

Land Use Systems Analysis



(A selection of) Difficulties faced

P.M. Driessen

Single LUS: one LUT on one LU

- LUT (primary production) is described by *crop data and management info*
- LU is described by *land data (soil data, weather data, topography info)*
- Note that Crop, Soil and Weather data change over time: *dynamic analysis needed*

The Algorithm

- The LUS model describes a complex system
- “WE SIMPLIFY”
- “WE SMPLFY” (*2 bytes saved; strong message*)
- “WE SPLFY” (*3 bytes saved; less clear message*)
- “WE SPY” (*5 bytes saved; wrong message*)

The Analysis Procedure



- *State Variable Approach*: divide crop cycle in successive intervals and adjust variable values after each set of interval calculations
- *Temporal resolution*: Interval lengths are dictated by most dynamic process in the LUS (compromise: 1 day)
- *Spatial resolution*: size of LU/field/pixel

Production Situation 1 (PS1)

- We need a Reference : “What would we produce with perfect management?”
- $Prod(PS1) = f(\text{crop, irradiance, temp.})$
- Note: PS1 resembles the situation of an adequately fertilized plot in a field experiment. Soil/land properties and management are “non-limiting”

Production Situation 2 (PS2):

$$Prod(PS2) = f(\text{crop}, \text{irrad.}, \text{temp. and } \underline{\text{water}})$$

- Water availability is matched with crop water needs; water shortage/excess affects assimilation and production
- PS2 applies to *capital-intensive* farming with fertilizer application, crop protection and harvest methods assumed “*non-limiting*”
- PS2/PS1 is an expression of the adequacy of water management

Data needs for PS2-analyses

- One complete data set for each time interval in the crop cycle: *weather data, crop data, soil/land data, management specifications.*
- *Soil data: mainly soil physical data (soil moisture retention, saturated and unsaturated hydraulic conductivity, infiltration curves)*
- In practice: Class *pedotransfer functions: $f(\text{soil texture class and vol. gravel content})$*

“Standard Soil Data”



- *Pore geometry* dictates soil water *retention* and *movement*
- For practical reasons *pore geometry* is related to *soil texture class*
- *Field estimates* (by a competent soil scientist) *outperform “standard” lab. data* (no errors incurred in sample storage, pretreatment and analysis procedures)!

“*Standard Soil Data (cont’d)*”


- Standard Soil Data were (mainly) meant to support *soil classification*. Using Standard Soil Data in LUS analysis/land evaluation is dangerous!
- Example: “*cotton will fail at ESP > 16*”
(Recall that $ESP = 100 * Na / CEC$; CEC is determined in 1 M NH₄-acetate buffered to pH 7.0. **CEC is pH-dependent!**
Field-pH in Wad Medani (Sudan) $\gg 8.5$. *Measured* ESP is $\gg 16$ but *actual* ESP is not. Cotton grows and produces just fine.)

Production Situation 3 (PS3)

Prod.=f(crop, irrad.,temp.,water, nutrients)

- PS3 is (as yet) too complex to be handled by a dynamic model: *nutrient budgets* are calculated instead.
- Output after PS3-calculations: reference production potential (PS1), water-limited production potential (PS2)+ approximate fertilizer input requirements.

LUSA is not LE !

- 
- LUSA is a tool in LE (*to explore what would happen if...*)
 - LUSA is still under development but results obtained so far are most encouraging.
 - *A much needed word of caution:* LUSA has the appeal of a Maserati sports car. It is a wonderful thing but you need a driving license...