Towards a Framework for Linking Soil-Landscape Modelling and Land Evaluation

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1.   Abstract of Poster

Land evaluations involve manual or automated qualitative expert judgements, quantified empirical modeling, mechanistic process modeling or some combination of these methods. In either case, land evaluations heavily depend on soils data. In most projects the soil survey, construction of the soil data base and land evaluation are carried out by different scientists. These scientists may use different space-time concepts to model their objects of study. For example, while soil-landscape models are two or three-dimensional spatial representations, land evaluation usually does not take into account interactions among different spatial elements. Especially at small scales, when the mapping units comprise compound soil units, it is difficult to exercise zero or one dimensional land evaluation on soil survey data. We argue that there is a need for a common conceptual and methodological framework to bridge the gap between soil-landscape modeling and land evaluation. Our poster explores this problem for the Guadalhorce catchment area near Alora, Southern Spain.

A hierarchical description of the soil-landscape has been developed and stored in a GIS. The a-biotic landscape was mapped at three main scale levels: point/facet, landform elements and major landforms.

Two Land Use Types are defined with a different homogeneity: the 'Dehesa' system (a compound agroforestry Land Use Type) and wheat. The suitability of the landform elements for the defined land use types has been evaluated with the WOFOST crop yield and ALES land evaluation model.

The transformation of the 2-D landscape data from the GIS to the 1-dimensional evaluation models formed a technical problem. This was solved by developing, programs which convert the data from the GIS to the models vice versa.

At the lowest level of aggregation one elementary land unit combines with an elementary LUT to form a simple LUS. This system can be evaluated by way of mechanistic process modeling.

At the next higher level the LUS becomes compound. It consists of the combination of a compound land unit and an elementary (spatially not decomposable) LUT. The compound LUS can be decomposed into its elementary components, which could be evaluated

separately. However, LUS behaviour is not only determined by the states of the individual LUS components; it also depends on the interactions among these components. At this level, LUS complexity and data requirement make it practically unfeasible to use mechanistic process modeling for system evaluation.

At the third level the LUS is composed of both a compound land unit and a compound LUT. At this level of aggregation, besides the interactions among the LUS components, land evaluation is confronted with a LUT allocation problem. Our poster exemplifies in a graphical way how land evaluation through proper model selection and system definition, can cope with data requirement and system complexity at different levels of aggregation.

See Poster on the Next Page

Towards a framework to link soil-landscape modelling and land evaluation

Problem statement

Land evaluations involve manual or automated qualitative expert judgements, quantified empirical modelling, mechanistic process modelling or a combination of these methods. In either case, land evaluations heavily depend on soil data. In most projects the soil survey, construction of the soil data base and land evaluation are carried out by different scientists. These scientists may use different space-time concepts to model their objects of study. Especially at small scales, when the mapping units comprise compound soil units, it is difficult to exercise zero or one dimensional land evaluation on soil survey data. We argue that there is a need for a common conceptual and methodological framework. This poster explores how the gap between soil-landscape modelling and land evaluation could be bridged, with an example for the Guadalhorce catchment area near Alora, Southern Spain.

Land Use Types:

Dehesa
- *wheat*
- *holmoak*
- *olive*
- *pasture*

(3)

Land Mapping Units
major landform

LMU elements

LUT elements

interactions

interactions

Landscape Model → conversion → **Land Evaluation Model** → conversion → **Suitability Map**

Major landform
Hsc2 = Erosional landform, fluvial capped hill with adjacent slopes, intermediate with old terrace remnants

Allocation models (2D)

- optimisation
- multi-criteria

(should include spatial interaction among LU's and LUT's)

holm- oak

(2)

landform element

LMU elements

LUT

interactions

Landform elements
GeL6 = Erosion glacis, carbonate rich over marl
HuM0 = Hills/mountains, > 80% marl
C3M2 = Landslide mod. slope, marl+sandstone
O1L1 = Very old river terrace, carbonate rich mixed, n
O1L6 = Very old river terrace, carbonate rich over mar

Expert models
- for example: ALES (meta-model (1D)- GIS (2D) interaction);
meta-model can be supported by process models

Suitability map for holm-oak
- S1 highly suitable
- S2 suitable
- N2 not suitable

wheat

(1)

point/ facet

LMU

LUT

Facets/points: morphographic + soil characteristics
- crest
- slope
- scarp
- valley side
- terrace
- footslope
- bottom, plain, depression

Mechanistic and empirical process models
- for example WOFOST (1D)
(model (1D)-interactions are regarded as input-output)

Modelled yield Winter Wheat
- 4084 kg/ha
- 2926 kg/ha
- 3214 kg/ha

Methodology

A hierarchical description of the soil-landscape has been developed and stored in a GIS. The a-biotic landscape was mapped at three main scale levels: point/facet (1), landform elements (2) and major landforms (3).

Two Land Use Types are defined with a different homogeneity: the 'Dehesa' system (a compound agroforestry Land Use Type) and wheat. The suitability of the landform elements for the defined land use types was evaluated with the WOFOST crop yield (Wheat) and ALES land evaluation model (Holm Oak, a component of 'Dehesa').

The problem of transformation of the 2D landscape data to the 1D evaluation models was solved by developing programs which convert the data from the GIS to the models and vice versa.

Towards a framework........

- At the lowest level of aggregation (1) one elementary LMU combines with an elementary LUT to form a simple LUS. This system can be evaluated by way of mechanistic process modelling.
- At the next higher level (2) the LUS becomes compound: a combination of a compound LMU and an elementary (spatially not decomposable) LUT. The compound LUS can be decomposed into its elementary components, which could be evaluated separately.
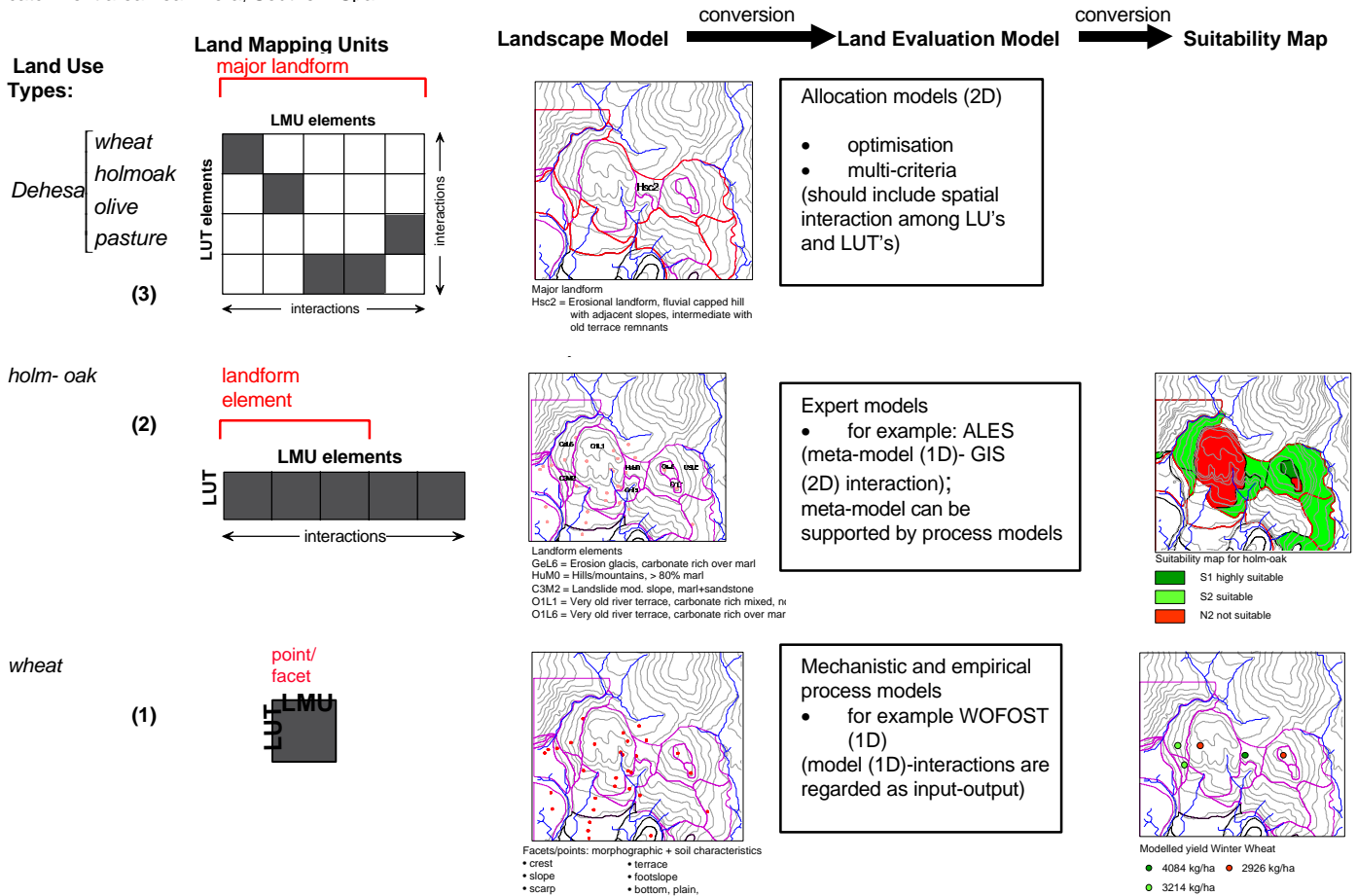- At the third level (3) the LUS is composed of both a compound LMU and a compound LUT. At this level of aggregation, besides the interactions among the LUS components, land evaluation is confronted with a LUT allocation problem, which requires optimisation or multi-criteria evaluation
- The existing (1D) land evaluation models do not take into account spatial interaction between components, which occur at two levels of complexity: among only LMU's and among both LMU's and LUTs.At these levels, LUS complexity and data requirement make it practically unfeasible to use mechanistic process modelling for system evaluation.

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PRODUCTION ECOLOGY

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