INTEGRATED SINK ENHANCEMENT ASSESSMENT

I N S E A
P A R T N E R S

Validation of SOC initial values for EPIC modelling through comparing European and regional datasets

by

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Brussels 21.-22. June 2006

Outlines

1. Validate initial OC contents for biophysical modelling for EU25 (arable land only)

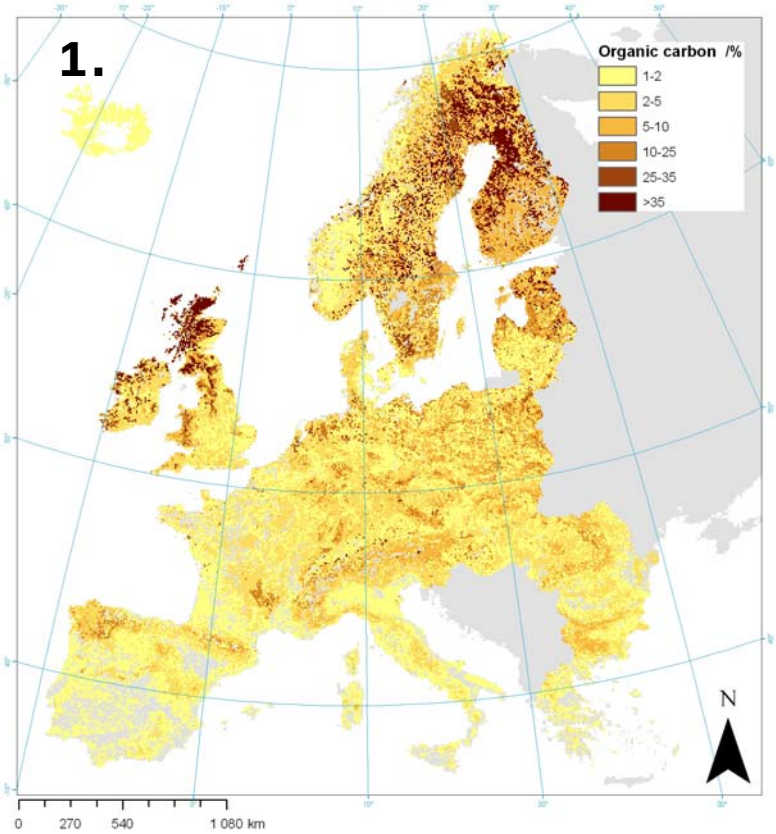
    - Identify the potential of EPIC to improve initial OC contents
    - Sensitivity to soil and topography data

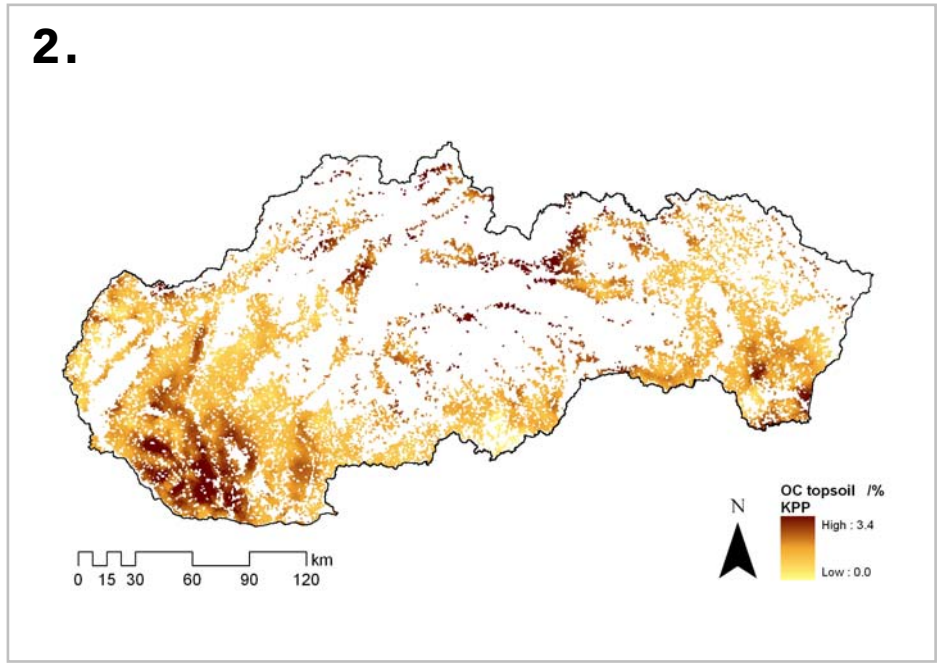
2. Identify the effects of different tillage management modelled with data of different quality (SK data contra EU data)

    - Conventional versus reduced tillage
    - Sensitivity to soil and topography data

Thematic OC layers:

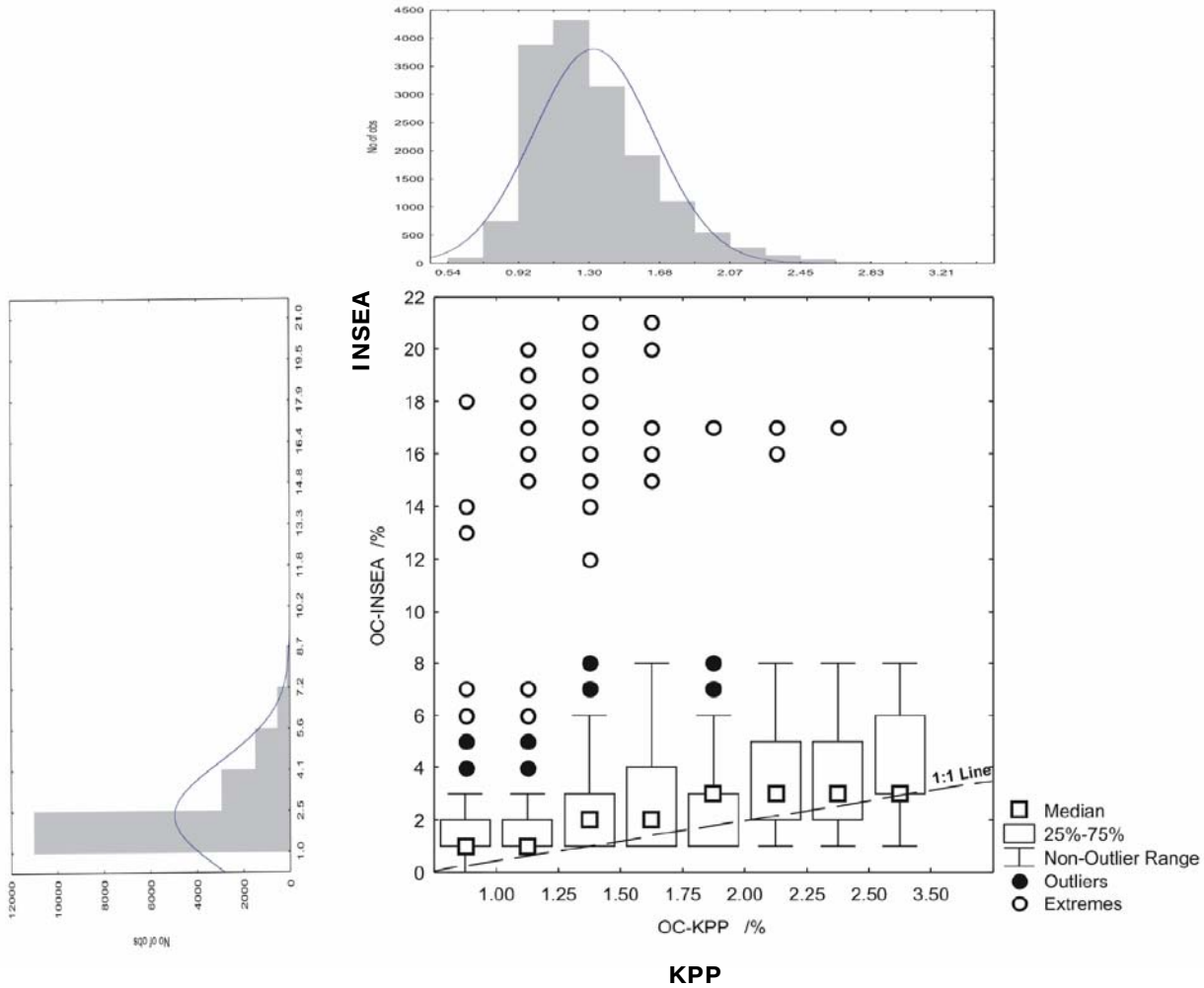
1. The map of organic carbon in topsoils in Europe (OC INSEA) – 1km resolution raster
2. Soil information system of Slovakia (**KPP** of AISOP) – 1km resolution raster of OC content [%] interpolated from app. 12,000 measured point data on arable land





A. Raster based (pixel-by-pixel) comparison of OC layers

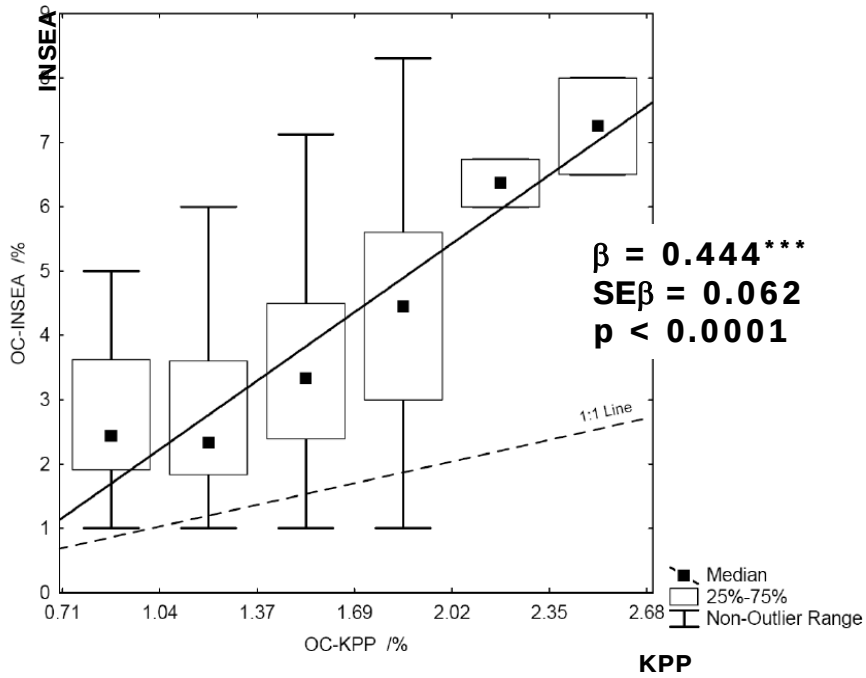
- only a weak correlation (some median accordance exists),
- **geographically explicit information is overestimated for much of the area.**

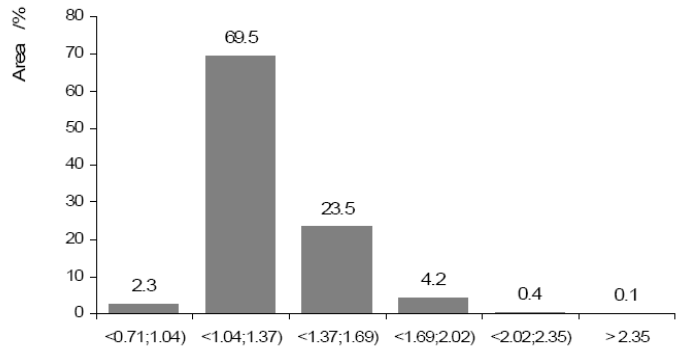


B. Comparison of initial OC values using the HRU concept

HRU concept – geographically explicit layer of homogeneous units for EPIC modelling

1. HRU respects homogeneity of parameters that are hardly adjustable by farmers (elevation, slope, soil texture, soil depth, and stoniness)
2. Was obtained by GIS intersection of categorised parameters
3. Is representative for scale 1:1,000,000
4. Is explicit for NUTS2 region and Land-cover category
5. Is characterised by homogeneous climate and management

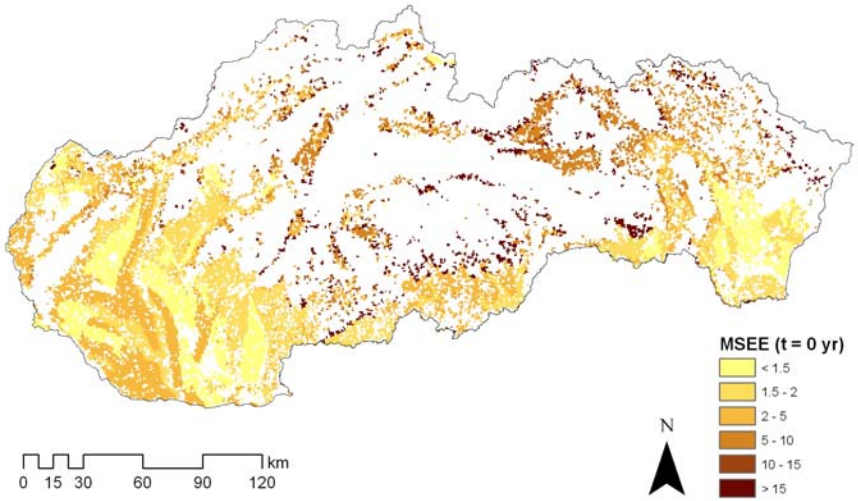




Conclusion

- There is a significant relation between OC INSEA and OC KPP when processed through HRUs
- **The aggregation to HRUs improves initial OC inputs**
- **However, the overestimation is substantial !**

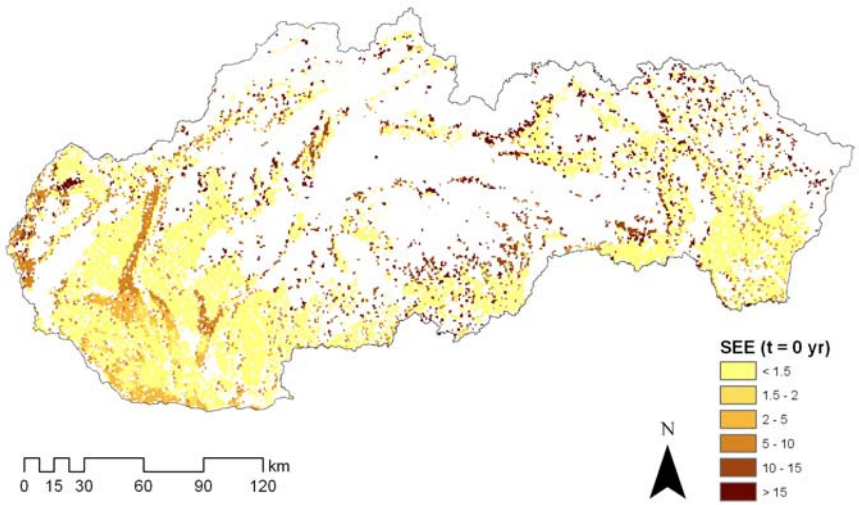
B. Comparison of initial OC values using the HRU concept



Mean square estimation error:

$$\mathbf{MSEE} = \frac{1}{\mathbf{n}} \sum_{\mathbf{i}=1}^{\mathbf{n}} (\mathbf{OC_E} - \mathbf{OC_M})^2$$

OC_E – estimated OC, OC_M – measured OC, n – number of pixels per HRU



- Overestimation is located mostly to uplands and low-mountains,
- Lowland hilly-countries are matched well.

C. EPIC pre-run simulation to adjust initial OC values (using HRU concept)

Q.1. Will EPIC pre-run simulations with base management balance OC stocks to a reasonable range?

Q.2. How are EPIC simulations affected by exactness of soil and topography information?

SET 1. **Initial OC: INSEA**, soil: **INSEA**, topography: **INSEA**, climate: **INSEA**, management: **INSEA**, time of simulation: 20 yrs.

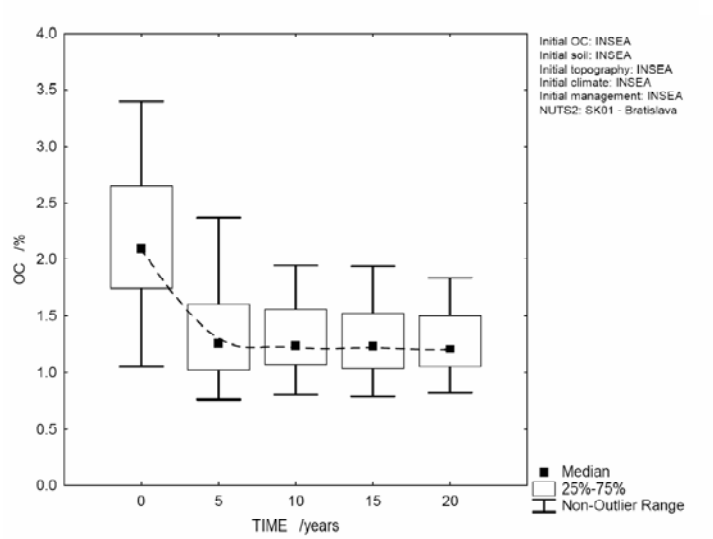
SET 2. **Initial OC: INSEA**, **soil: KPP, topography: KPP,** climate: **INSEA**, management: **INSEA**, time of simulation: 20 yrs.

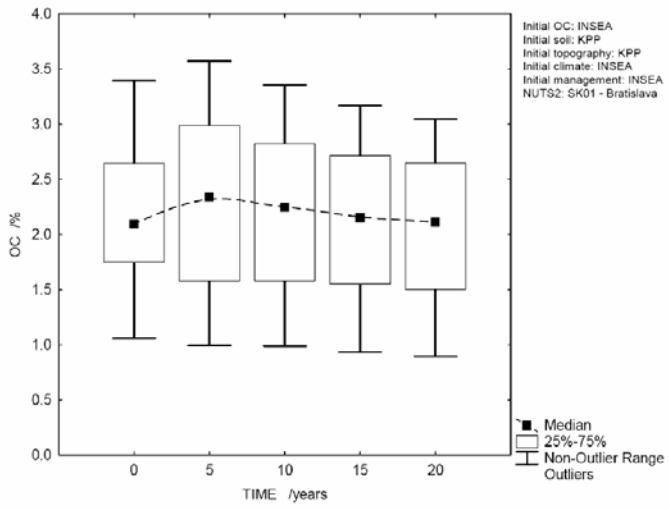
Dynamics in OC content (NUTS2 level):

SET1: INSEA DB

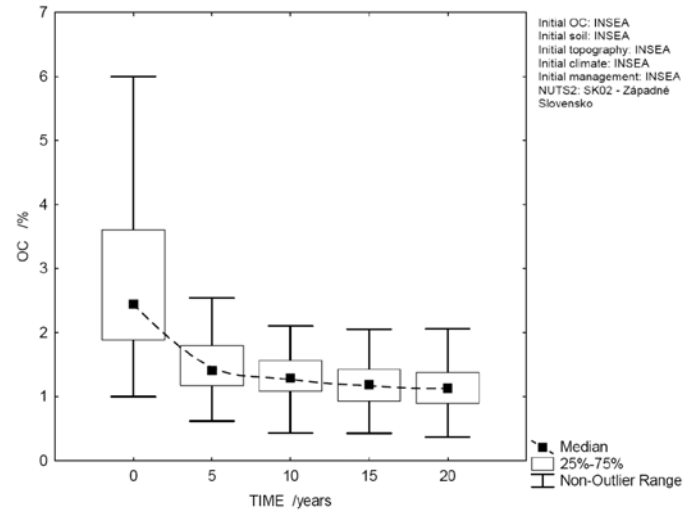
SET2: KPP DB

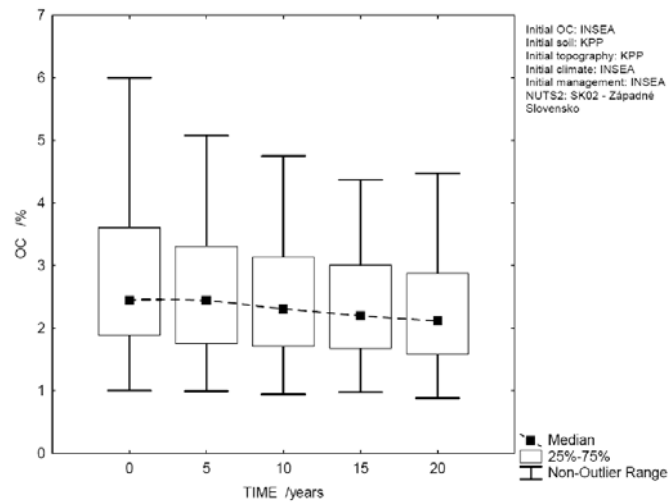
SK01 – Bratislava





SK02 – Západné Slovensko



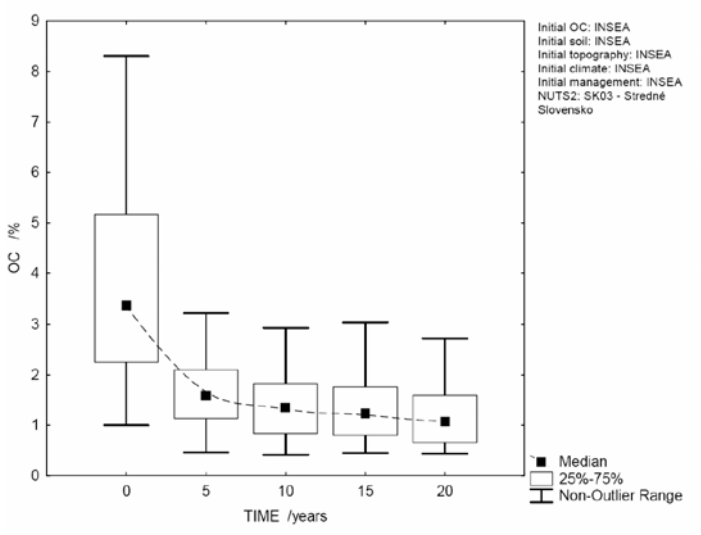


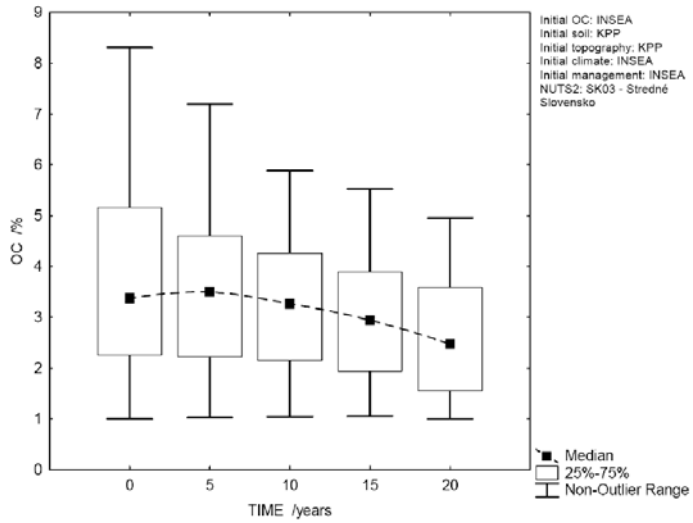
Dynamics in OC content (NUTS2 level):

SET1: INSEA DB

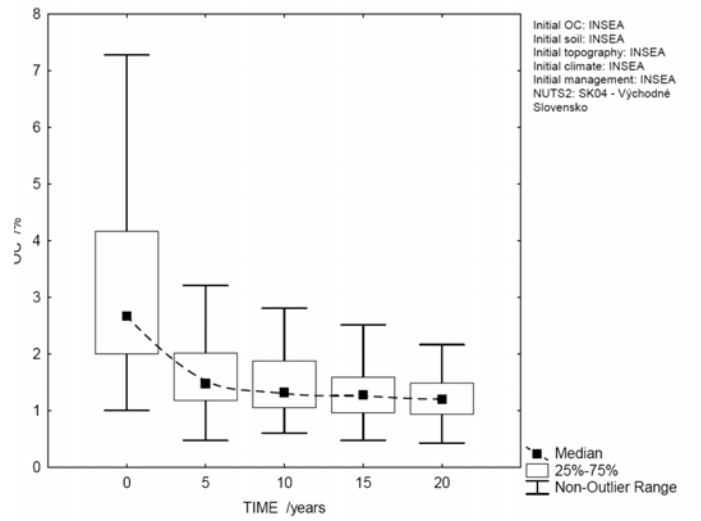
SET2: KPP DB

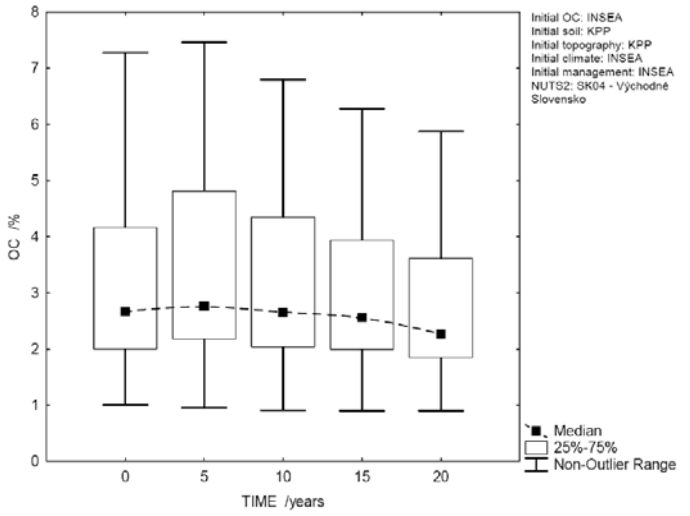
SK03 – Stredné Slovensko





SK04 – Východné Slovensko





Conclusion

- Quick decrease in OC contents was observed in all NUTS2 regions for INSEA data

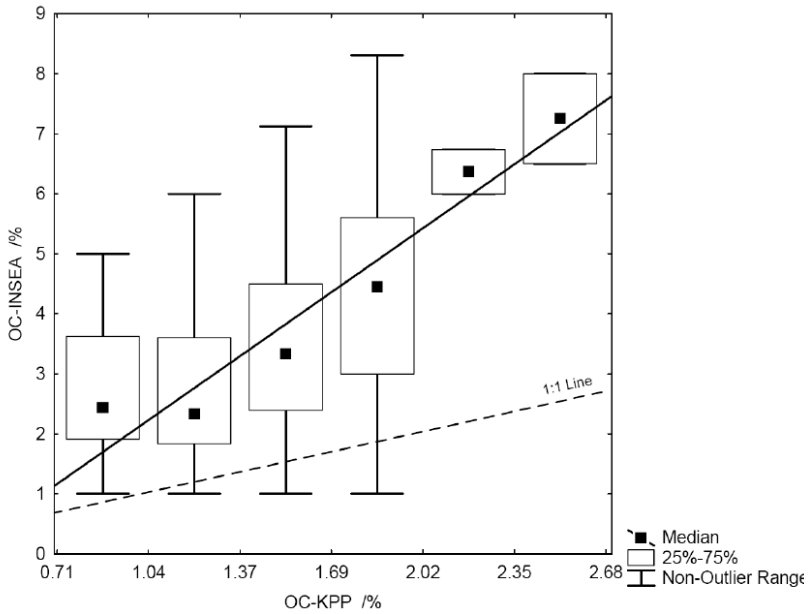
- Only slow decrease in OC contents was observed when precise soil and topography data were used (KPP DB)

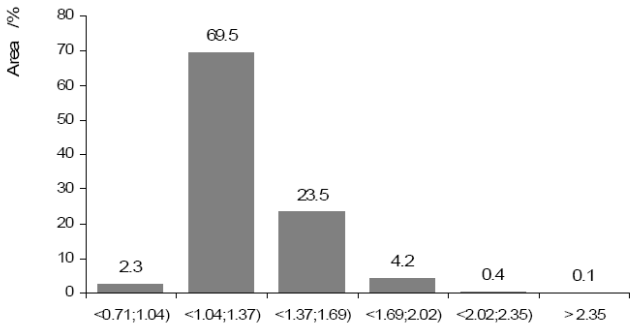
- **Auto-initialization of model, when OC converges from highly over-estimated (t=0 yr) to „balanced“ contents (t=20 yr), is much more intensive for INSEA data.**

OC dynamics in EPIC simulation with base-management:

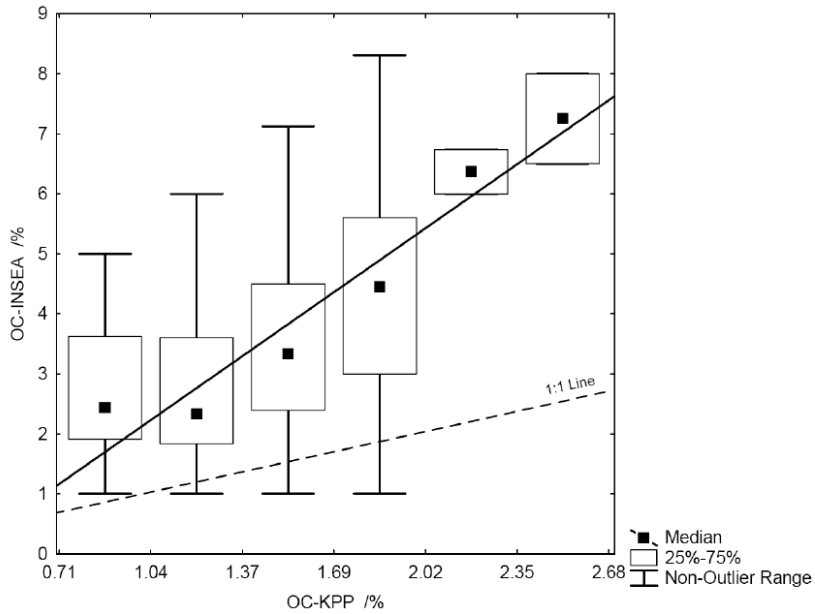
t=0 yr.

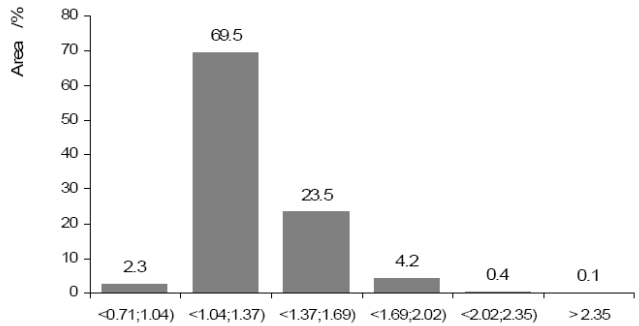
SET1: INSEA DB





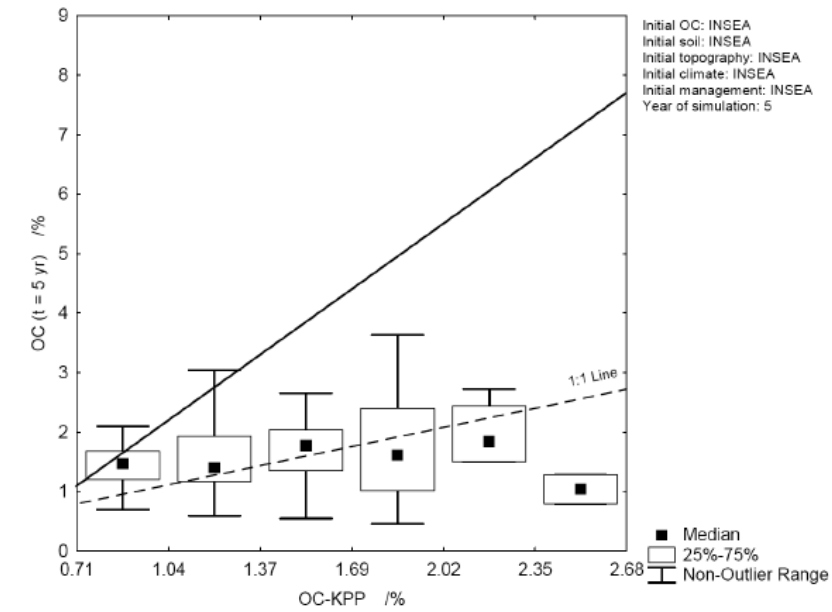
SET2: KPP DB

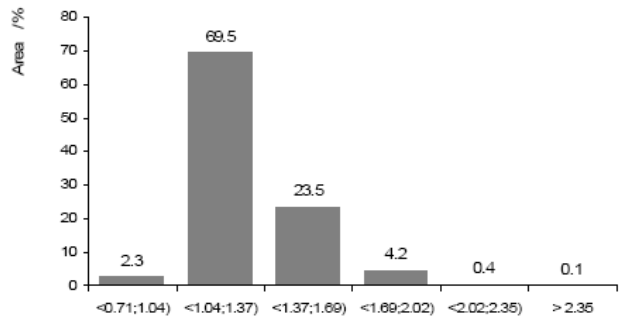




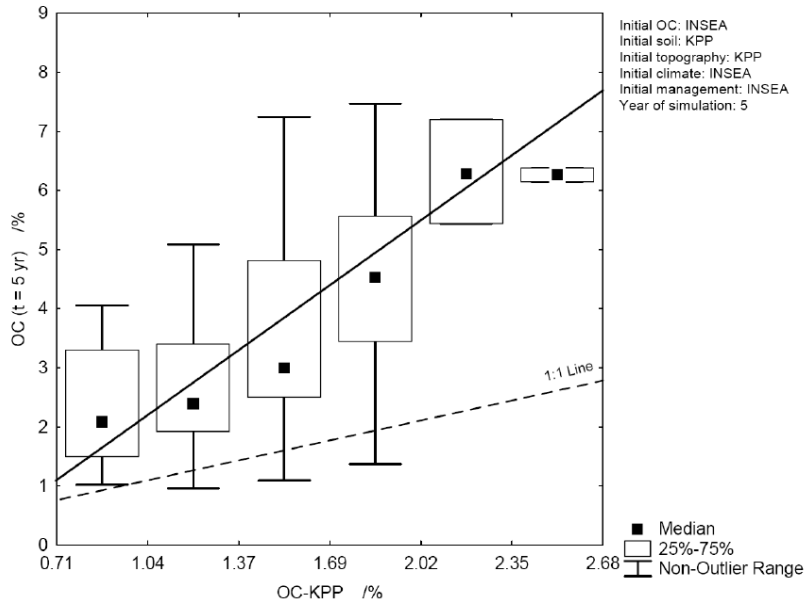
t=5 yr.

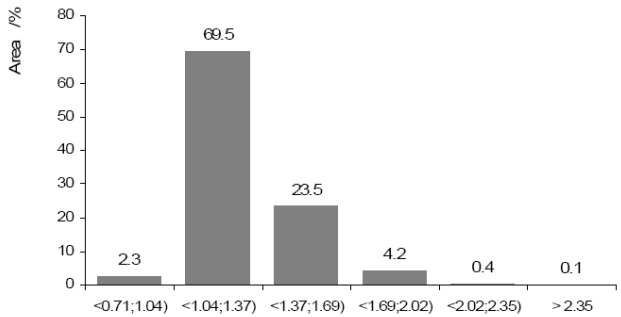
SET1: INSEA DB





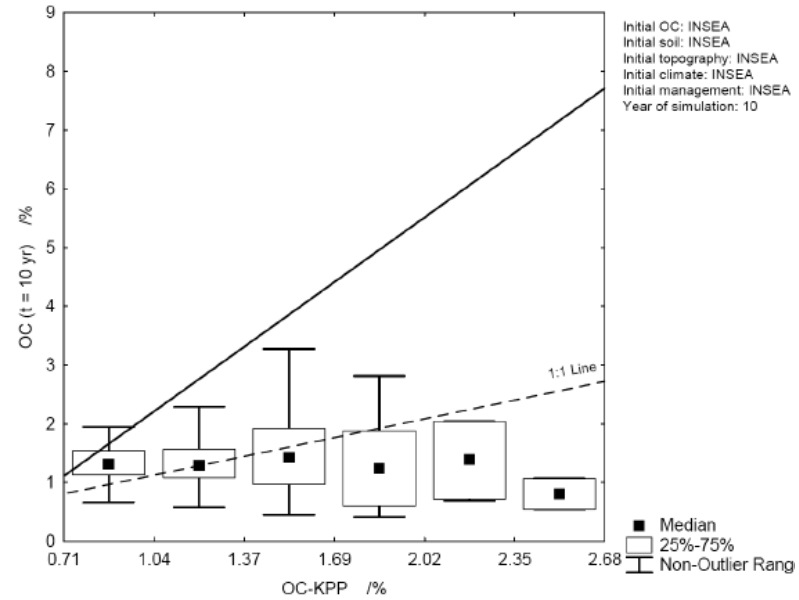
SET2: KPP DB

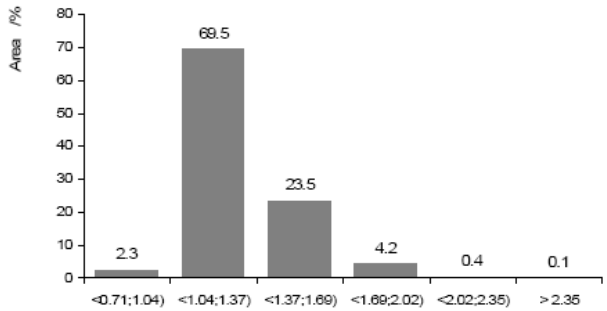




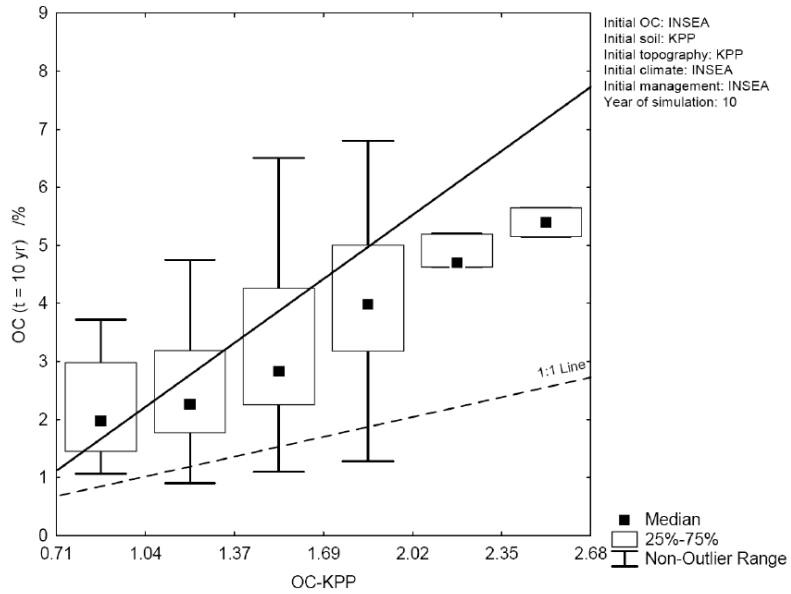
t=10 yr.

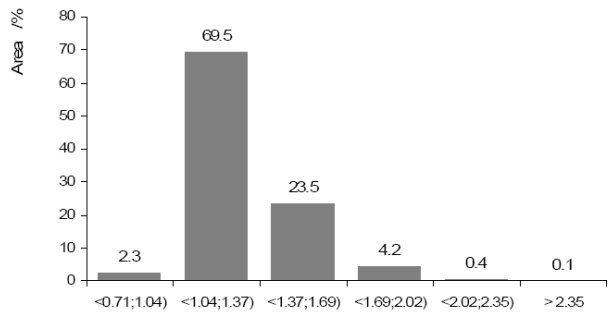
SET1: INSEA DB





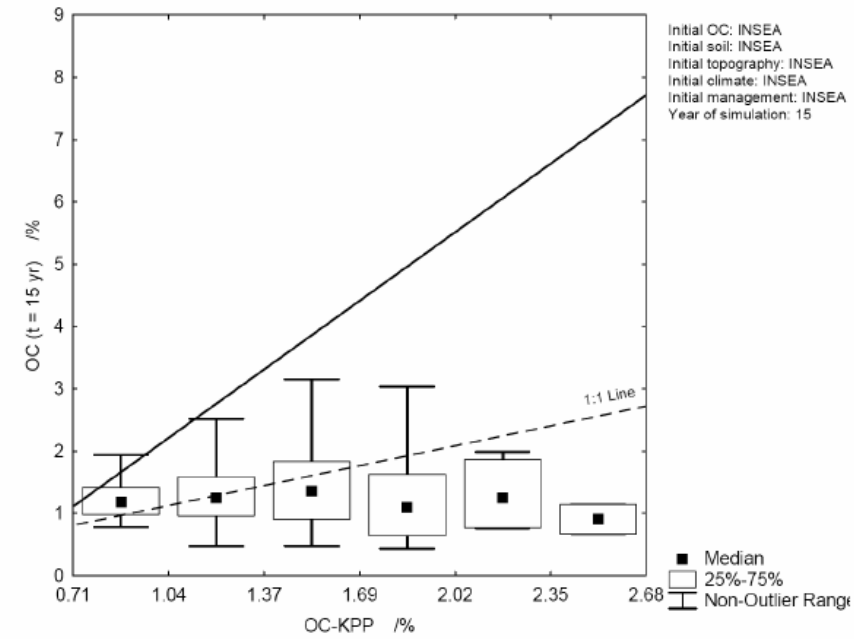
SET2: KPP DB

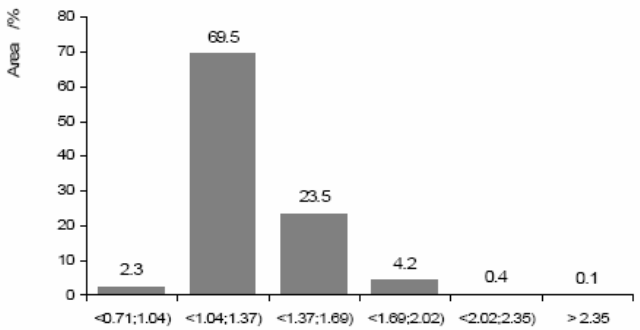




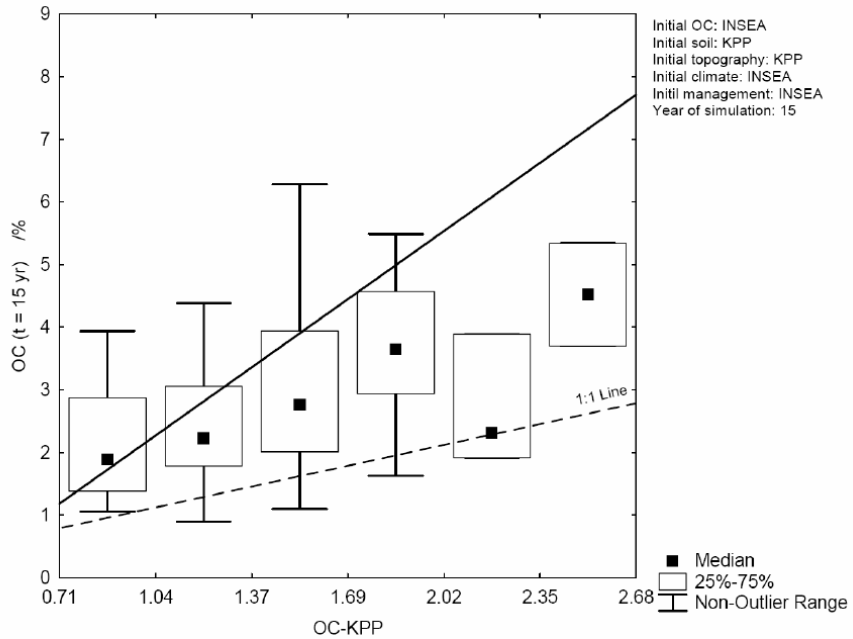
t=15 yr.

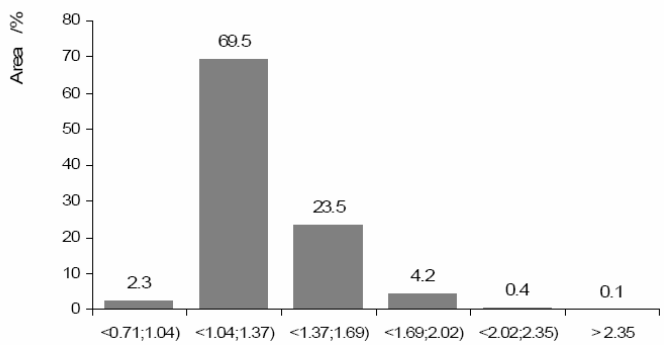
SET1: INSEA DB





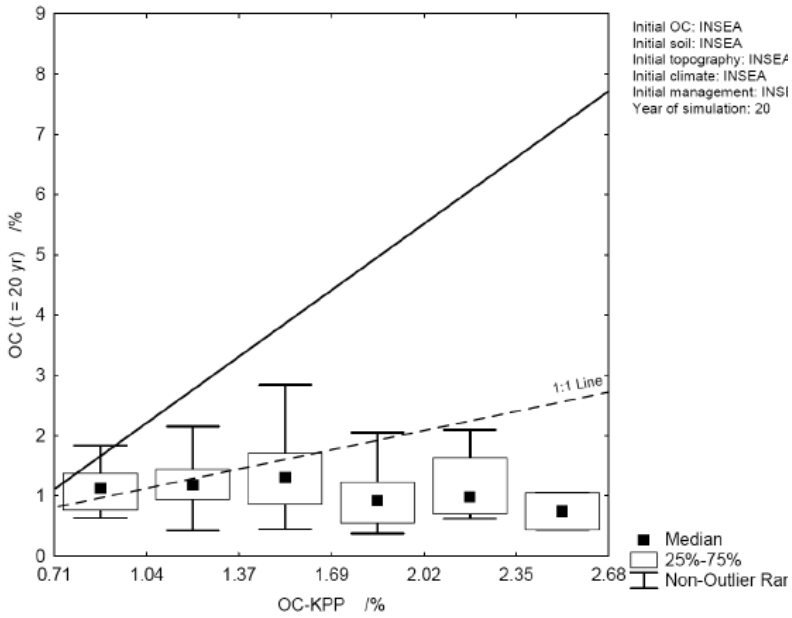
SET2: KPP DB

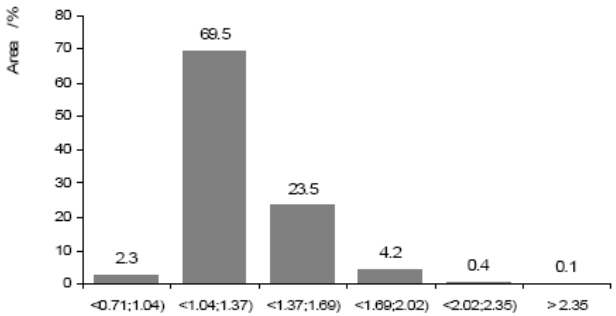




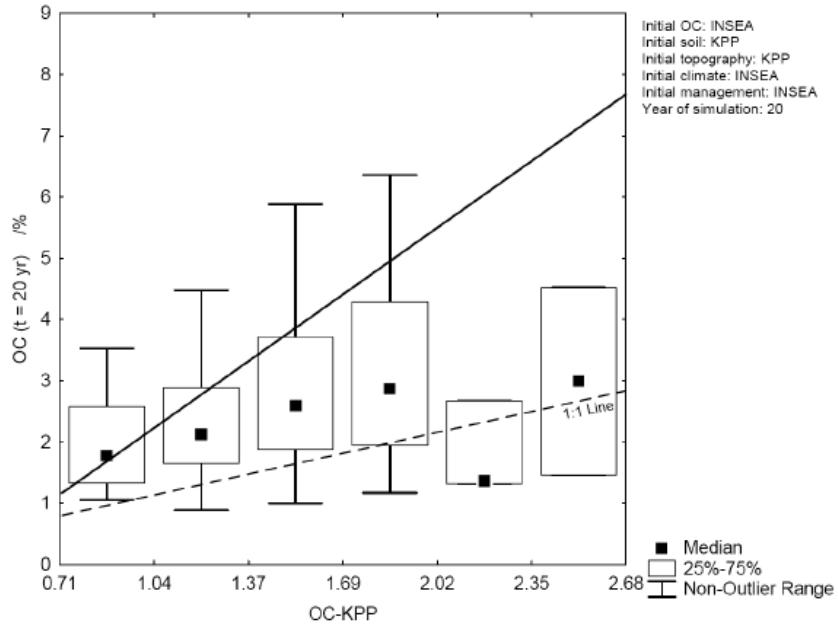
t=20 yr.

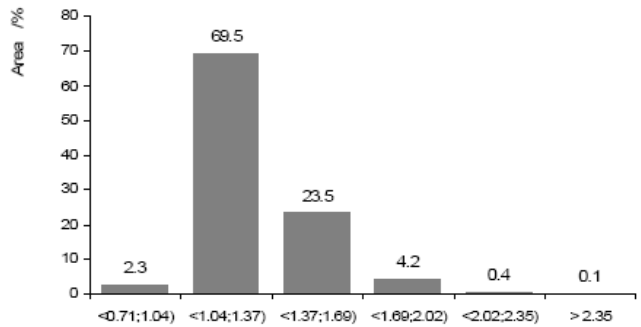
SET1: INSEA DB





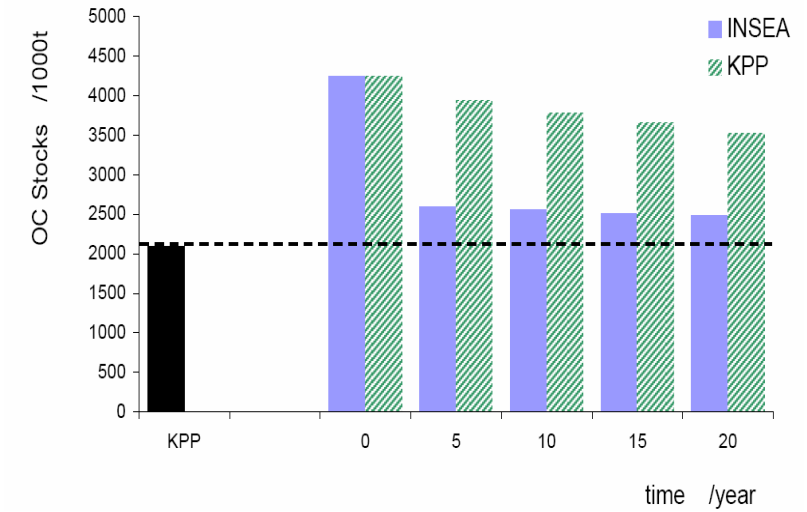
SET2: KPP DB



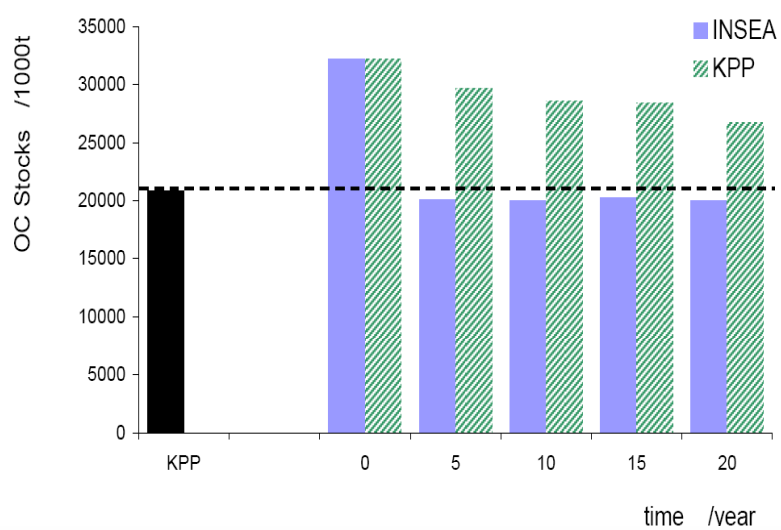


Absolute OC stocks [1000t] per NUTS2 regions during simulations

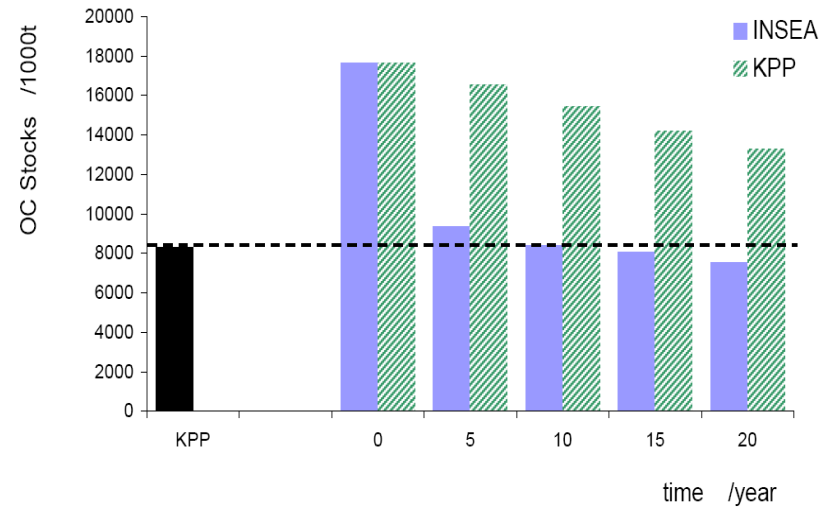
SK01- Bratislava

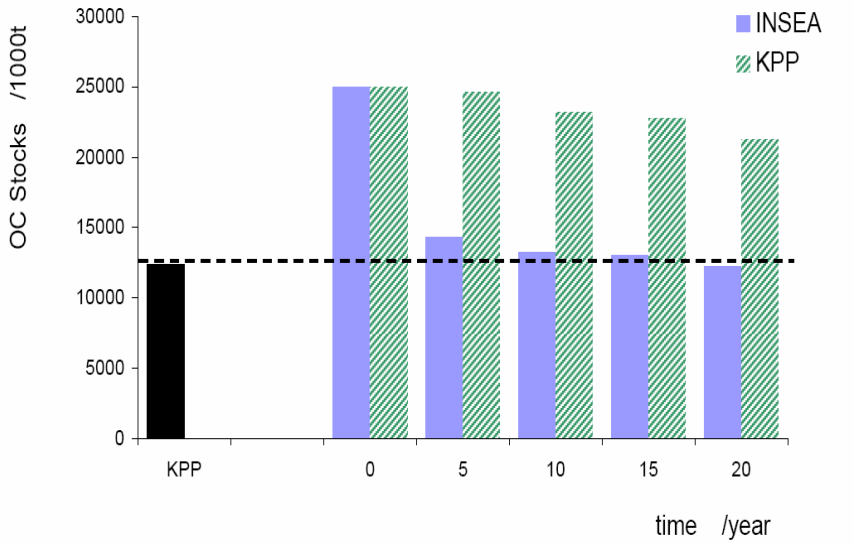


SK02 - Západné Slovensko



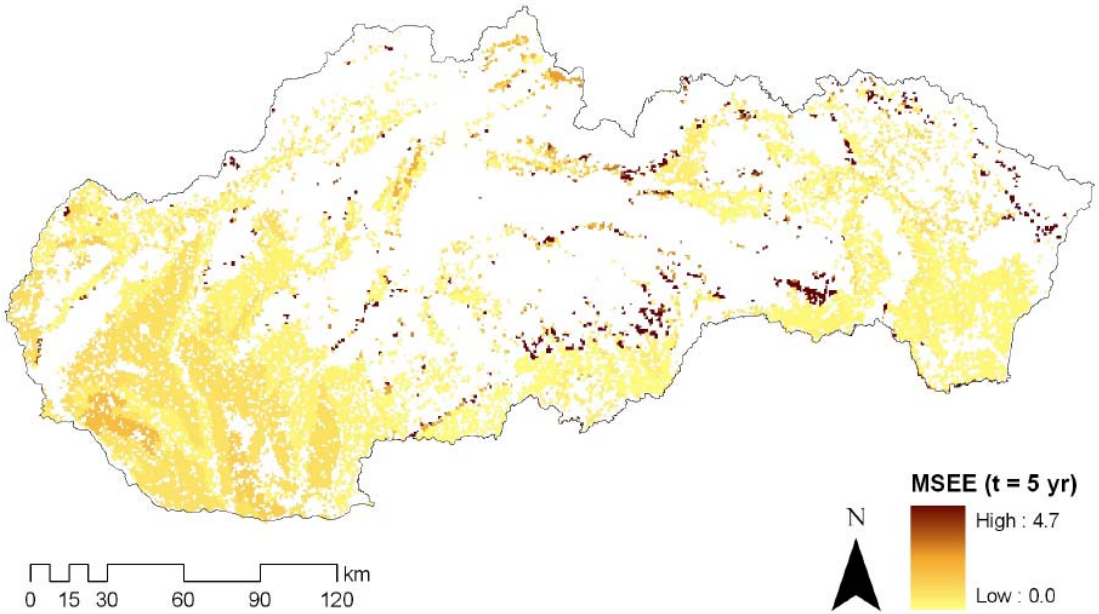
SK03-Stredné Slovensko

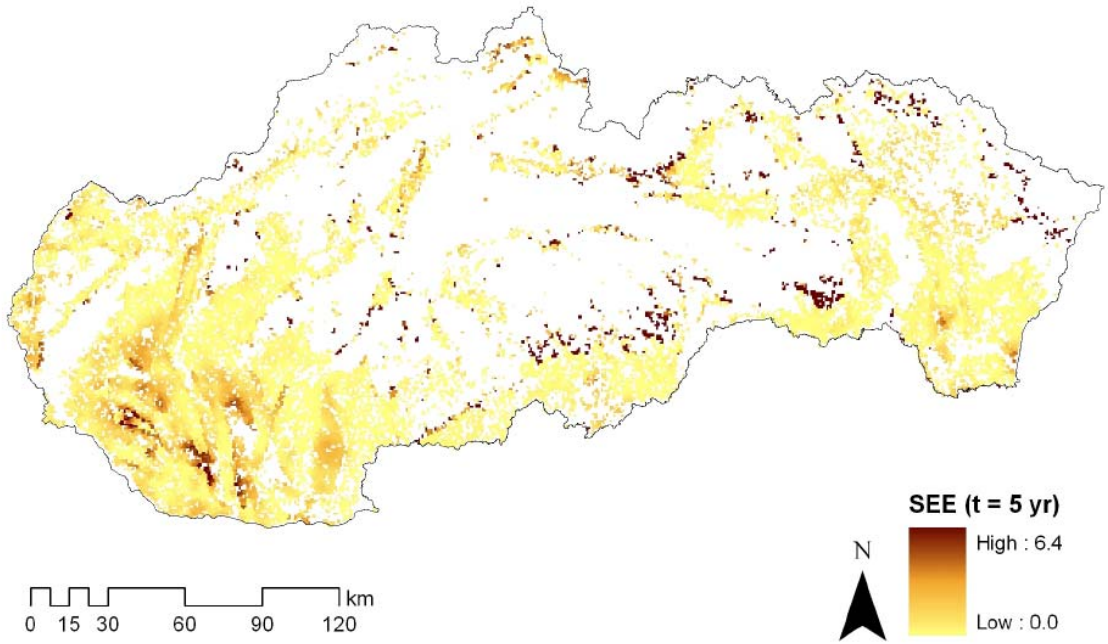




Conclusion

- Already after 5 year simulations with INSEA data, OC contents have approached measured data; especially those categories which cover high area portion
- Long-term simulations under-estimate OC stocks, especially in very heterogeneous area (SK03, SK04)
- HRUs with naturally high OC content appeared to be highly sensitive to EPIC simulations
- This sensitivity can be explained by high losses of OC due to erosion (high slope), and relative homogeneity in soil parameters within INSEA database,
- Soil and topography parameters are not sufficiently precise to support unbiased simulations in heterogeneous regions with small-scaled diversity
- **For most of area the initial OC values can be adjusted by pre-run simulations to reasonable range**

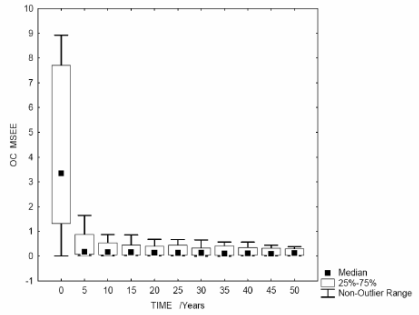




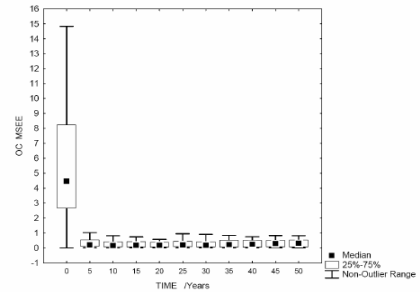
MSEE

TIME

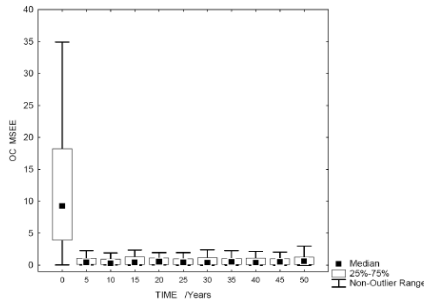
SK01 – Bratislava



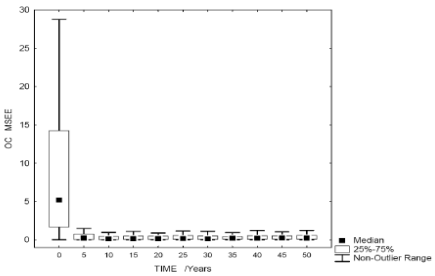
SK02 – Západné Slovensko



SK03 – Stredné Slovensko



SK04 – Východné Slovensko



Conclusion

- Generally, the decrease of MSEE after 5 yr simulation is significant compared to the „zero time“, and MSEE does not change much with progressing time of simulation

- Higher uncertainty is located to low mountains and uplands, and to alluviums with complex soil cover that was not gathered by HRU distribution

Effects of different tillage management modelled with data of different quality (SK data versus EU data):

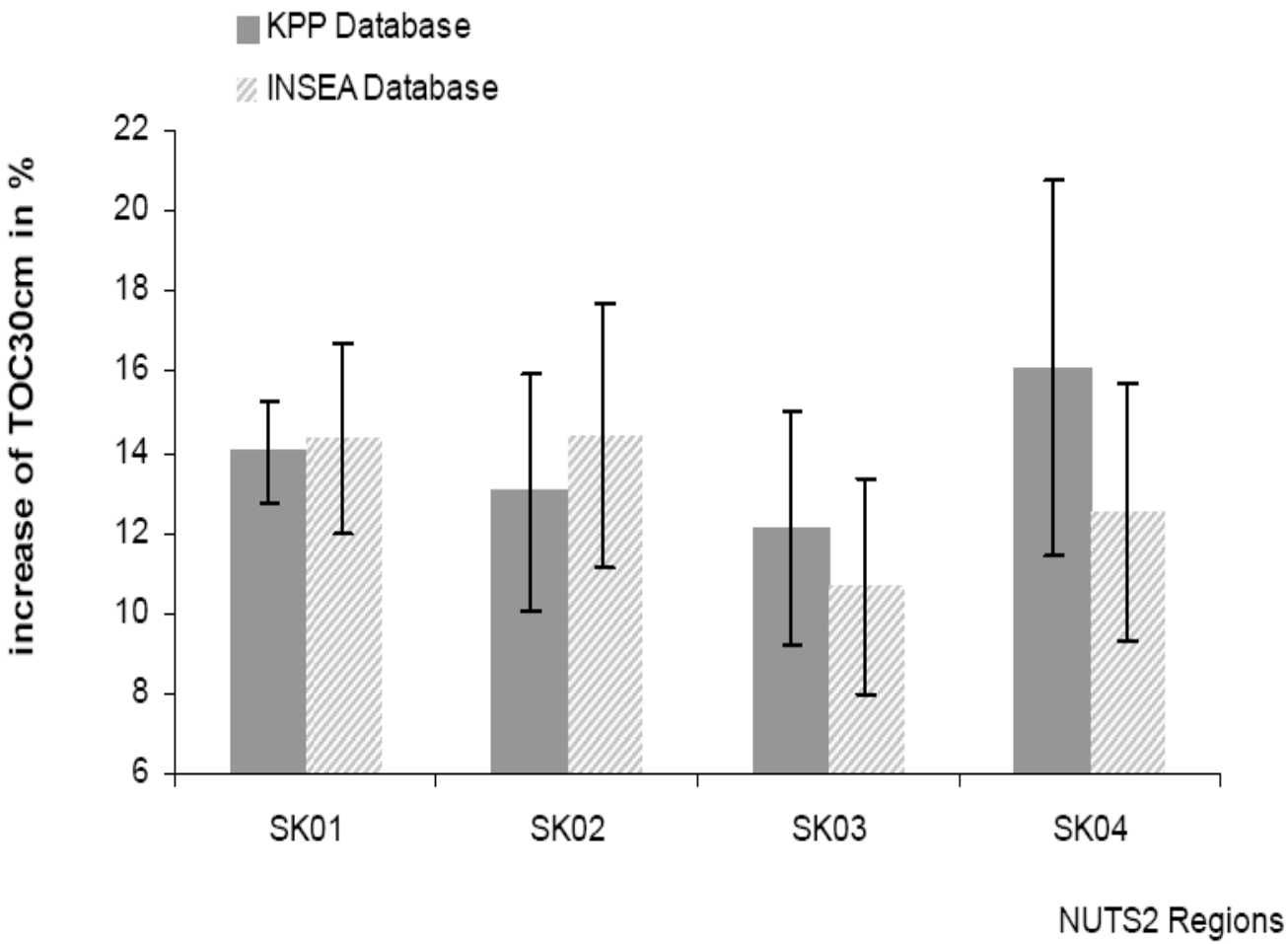
Task:

Compare the effects of reduced tillage to conventional tillage through modelled changes in TOC stocks for 30 cm topsoil...

Reference Data: Initial OC: **KPP**, soil and topography: **KPP**, climate: MARS, management: INSEA, time of simulation: 20 yr.

INSEA Data: Initial OC: **INSEA**, soil and topography: **INSEA**, climate: MARS, management: INSEA, time of simulation: 20 yr.

The increase in TOC30cm estimated for conversion from conventional to reduced tillage



Conclusion

- INSEA data resulted to difference in net TOC benefit between 0.3% (SK01) and 3.6% (SK04) compared to National SK Data (KPP)

- Heterogeneous regions with small-scaled diversity are most biased