

to 10% of sheep infected at slaughter in some locations and age categories). This will hopefully shed some light on some of the intrinsic (biological) and extrinsic (environmental) factors that influence the life cycle of the parasite in the Falklands.

Hopefully this article has shed some light on how we use models to control infectious diseases, from theoretical models of complex systems, to data-based statistical models, to more complex simulation models of spread. I want to end by saying that the story does not end there. Models are not a complete solution, and if Covid-19 has taught us anything it is that we need the input and cooperation of people on the ground if a control scheme is going to work. Working closely with you all is central to my project, and I hope to see you all again sometime soon!

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# SOILS IN THE FALKLANDS

*By Jim McAdam, Matthew McNee & Sergio Radic*

## ***The Origin of Falkland Soils***

How has soil developed in the Falklands? Soils are a function of the bedrock and past and present climates. Ice sheets in the last world glaciation, between 14,000 and 25,000 years ago did not completely cover the Islands. Thus, the mixing of material that occurs during glaciation did not obscure soil parent materials. Instead, the Falklands lay in a “peri-glacial” environment, around and near ice caps, but not below them. At that time, the Falklands climate was very cold, freezing and thawing the soil by season, and even in shorter cycles. The result was that rock outcrops were left intact, slopes were smoothed by the process and upstanding stones were pushed into ‘stone runs’. Rock building stopped in the Falklands about 250 million years ago, and the Islands were in their present position by about 150 million years ago. That crucially means that the Falklands have no rocks from the most recent geological periods of Jurassic, Cretaceous and Tertiary, which usually contain lime-rich rocks. The loss to the Falklands of these lime-rich rocks is critical from a soil composition point of view-there are no basic (alkaline) rocks to counteract the acidity in the soils.

## ***Mineral Soils***

The mineral soils of the Falklands have developed by chemical and physical changes from the underlying rocks. What matters is not that the rocks are old or ancient in geological time, but that they are all acid or very acid – as are the related soils. The main difference among the rocks is between the hard, quartz-rich rocks of the mountains lying mainly above 500m (Port Stanley and Port Stephens formations), and the soft rocks of silt stone, mud stone and tillite which form the lowlands (Fox Bay, Port Philomel, Fitzroy and Lafonia formations). The fine soil material of the latter group contains mainly silt and clay particles, and these have a better mineral nutrient store than the quartzite hard rocks. The soils of the latter have very low fertility and thus are likely to need relatively more inputs to improve them for agriculture. The differences in soil nutritional quality are generally reflected in the vegetation. Fine grasses grow in small pockets of the most fertile mineral soils on the islands and large areas of lowland whitegrass are more fertile than mountainous zones which are inhabited by shallow rooted woody shrubs, ferns and mosses. Invasion and woody-thickening of productive grassland areas by woody shrubs like the Diddle-dee is common in rangeland grazing systems world-wide. This phenomenon can indicate a reduction in the nutritional quality of mineral soils, perhaps as a consequence of a changing hydrological cycle and land drying out in line climate change predictions. This is discussed in more detail in relation to peat soils.

## **Aluminium in Falkland Soils**

Falkland soils are known to have exceptionally high levels of Aluminium (Al). Dr Phil Stone, an expert on Falklands' geology writes "Geologically, in the rocks, Al will be held in silicates (feldspar etc) and clay minerals. So you would expect a big difference in the Al content of the Port Stanley quartzite at the low extreme and the mudstones and clay-rich sandstones of the Fox Bay Formation and Lafonia Group at the high extreme. Also, there is quite a lot of feldspar in the Port Stephens quartz-sandstones which would boost their Al levels, and typically rocks have high Aluminium Oxide contents of 12-15%. From comparisons with other areas, the sedimentary rocks might be expected to range from about 5 percent up to about 12 percent. Consequently, soil levels in the Falklands are uniformly high despite the variation in rock types. This may be because there is a layer of clay-rich, loose superficial deposit covering the solid bedrock in the Falklands which is overlain by the peat. This layer contains a lot of kaolinite (a hydrous Al silicate) probably derived from the weathering break-down of feldspar and it may have been relatively uniformly distributed across the islands by wind before "recent" soil formation started". When loss of peat cover exposes this layer, it is easily dried and dispersed by wind which can lead to deep scalds down to bedrock and eroded hillsides.

This is very important for agriculture as any practice which releases more Aluminium into the soil profile is likely to be detrimental to plant growth-further exacerbated by the acid soils. Legumes like clover and, to a lesser extent, lotus are particularly affected by exchangeable aluminium in the soil. This is probably why we have no legumes in the native flora of the Falklands, but from a forage perspective, legumes with their high protein levels and biological nitrogen fixation ability are potentially very important for animal nutrition. Samples collected during the soil survey project have been analysed for exchangeable Aluminium and we will deal with the legume-aluminium issue in future articles.

## **Peat Soils**

Peat is formed where environmental conditions prevent or greatly slow down the decay of dead plant material. These undecayed remains gradually accumulate with other plants continuing to grow on the surface and slowly add to the accumulating organic matter. In most areas of the world where there are peaty soils, the main cause is high rainfall and water-logged conditions preventing the growth of the organisms that drive decomposition. However in the Falklands it is likely that it is low temperatures and wind driven evapotranspiration that restrict the growth of decomposing bacteria and cause peat to accumulate. Falkland's climate is close to semi-arid therefore moisture in peat is valuable. Peatland initiation estimates are quite variable across the Falklands and date back as far as the pre-Holocene era. Annual carbon accumulation rates also range widely but are highest in tussac peat, likely due to high nutrient input from marine birds and mammals.

Peat and peaty soils are an important carbon sink, and are our most stable, long-term land-based carbon storage resource. Peatlands will play a key role in addressing the challenge of climate change. However, climate change predictions are for conditions which make erosion a greater risk so particular care will need to be placed on sustainable soil and vegetation management.

From previous research projects on the risk to the Falklands posed by climate change, key areas identified where soils play a major part are (1) drying-out and larger soil-moisture deficits impacting plant growth (2) [changes in soil organic carbon](#) (3) soil erosion. Climate change is predicted to increase soil moisture deficits with potentially large knock-on effects for plant growth and the soil functions normally associated with peats e.g. slow nutrient cycling, carbon sequestration. In the Falklands, water losses through evapotranspiration during spring and summer are predicted to increase, with a swing towards a greater increase in the spring soil-moisture deficit and only a small increase in those that occur later in the season. The bigger picture is that predicted climate change is likely to lead to Falkland peatlands as a whole becoming a carbon source rather than sink. In the more immediate future, increased spring soil-water deficits have obvious implications for productive and profitable agriculture on the islands. Of note, are effects on the quantity and quality of feed available for grazing livestock transitioning out of a winter-feed deficit and the survivability of lambs. Spring soil water deficits also have

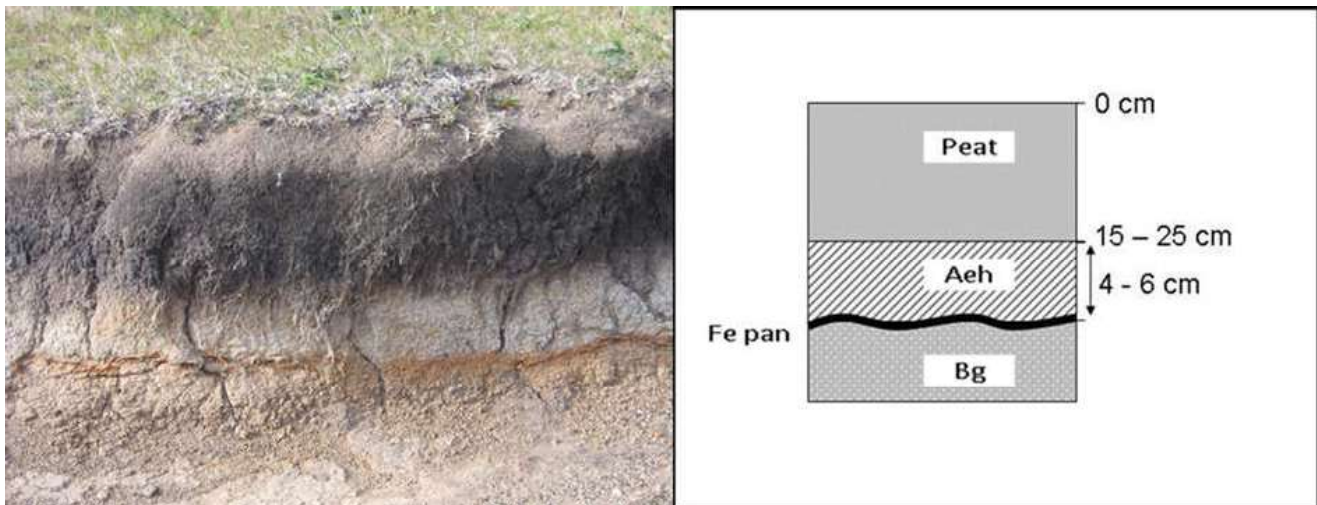
*Continued on pages 18 & 19*

implications for successful crop and pasture establishment. The development of different plant establishment techniques like early deeper sowing / moisture seeking, dry sowing or late time of sowing may be needed.

The implications of the results from this research highlighted the need for a soil type, fertility and depth distribution map. This provides a more accurate assessment of the soil carbon stocks to plan land use strategies which will help ameliorate the risk from climate change and promote sustainable use of the peatlands. The DarwinPLUS-funded soil mapping project currently nearing completion is particularly targeted at farmers and will be a great asset in helping them to sustainably manage the islands' most valuable environmental asset and resource for agricultural production. One of the outcomes of the current soil mapping project is that we will have a better idea of the distribution of peat and mineral soils in the Falklands. We have not completed the analysis yet, but it is more likely that peat soils cover just under a half of the Falklands land area.

## ***The Soil Profile***

An understanding of the soil profile is critical to how we make use of our soils. The commonly found soil profile of the Falkland lowlands (see photo) has 30-35cm surface peaty horizon, overlying a thin bleached horizon (5-10cm), possibly an iron pan (up to 1-2 cm thick), and all overlying the silty clay, poorly drained, mineral subsoil. Ideally, such a soil should be deep ploughed to break up the iron pan and mix the upper part of the subsoil with the surface peat, but such mixing may bring up subsoil with levels of Aluminium likely to be toxic to sown plants. In poor re-seeds this may be a risk worth taking if shallow soil with a low water holding capacity and restricted rooting depth is already constraining production. Applications of lime and phosphate mixes (e.g. calcified seaweed, rock phosphate) are necessary to raise nutrient levels and to lower acidity. In a future article we will look at the results of some of the many trials carried out over the years in the Falklands on liming and phosphate application.



*Typical soil profile with a well - developed Iron Pan*

Peat = A surface organic horizon, variable depth between 15 – 25 cm.

Aeh = A leached and bleached horizon, variable strength and with some humus staining.

Fe pan = An iron pan variable in degree of development. From continuous to a fragmented and discontinuous form.

Bg = Horizon well-weathered, clay-rich (may contain up to 60%).

Adapted from Cruickshank (2001)

## **Surveying and Mapping the Soils of the Falklands**

Soil survey is not an end in itself. It is an inventory, a stock taking of the soil store. Soil survey becomes useful when it is applied to a specific use of soil, soil improvement for agriculture in the Falklands case. The soil mapping project aims to create a national soil map of the Falkland Islands (which will be made available online through a webGIS but also offline to each landowner in the form of PDF maps. These maps will make data such as soil type, chemical properties, pH and bulk density available at farm level at a resolution of 30 m which can then be utilised by farmers as well as agricultural advisors, conservation and research organisations for improved land management. In order to address challenges faced through climate change, the project also aims to establish a baseline for estimation of peat extent, carbon stock and erosion.

The current soil mapping project will throw up a huge range of possibilities for identifying areas best suited to different farming activities and management practices that can sustainably increase land and livestock productivity.

### ***To come.....***

In this article we have looked at the origins of Falklands soils, the types of soils we have, the important asset our soils are for climate change resilience, where the key problems are in soil fertility and using our soils to improve pasture production and nutritional quality. These are all topics we will cover again in future articles in this series. Throughout, we will be referring to results from past trials in the Falklands (and elsewhere) on acid soils and demonstrate the value of the soil mapping database.

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# **RECIPES**

*From Mandy Ford*

## **Salt Beef**

36 Litres Water  
4 egg cups of salt petre  
16 lb salt, (7.25kg)  
Handful pickling spice  
4 lb sugar can be added but if the beef is very fat it can make the fat go slimey.

Combine everything together with hot water to dissolve and when cold add meat, but all meat needs to be under the water. Keep cold and pickle for 21 days.

To cook. Boil for about 4 hours until tender, half way through change the water for fresh and add a cup of sugar.

## **Potted Tongue**

1 x beef tongue

Boil in salted water until tender and skin comes off easy.

Mince while still warm and add onions, salt, pepper and any seasoning you prefer, then press until set enough to slice.