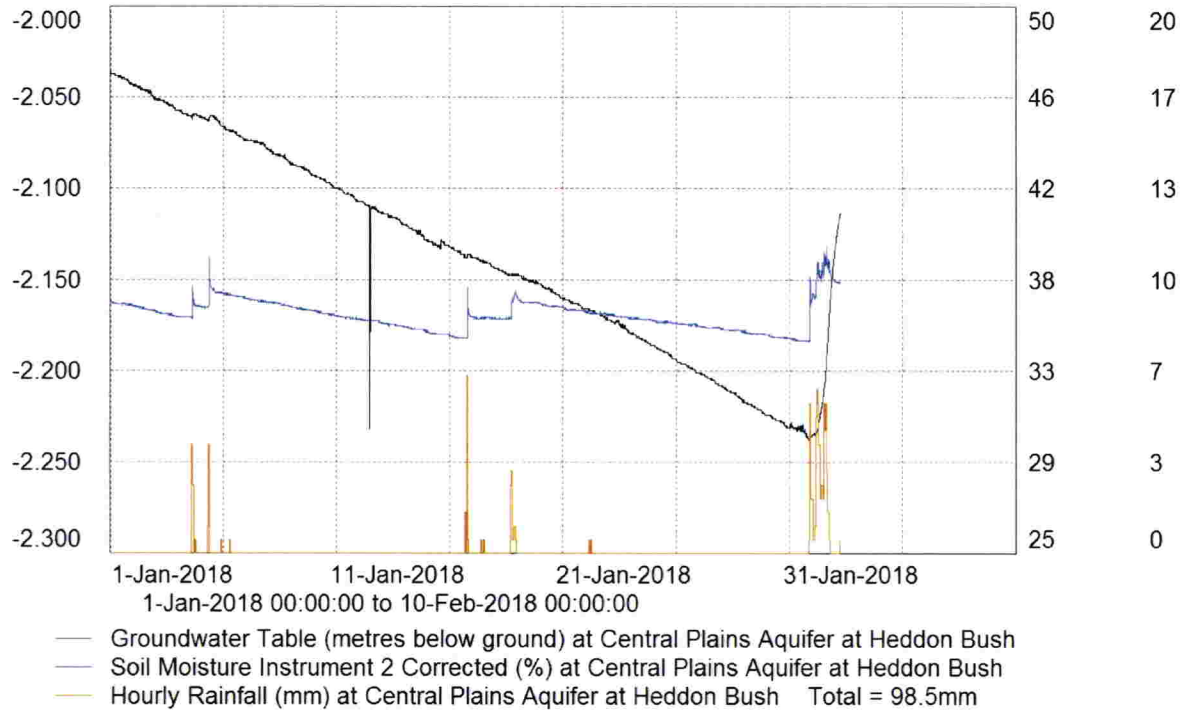

Figure 8. Groundwater level, soil moisture and rainfall at the Environment Southland Heddon Bush monitoring site.

Discussion

All the soils observed were dry and pasture was stressed and sparse to varying degrees. Some soils mapped as Braxton + Pukemutu showed cracks, while other soils with this mapped description did not. Likewise, some stony soils (mapped as Glenelg and Tuatapere) in the area were cracked and some not. It is not surprising that some stony soils were cracked as the fine matrix material in these soils is sourced from the same mafic parent materials in the Takitimu Mountains as the Braxton and Pukemutu soils, and so may also contain clays prone to shrink-swell behaviour. Cracking in stony soils may, however, have drawn less attention in studies of soil behaviour as it would not greatly alter the soil properties from those they are already thought to possess i.e. free drainage with risk of nutrient leaching.

The largest cracks seen were ~10mm wide. Most were 2-5mm wide. As discussed above, some Braxton/Pukemutu soils or variants were not cracked. Glenelg soils at the nearby Environment Southland monitoring site (Central Plains Aquifer at Heddon Bush) had volumetric soil moisture <35% throughout December 2017-January 2018 and <30% for two weeks prior to the observations[1] (and were not visibly cracked). Soil moisture at comparable sustained, low levels was last recorded at the Heddon Bush site in January-February 2008 which was recognized as a drought year. Soil temperature in the two weeks prior to the current observations was 18-27°C. In these conditions further drying of the soil occurs only slowly as the residual moisture is tightly held in fine pores, hence it would take a significant

[1] These soil moisture figures are the average of two calibrated soil moisture sensors at the Heddon Bush site. Calibration is against periodic neutron probe measurements.

continuation or intensification of the conditions then current to make the soils significantly drier with whatever structural changes might accompany that.

It seems reasonable to conclude that the occurrence of very large cracks such as feature in some anecdotes about the soils (e.g. 'to reach your arm into') would now be rare in the soils observed for this investigation, and might not occur. Continued development or changes in management of the soils e.g. the ongoing effects of drainage, or conversion from sheep to dairy, may have influenced the historical pattern of soil behaviour. Or it may be that occurrences of Braxton soils other than those described here, crack more.

The strong, friable structure of the Braxton/Pukemutu soils observed raises the prospect that they may behave as free draining soils when very dry, with or without visible cracking. This behaviour of the dry soils with regard to drainage, and the effects of cracks where present, has not been quantified, but is described in the literature relating to the Central Plains physiographic zone (see following link).

http://eswaterandland.datacomsphere.com.au/southland-science/physiographic-zones/physiographics-and-farm-management

The potential for Braxton and related soils to crack when dry – as was observed for some soils in the investigation described above - has perhaps attracted more attention than the general capacity of these soils for 'bi-modal' transport of leachate and contaminants, as described in the physiographic zone technical sheet, via more general structural changes which may include visible cracking. Understanding the transition from the 'summer soil' to the 'winter soil' – when wetting of dry soils occurs - could help further explain nutrient loss processes in the Central Plains physiographic unit where the observations described above were made.

During the investigation there was some discussion of the possible influence of different pasture conditions, or variations in soil type, on the prevalence or absence of cracking. Some soils in the area are thought to have been mapped previously as Makarewa soils (now Braxton). The distinction between these soils apparently relates to the geomorphic setting with Braxton soils on terraces and Makarewa soils on flood plains (because of this, Makarewa soils may also be younger). It was seen, however, that cracking could occur in a variety of soils in the area. Further investigations could shed light on the influence of pasture condition, soil type and moisture content on the drainage capacities of soils and thresholds of dryness and rainfall associated with deep drainage.

Further pictures of soil cracks follow, at the risk of emphasizing these at the expense of areas where cracks were few or absent. As there are not many pictures of the cracks, however, they are included here for interest.