Climate change is expected to alter regional temperature and precipitation patterns and will subsequently impact soils and the distribution of plants and animals. Understanding how soils might vary with climate change will allow us to better prepare for and adapt to the altered soil conditions, according to Jonathan Gray, Senior Scientist with the New South Wales (NSW) Government Office of Environment and Heritage. And this, he says should ultimately improve our management of agricultural lands and native ecosystems into the future.

Gray describes a novel approach to modeling potential changes in soil organic carbon (SOC) as the lead author on a recent paper in the *Soil Science Society of America Journal* titled, “Change in Soil Organic Carbon Stocks under Twelve Climate Change Projections over New South Wales, Australia.”

The researchers used digital soil mapping (DSM) in combination with space-for-time substitution (SFTS) to model changes in SOC. Gray says this method “was an alternative to the dynamic process modeling that is normally applied in similar studies.” The authors believed this was a conceptually simple but robust approach, suitable for providing predictions at a finer scale, and one of the objectives of the study was to demonstrate the validity of this method.

According to Gray, this analysis focused on SOC because “it is a major determinant of soil health,” influencing many chemical, physical, and biological properties such as fertility, water-holding capacity, and biological activity, and it is also important for carbon sequestration and potential climate change mitigation programs.

Gray and his fellow researchers selected four global climate models, CSIRO_MK30, CCCMA31, ECHAM5, and MIROC32 (developed by research groups in Australia, Canada, Germany, and Japan, respectively). Each global model was downscaled with three regional climate models, resulting in a total of 12 climate change projections. These models were selected on the basis that they reflected a full and varied range of projected future climate outcomes.

The authors mapped SOC for three time periods: current conditions (1999–2009), near future (2020–2039), and far future (2060–2079) at five soil depths. This resulted in 180 maps. To determine the change in SOC, the two future projections were compared with the current conditions. The final results were presented at just two depth intervals: 0–30 cm and 30–100 cm.

There was much variation in SOC predictions among the 12 climate projections, but Gray points out that some broad trends were apparent at both the state and regional levels. For example, he says all 12 climate projections predicted a loss in SOC over the alpine areas in the southeast of the state. The researchers also observed the “wetter” models (CCCMA31, MIROC32) consistently predicted an increase in SOC over time while the “drier” models (CSIRO_MK30, ECHAM5) predicted a loss in SOC.

When comparing the different projections for different soil types, the authors noted...
systematic variation for soil type, current climate, and land use regimes.

“The projected average decline of SOC across NSW to 2070 was less than 1 Mg/ha for sandy, low-fertility soils in dry conditions under cropping regimes but over 15 Mg/ha for clay-rich, fertile soils in wet conditions under native vegetation regimes,” Gray says. Understanding how different soil types are likely to respond to changes in climate could help in planning efforts to reduce SOC loss or maximize SOC gains.

The differences in predicted SOC among models were also important as they point to the variation in climate models.

“We need more consistency and reliability in climate change models,” Gray says, “especially with respect to changing rainfall, in order to reliably predict soil property change due to climate change.”

The authors were able to demonstrate the usefulness of this method, but also see room for improvement in terms of reducing some of the uncertainty and incorporating other soil properties and updated climate models in future analyses.

The series of maps produced in this analysis are of interest to many stakeholders. Economic modelers are interested in SOC for future carbon trading, nature reserve managers could predict changes in plant distribution based on changes in soil properties, and agricultural land managers are interested in future soil conditions with consideration of soil amendments or changes in crop suitability. Although there are limitations to these models, Gray says recognizing that a change in SOC and other soil properties is coming, along with the likely direction of change, will be important for these groups and other individuals interested in planning for future climate and soil conditions.

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View the open access Soil Science Society of America article, “Change in Soil Organic Carbon Stocks under Twelve Climate Change Projections over New South Wales, Australia,” online at dx.doi.org/doi:10.2136/sssaj2016.02.0038

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