



Digital Soil Mapping for Agricultural Land Evaluation in Chilean Landscapes

Sam Diaz*

Department of Agricultural Sciences, University of Chile, Santiago, Chile

DESCRIPTION

Digital soil mapping is increasingly applied in agricultural regions of Chile where terrain diversity and climate variation create strong differences in soil conditions over short distances. In many farming zones, especially those extending from coastal valleys to inland slopes, soil characteristics can shift significantly even within a single property. These variations influence water retention, nutrient availability, root development, and long-term field productivity. Digital soil mapping provides a structured way to represent these differences using spatial data combined with field measurements and environmental information.

In Chilean agricultural systems, traditional soil surveys have been used for decades to describe soil types and classify land suitability. These surveys rely on field sampling and laboratory testing, but they often cover limited points due to logistical constraints. Large agricultural areas, particularly those with complex terrain, are difficult to sample in detail using only conventional methods. Digital soil mapping extends this approach by integrating observed soil data with environmental indicators such as elevation, slope orientation, climate records, satellite imagery, and vegetation patterns. This combination allows estimation of soil properties in areas where direct sampling has not been performed.

Geographic information systems play a central role in organizing soil-related datasets. Each soil sample collected in the field can be linked to precise geographic coordinates, allowing the creation of spatial layers that represent different soil attributes. These layers can be compared with environmental variables to identify patterns. In Chile, for example, vineyards located on sun-exposed slopes may show different soil moisture behavior compared to those in shaded valley positions. Similarly, areas closer to river systems may display higher organic content due to sediment deposition processes over time.

Remote sensing data contributes additional information for soil interpretation. Satellite imagery captures surface reflectance across multiple spectral bands, which can be processed to

estimate vegetation vigor, surface moisture conditions, and mineral composition indicators. In agricultural regions of central Chile, seasonal changes in vegetation cover can help infer underlying soil conditions. Although remote sensing does not directly measure soil properties below the surface, it provides useful indirect signals that improve spatial estimation when combined with field data.

Terrain analysis is particularly important in Chile due to the strong influence of the Andes and coastal mountain ranges. Digital elevation models allow extraction of variables such as slope gradient, aspect, curvature, and relative position in the landscape. These factors influence erosion processes, water movement, and soil depth distribution. Steeper areas often experience greater soil displacement, while lower-lying zones may accumulate finer particles and organic material. By incorporating these terrain variables into spatial models, soil property predictions become more consistent across varied landscapes.

Field sampling remains essential for building reliable digital soil maps. Soil samples collected from different locations provide measured values that serve as reference points for modeling. Sampling strategies in Chilean agricultural regions often need to account for elevation changes, irrigation systems, and land use differences. Grid-based sampling may be used in uniform fields, while stratified approaches are more suitable in areas with mixed terrain conditions. The selection of sampling locations directly influences the quality of the resulting soil predictions.

Laboratory analysis of soil samples provides detailed measurements of physical and chemical properties. Common parameters include soil reaction levels, nutrient concentrations, organic matter content, particle size distribution, and water retention capacity. These measurements are stored in databases and linked to spatial coordinates. When combined with environmental predictors, they form the basis for statistical and computational modeling. The accuracy of soil maps depends on the consistency of laboratory procedures and the representativeness of the collected samples.

Correspondence to: Sam Diaz, Department of Agricultural Sciences, University of Chile, Santiago, Chile, E-mail: sam.diaz@uchile.cl

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CONCLUSION

Digital soil mapping in Chile therefore represents a practical method for understanding complex soil variation across diverse landscapes. By combining field observations, laboratory analysis, remote sensing, terrain modelling, and computational

techniques, it provides a structured way to represent soil conditions in digital form. This information supports improved agricultural planning, more efficient resource use, and better understanding of land behaviour across different environmental settings.