Geophysical Research Abstracts,
Vol. 11, EGU2009-7475-1, 2009
EGU General Assembly 2009

Comparative approaches from empirical to mechanistic simulation modelling in Land Evaluation studies

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The Land Evaluation (LE) comprise the evaluation procedures to asses the attitudes of the land to a generic or specific use (e.g. biomass production). From local to regional and national scale the approach to the land use planning should requires a deep knowledge of the processes that drive the functioning of the soil-plant-atmosphere system.
According to the classical approaches the assessment of attitudes is the result of a qualitative comparison between the land/soil physical properties and the land use requirements. These approaches have a quick and inexpensive applicability; however, they are based on empirical and qualitative models with a basic knowledge structure specifically built for a specific landscape and for the specific object of the evaluation (e.g. crop). The outcome from this situation is the huge difficulties in the spatial extrapolation of the LE results and the rigidity of the system.
Modern techniques instead, rely on the application of mechanistic and quantitative simulation modelling that allow a dynamic characterisation of the interrelated physical and chemical processes taking place in the soil landscape. Moreover, the insertion of physical based rules in the LE procedure may make it less difficult in terms of both extending spatially the results and changing the object (e.g. crop species, nitrate dynamics, etc.) of the evaluation. On the other side these modern approaches require high quality and quantity of input data that cause a significant increase in costs. In this scenario nowadays the LE expert is asked to choose the best LE methodology considering costs, complexity of the procedure and benefits in handling a specific land evaluation.
In this work we performed a forage maize land suitability study by comparing 9 different methods having increasing complexity and costs. The study area, of about 2000 ha, is located in North Italy in the Lodi plain (Po valley). The range of the 9 employed methods ranged from standard LE approaches to the extensive use of simulation modelling (SWAP and CropSyst), using as data input pre-existing soil information (soil map 1:50000) and also hydraulic properties measured as well estimated by PTF.
The comparison between the different methods was based on both cost and predictive ability of each of the methods. The latter was evaluated by comparison to the estimate of forage maize biomass obtained by using locally tested remote sensing measurements. Statistical indexes like correlation, relative variance and ANOVA test were applied.
As expected, higher method complexity corresponds to higher quality/quantity of input parameters and as consequence higher costs. Generally, results show that more complex methods gave better results in terms of their predictive ability and those operating on measurements gave better performance than those operating on PTF. Moreover, the best predictive results were obtained abandoning the support of the soil mapping units, incrementing dramatically the number of sampling and analysis and applying the simulation modelling on real benchmark soils rather than averaging more soils observations.

Keywords: Land Evaluation, simulation modelling, CropSyst, SWAP, NDVI.