Soil health modelling with APSIM

M.B. Dodd [a], N. Schon [b] and A.D. Mackay [a]

[a] AgResearch Ltd, Grasslands Research Centre, Palmerston North, New Zealand
[b] AgResearch Ltd, Lincoln Research Centre, Lincoln, New Zealand
Email: mike.dodd@agresearch.co.nz

Abstract: Soil health is an integrative concept open to various definitions, e.g., "the continued capacity of soil to function as a vital living ecosystem that sustains plants, animals, and humans" (USDA 2012). It is of increasing interest to farmers and growers seeking to improve the delivery of ecosystem services from soils and ensure that they are resilient to disturbance and fit for future use. Recent promotion of the regenerative agricultural paradigm has soil health as one of its core principles and it is in the context of a research project studying RegenAg practises that we sought to utilise the AgPasture model within the APSIM framework to explore the simulation of soil health attributes to support decision making by pastoral farmers.

There are two aspects to consider: (1) how the metrics currently used for soil health assessment might translate into explicit and implicit model input parameters; and (2) how the available output parameters might be used as collective indictors of ecosystem service provision.

Some fixed input variables in the APSIM soil model correspond directly to metrics used in soil heath assessment, including pH, C:N ratio, water holding capacity (by changing drained upper limit, DUL), saturated hydraulic conductivity and microbial biomass (by changing FBiom). Other dynamic input variables (i.e., initial conditions are set but the values change during the simulation) also correspond directly to metrics used in soil heath assessment, including soil C and N concentrations. Some other key soil health metrics, such as available anions and cations can be incorporated into a growth limiting factor where there are well-developed response functions. The final group of soil health metrics, such as soil redox state, earthworm abundance, toxic contaminants, aggregate stability have no clear proxies.

As an initial step, it is of interest to know how key output variables (relating to specific ecosystem services) respond to variation in these input variables in a sensitivity analysis. This is to address the question of how responsive the model is to variation in those input parameters that might reflect changes in soil health. Table 1 indicates the responsiveness of output parameters to changes in three input parameters (DUL, pH and FBiom) for a case study soil in the Waikato Region of New Zealand. The soil type was a well-drained Otorohanga silt loam under a perennial ryegrass/white clover pasture and the simulation ran for 20 years with historical weather data.

Table 1. Response ranges (in % difference from base simulation) of three ecosystem service metrics to variation in fixed soil health-related input parameters. Response data calculated from the annual means of the last 5 years of a 20-year simulation

APSIM parameter	Range	Herbage yield	N_2O emissions	Topsoil C (0–100 mm)
DUL	± 20%	+9 to -11	-17 to +16	-0.01 to +0.02
pH	± 2 units	0 to +1	0 to -100	Nil
FBiom	0.04 – 0.16	-6 to +9	+2 to <1	-0.01 to +0.01

The model outputs in most cases responded to variation in the key input variables, but at a level that we consider different than might be expected from field observations. Thus, there is scope for both improving the algorithms within APSIM and working to find better proxies to reflect these relationships.

REFERENCES

USDA, 2012, https://www.nrcs.usda.gov/conservation-basics/natural-resource-concerns/soils/soil-health

Keywords: *Soil health, APSIM, pasture, input variables*