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Modelling the interaction between soil processes

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Modelling the interaction between soil processes

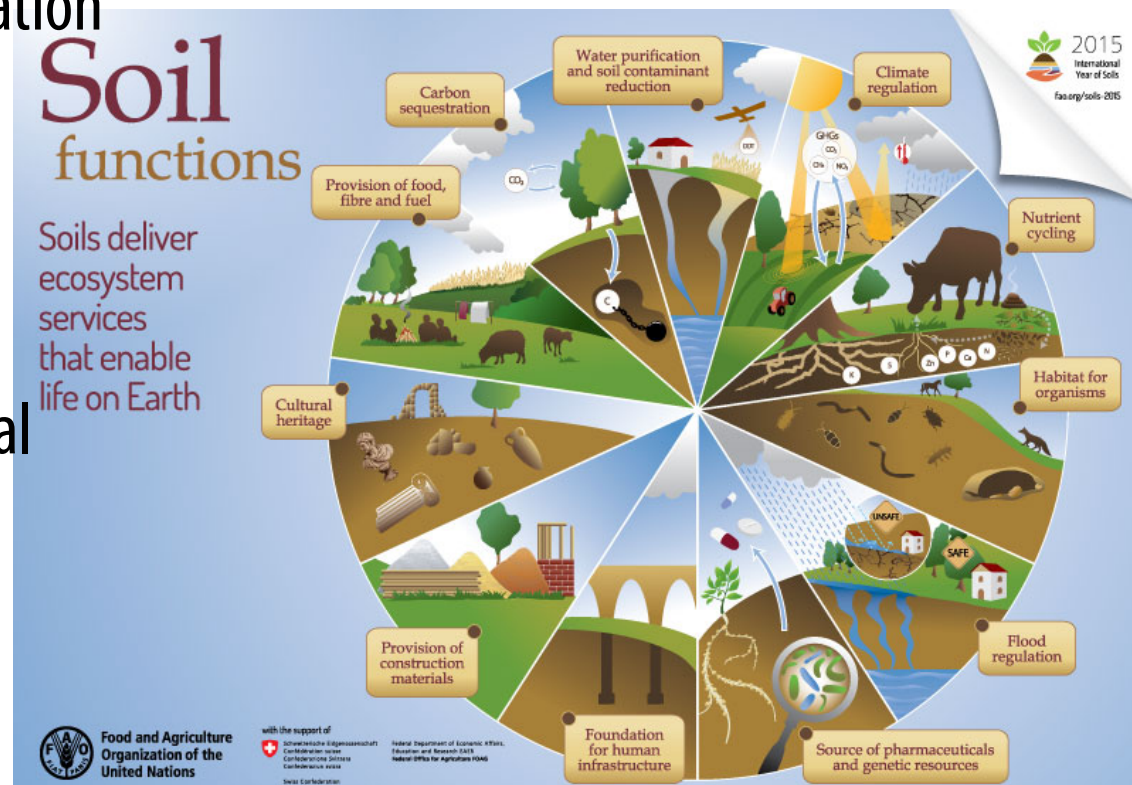
Sophie Leguédais

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Christophe Schwartz, Jean Louis Morel*

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Why modelling the interaction between soil processes?

- For ecosystem services assessment
- To quantify the impact of global changes on soil and the role of soil on global changes
 - Climate change and C sequestration
 - Nitrogen cascade and denitrification
- To be able to represent soil along a gradient of anthropization
 - Physical, biological and chemical processes

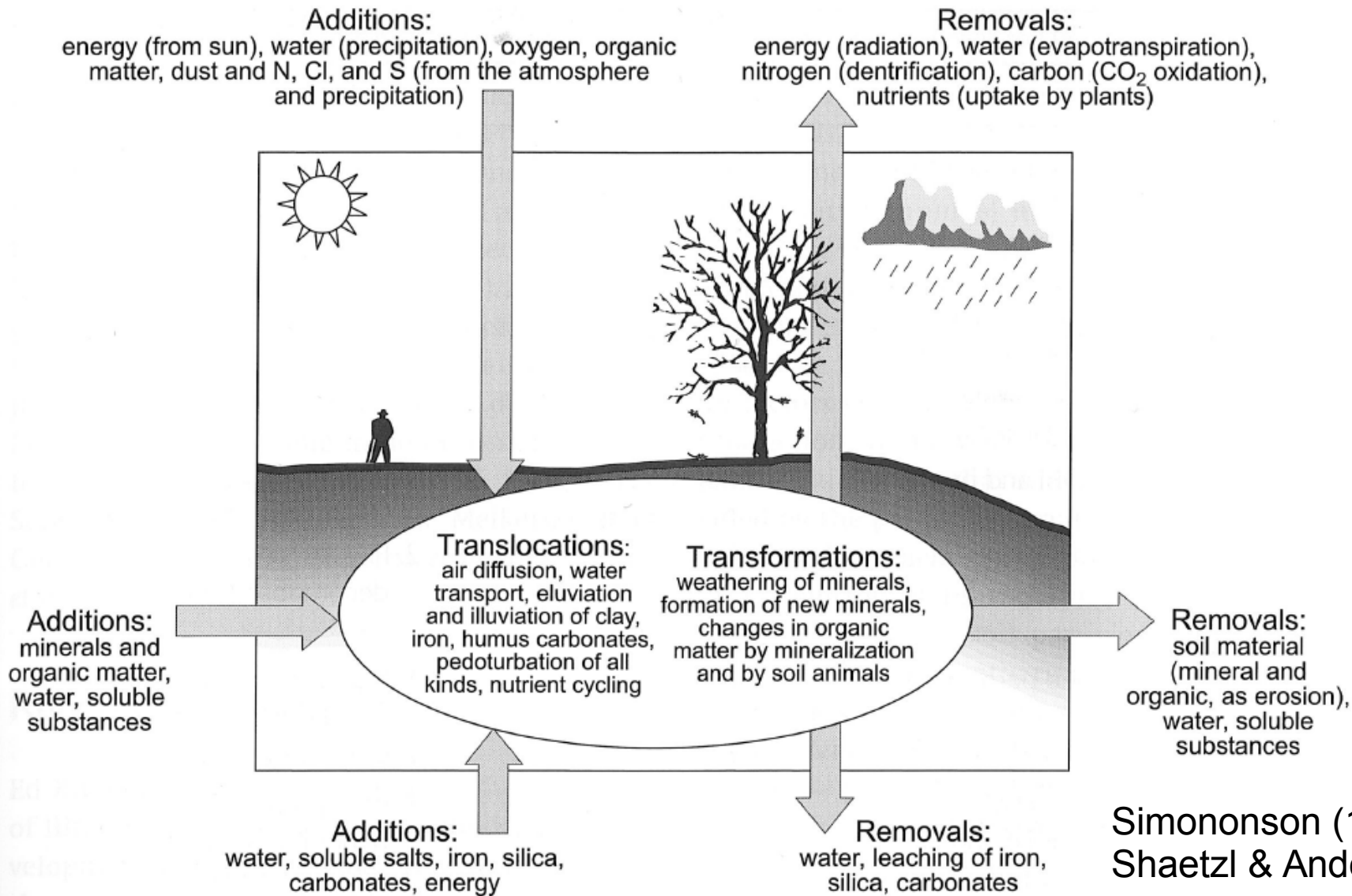


Are processes the same in soils along a gradient of anthropization?

- What are your thoughts after those 4 days of summer school?

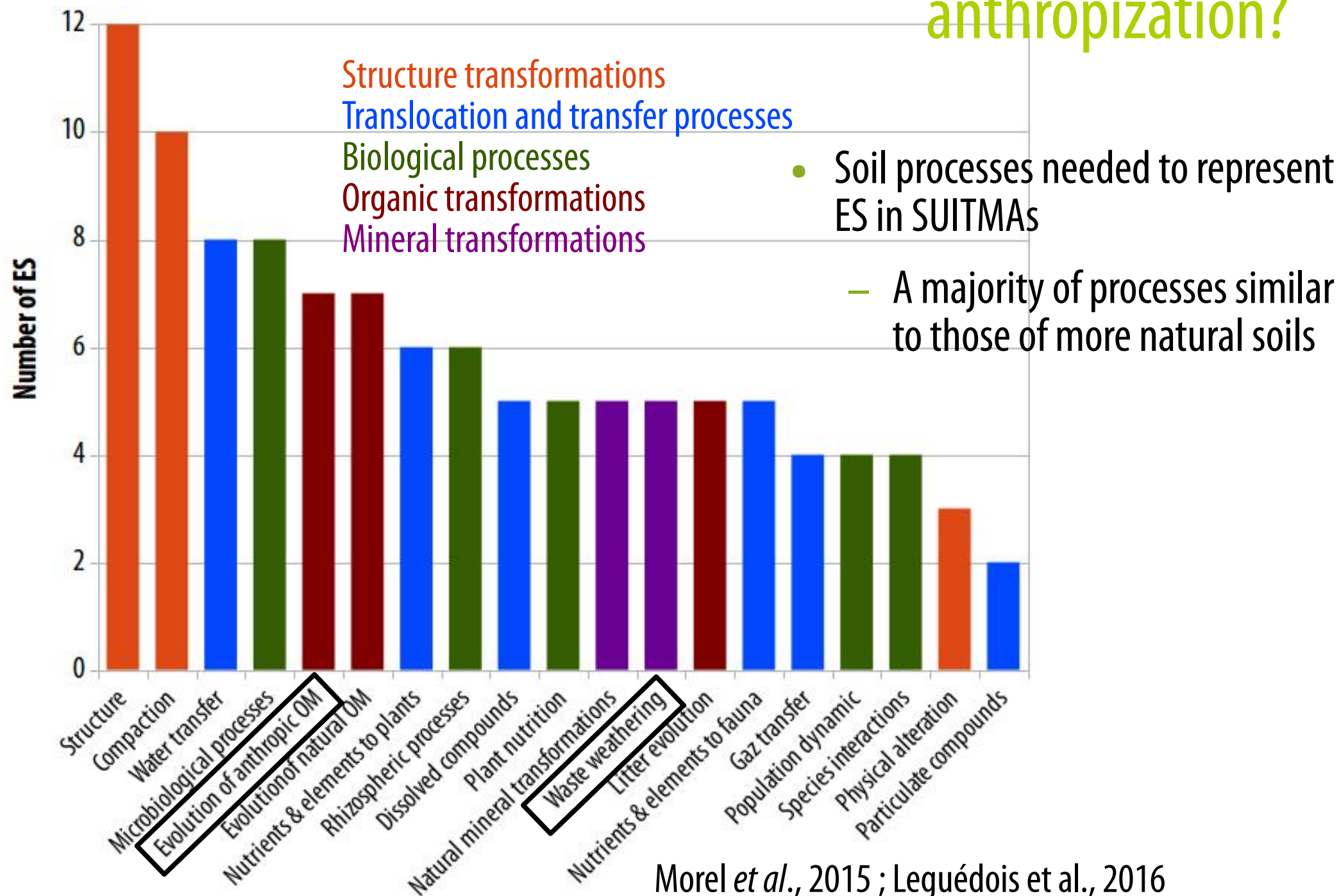
Are processes the same in soils along a gradient of anthropization?

- Processes in “natural” soils



Simononson (1978)
Shaetzi & Anderson (2005)

Are processes the same in soils along a gradient of anthropization?

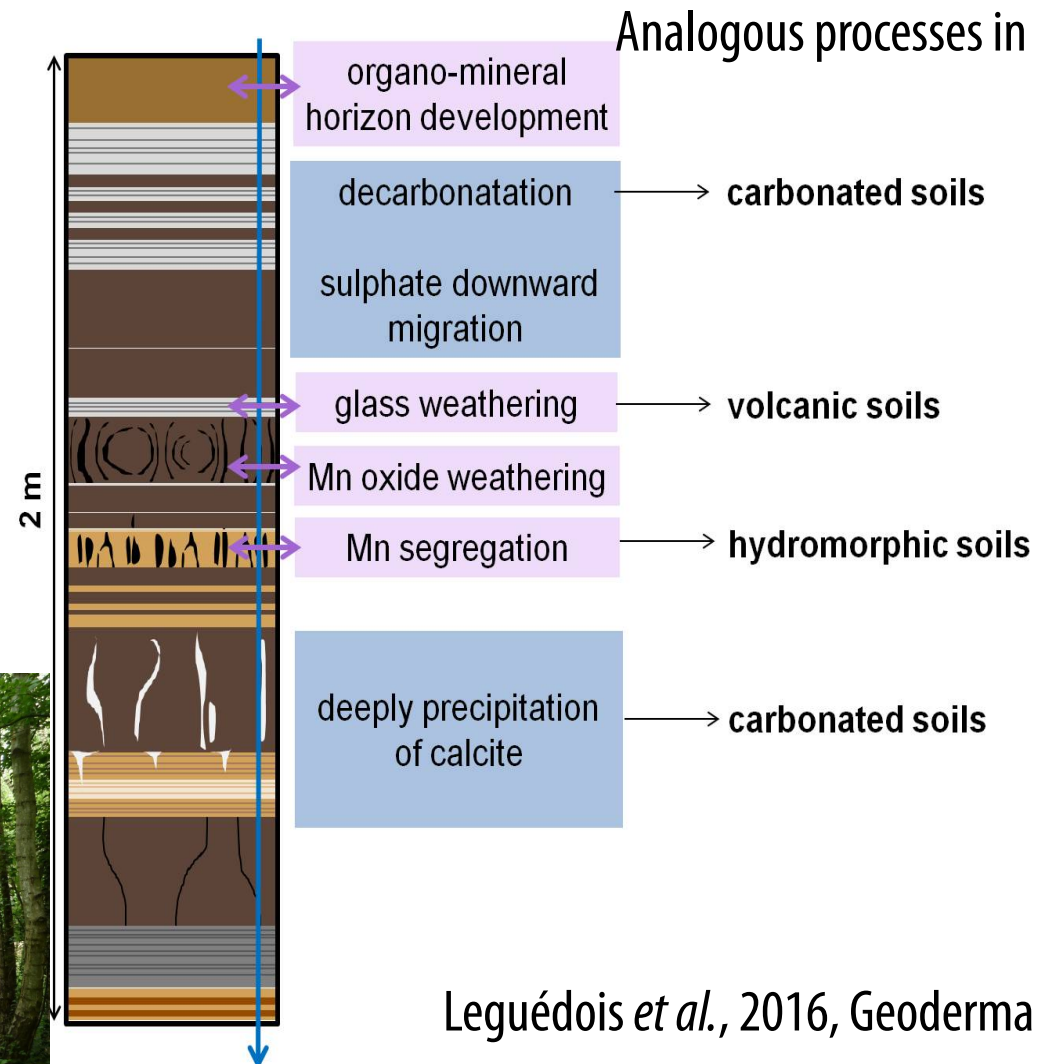


Are processes the same in soils along a gradient of anthropization?

- Example: pedogenic processes observed in a Technosol
 - Occurrence of a wide variety of processes in SUITMAs
 - Unexpected combinations of processes

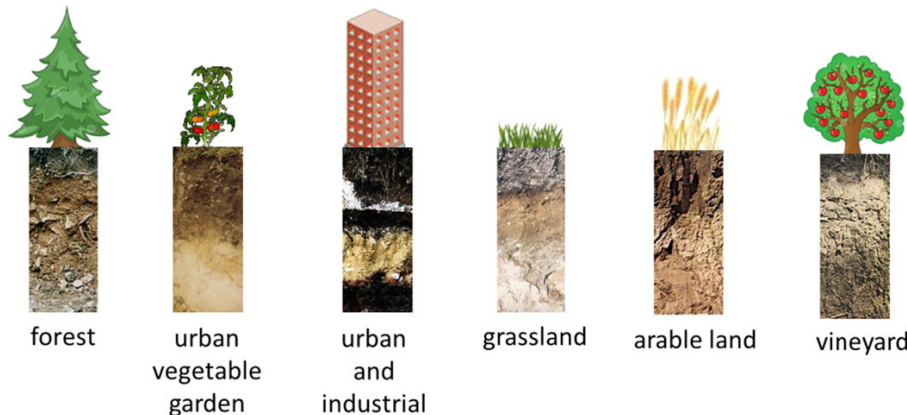
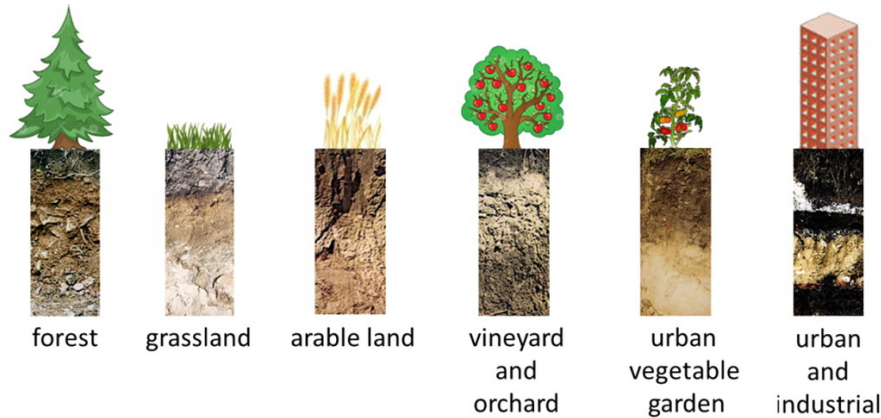


Spolic Technosol



Leguédouis *et al.*, 2016, Geoderma
Huot *et al.*, 2015, Soil Science

Do processes act the same in soils along a gradient of anthropization?



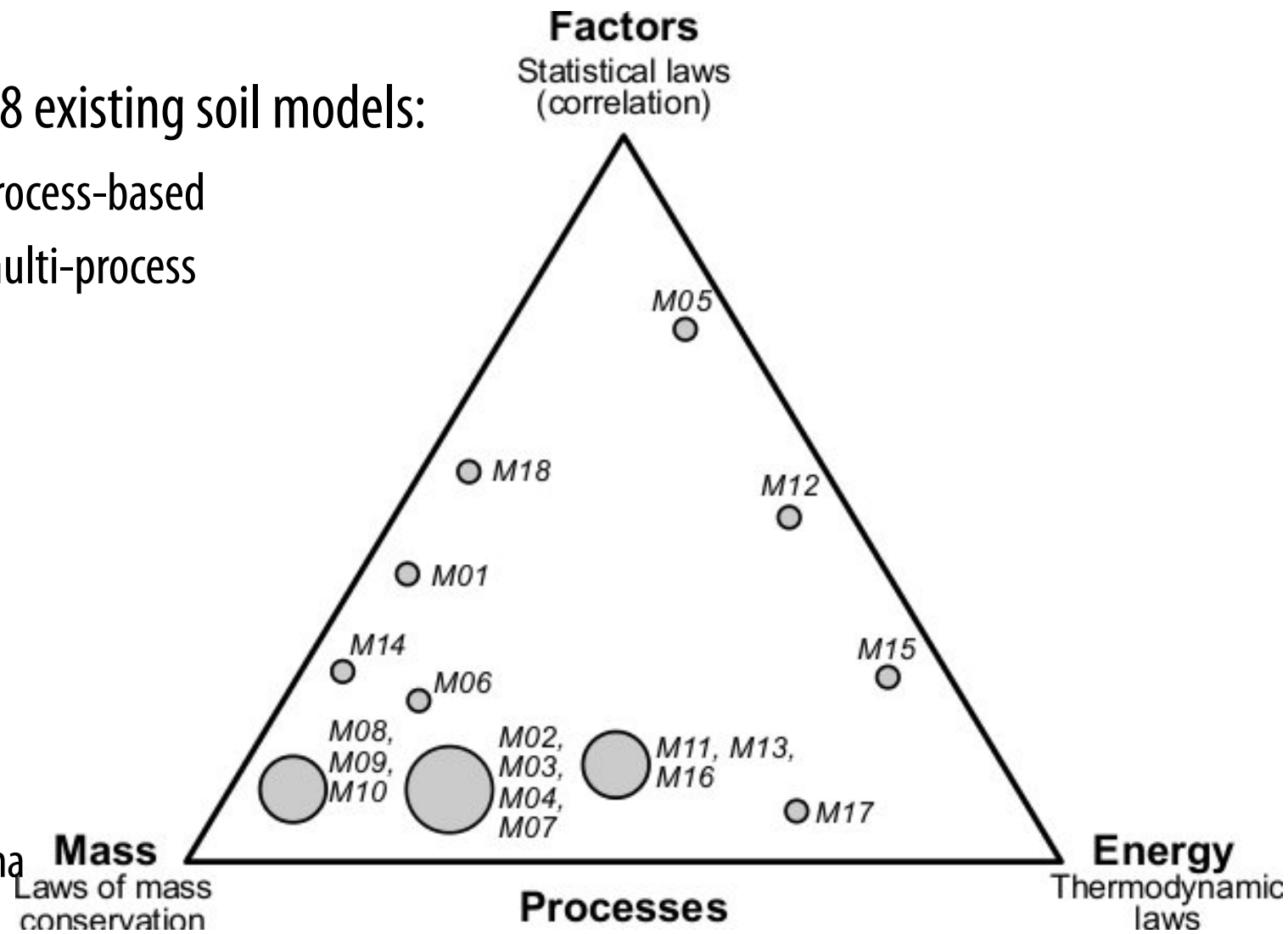
- The gradient of quality identified for geochemical and biological parameters highlights the difference of intensity in the processes along the gradient of anthropization
- Strong interactions between processes

How to model the processes?

- Most of the existing models of soil are process-based and multi-process

– Analysis on 18 existing soil models:

- 83% are process-based
- 67% are multi-process



How to model the processes?

- Existing tools to couple process-based models able to cope with the diversity of formalisms (e.g. differential equations, agent-based)

- Coupling platforms like Sol Virtuel, Record

- Bergez et al, 2010

- VLE modelling environment/ DEVS

- Quesnel et al., 2009; Zeigler et al., 2000

- Link with computing and numerical calculus domains

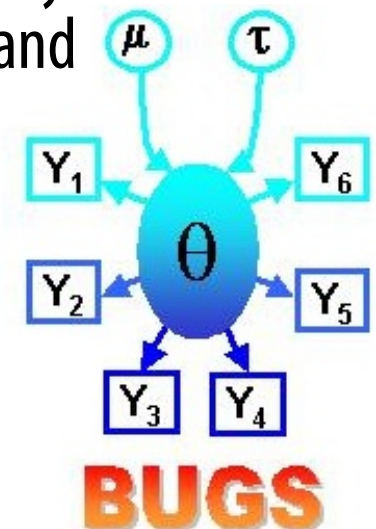


- Methods to handle complex codes with potential instability, difficulty in parametrisation and inverse modelling, high computing demand, and uncertainties on output data

- uncertainty and sensitivity analyses

- Saltelli et al. (2004)

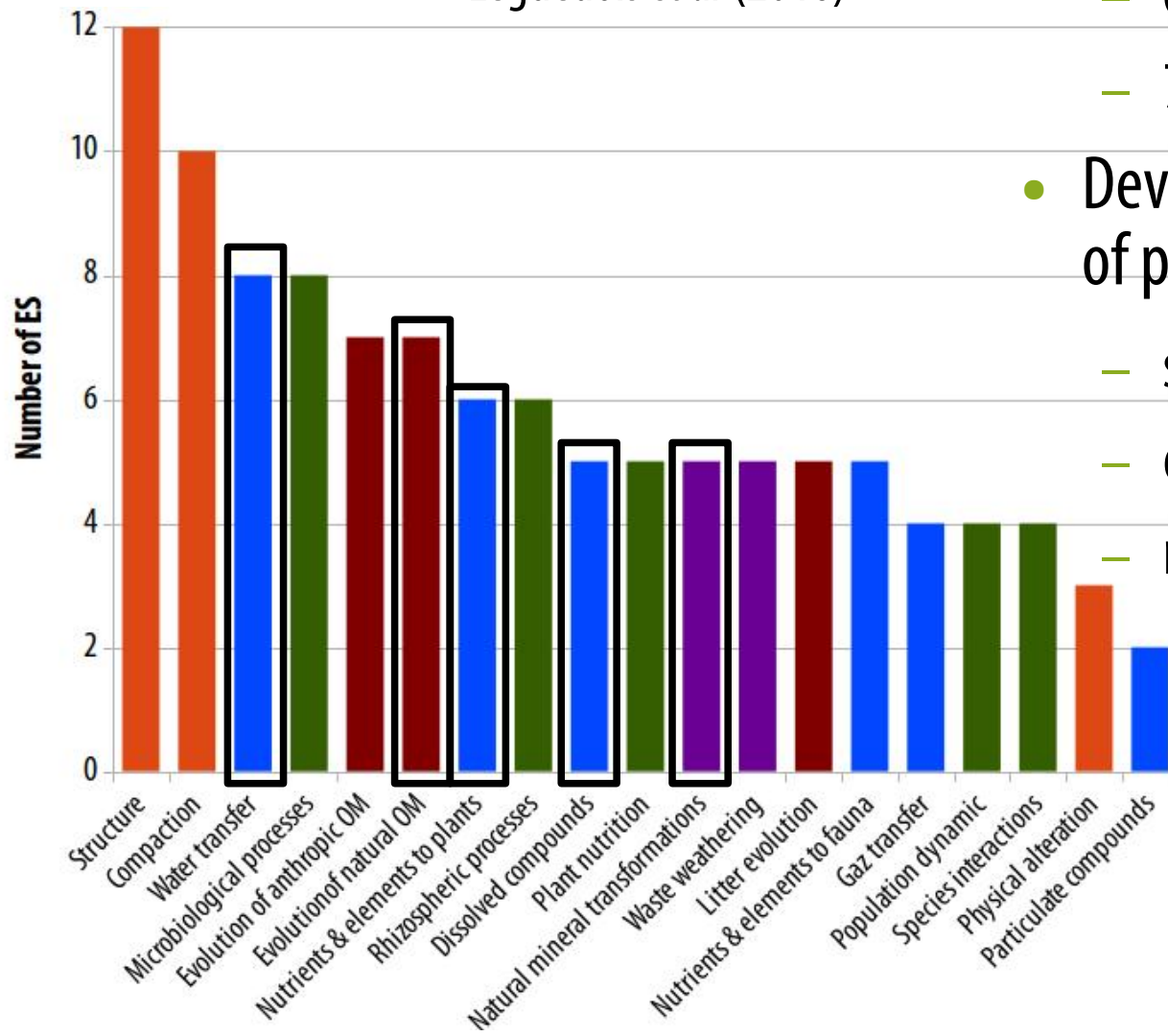
- Bayesian modelling



Which processes to model?

Soil processes needed to represent ES in SUITMAS

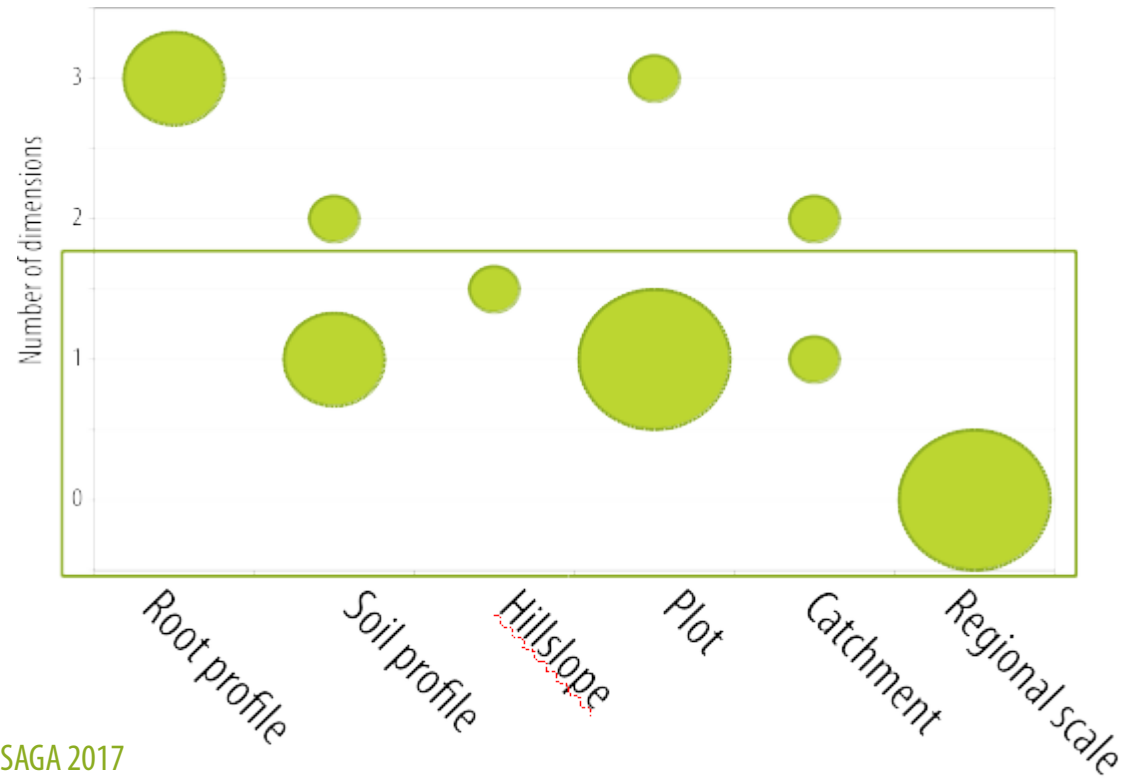
Leguédouis *et al* (2016)



- Analysis on 18 existing soil models:
 - 60 % represent water transfer
 - 73 % represent chemical reactivity
- Developments needed in the modeling of processes from SUITMAS related to:
 - structure
 - evolution of anthropic OM
 - microbiological activities

Modelling challenge: heterogeneous spatial representation

- Generally poor spatial description of the existing models
- Importance of spatial heterogeneity
 - \Leftrightarrow ecological intensification, lower fertiliser inputs, and no-tillage
 - Doré et al. (2011), Hinsinger et al., (2011)
 - \Leftrightarrow highly heterogeneous spatial organisations observed in SUITMAs and forested soils
 - De Kimpe and Morel (2000), Huot et al. (2013), Monseriée et al. (2009)



Conclusion

- Soil models have mainly been developed for agricultural or contaminated pollutions
 - Main modelled processes related to water transfer and chemical reactivity
 - Soil homogeneity due to tillage
- Development needed
 - Soil heterogeneity / structure evolution
 - Soil biological processes
- Existing technical tool to support complex coupled models
 - Coupling platform
 - UA and SA