# THE USE OF REFLECTANCE SPECTROSCOPY (VIS-NIR-SWIR-MIR) TO PREDICT SOIL TEXTURE

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## Introduction

The soil texture is the proportional distribution of sand, silt and clay particles in the soil mass and influences the distribution and size of the pores, which influence soil water dynamics and retention, and its analysis is important for planning of use and management of soil. Besides traditional methods, countless studies with sensors are beinf carried out, but few integratively. The aim of this study was to predict the content of soil texture in subtropical soils, using the spectral range of visible, near infrared, short wave infrared (VNS) and mid- infrared (MIR) regions individually and together (VNS-M)

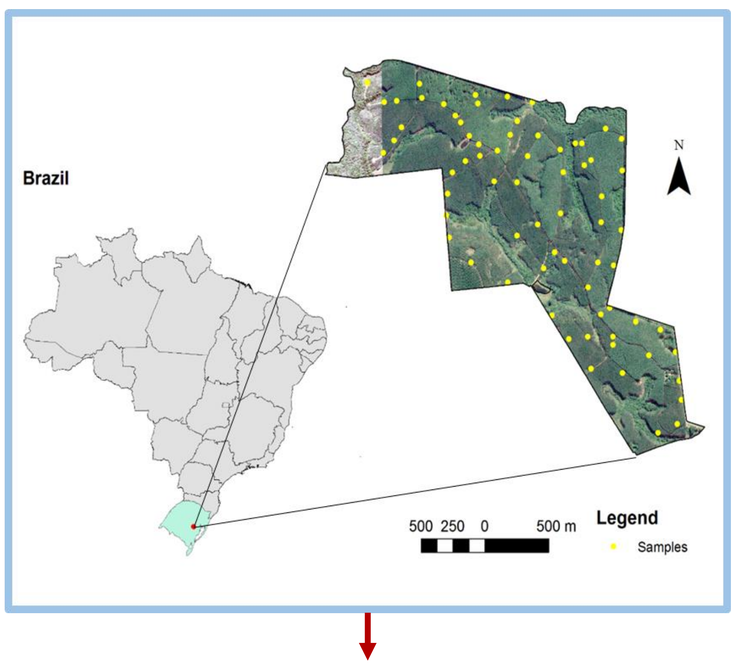


fig 1a. study area

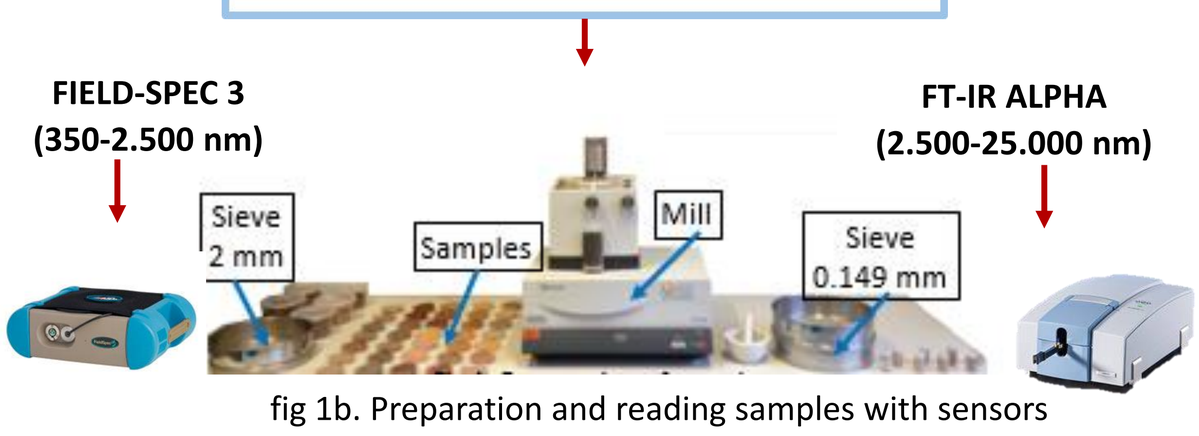


fig 1b. Preparation and reading samples with sensors

## Methodology

- A total of 197 samples were collected at depths of 0-20, 20-40 and 40-60 cm, in the state of Rio Grande do Sul, Brazil (fig. 1a).
- The soil samples were air dried, then milled and sieved. Fractions smaller than 2 mm were used in the soil texture and VNS analysis. For MIR analysis, the soil samples were milled and sieved at 100 mesh (fig 1b).
- The data set was randomly separated in training (70%) and validation samples (30%) to generate calibration models for the texture prediction, using the Cubist algorithm
- The coefficient of determination ($R^2$) and root mean square error (RMSE) were used to determine the performance of each prediction model

## Results

The modeling results showed a good prediction performance for sand and clay, however, inferior results were obtained for silt.

For clay content, the $R^2$ values obtained was very high in the training (0.92, 0.96 and 0.97) and in the validation (0.89, 0.94 and 0.94) with a low error in prediction (RMSE of 5.2, 3.7 and 3.6%), considering the VNS, MIR and VNS-M models, respectively (Table 1).

For the sand content, the results were also significant. The prediction of silt did not obtained a good results compared to clay and sand models.

**Table 1.** Performances of the models for clay and sand content applying Cubist algorithm in the reflectance spectroscopy ranges of visible, near and short wave infrared (VNS), mid-infrared (MIR) and both combined (VNS-M).

| Soil Attribute | Spectral range | Calibration | | Validation | |
|---|---|---|---|---|---|
| | | $R^2$ | RMSE % | $R^2$ | RMSE % |
| Clay | VNS | 0.92 | 4.2 | 0.89 | 5.2 |
| | MIR | 0.96 | 2.8 | 0.94 | 3.7 |
| | VNS-M | 0.97 | 2.7 | 0.94 | 3.6 |
| Sand | VNS | 0.87 | 5.4 | 0.81 | 6.5 |
| | MIR | 0.96 | 3.2 | 0.88 | 5 |
| | VNS-M | 0.96 | 3.1 | 0.88 | 5.1 |

## Conclusion

MIR presented a greater potential to quantify clay and sand content compared to the VNS, showing excellent performance for efficient analysis of soil particle-size. This result was made possible by the use of the Cubist model, therefore, it can be used to complement the standard analysis and reach the largest number of analyses in shorter time reducing costs.

Thus, it is believed that soil reflectance spectroscopy can enhance standard methods of analysis, saving time, reducing costs and facilitating the provision of data for digital soil mapping.

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