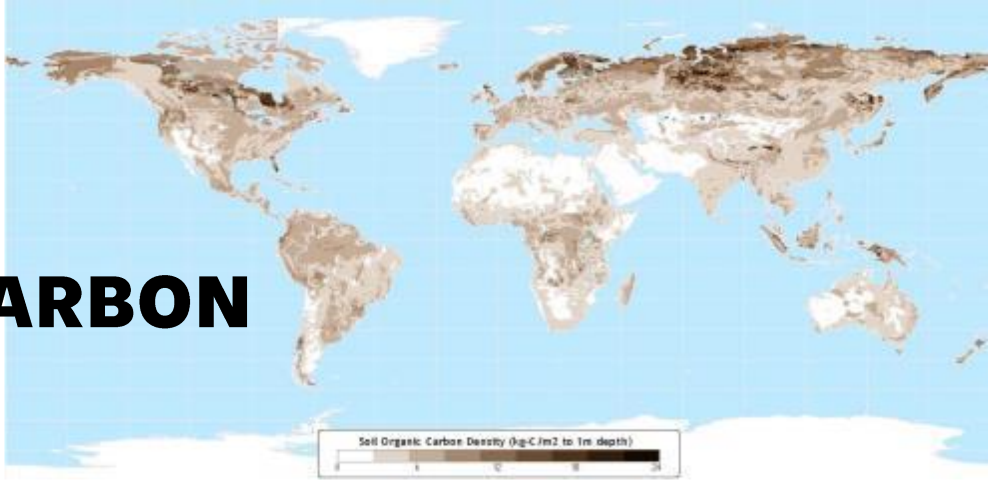
SOIL PROTECTION AND CLIMATE CHANGE

DAVID ZUMR, Josef Krása, Tomáš Dostál et al.

Faculty of Civil Engineering, CTU in Prague



http://nelson.wisc.edu/sageatlas/maps/soilcarbon

SOIL & ORGANIC CARBON

Soil = large pool of carbon

stock of C in soil is twice times as large as that in the atmosphere and 3 times that in biota (IPCC, 2001)

SOC pools: 30 t/ha (arid) – 800 t/ha (cold regions);

Small losses impact atmospheric CO_2 concentration

Possible positive feedback (C release increases global warming)

SOIL CARBON STORAGE

Vital ecosystem service

Affected by humans

SOC (organic matter) has important effect on soil quality

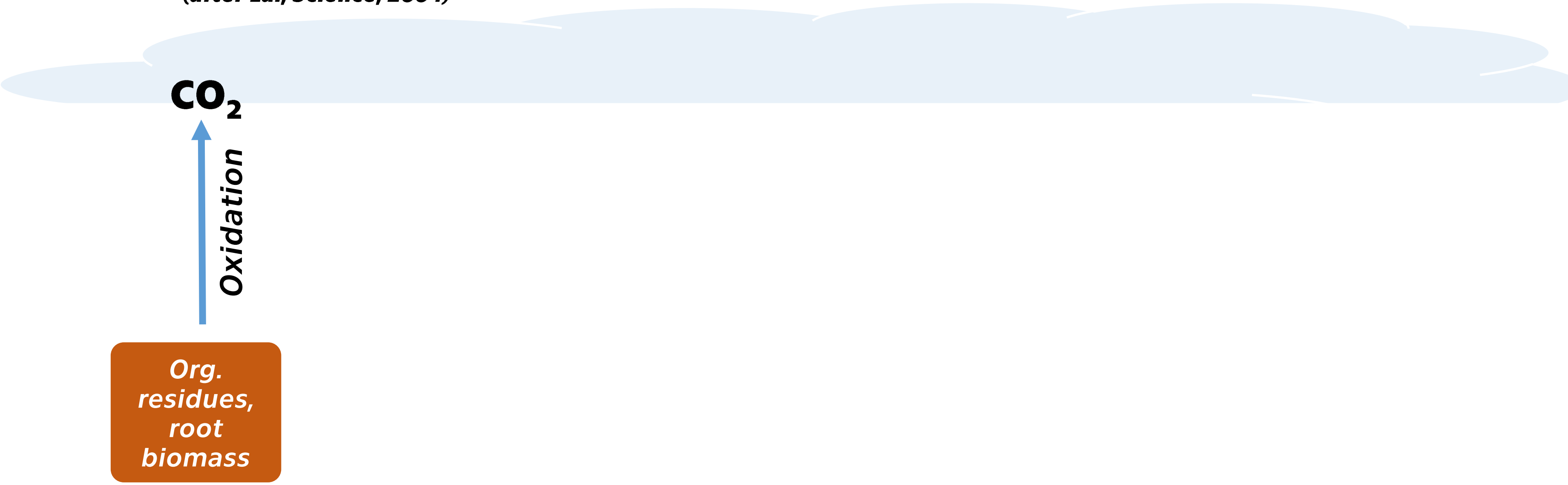
Physical, chemical and biological properties

Ensures proper soil functioning (we depend on)

Reduces soil degradation processes (incl. complex consequences)

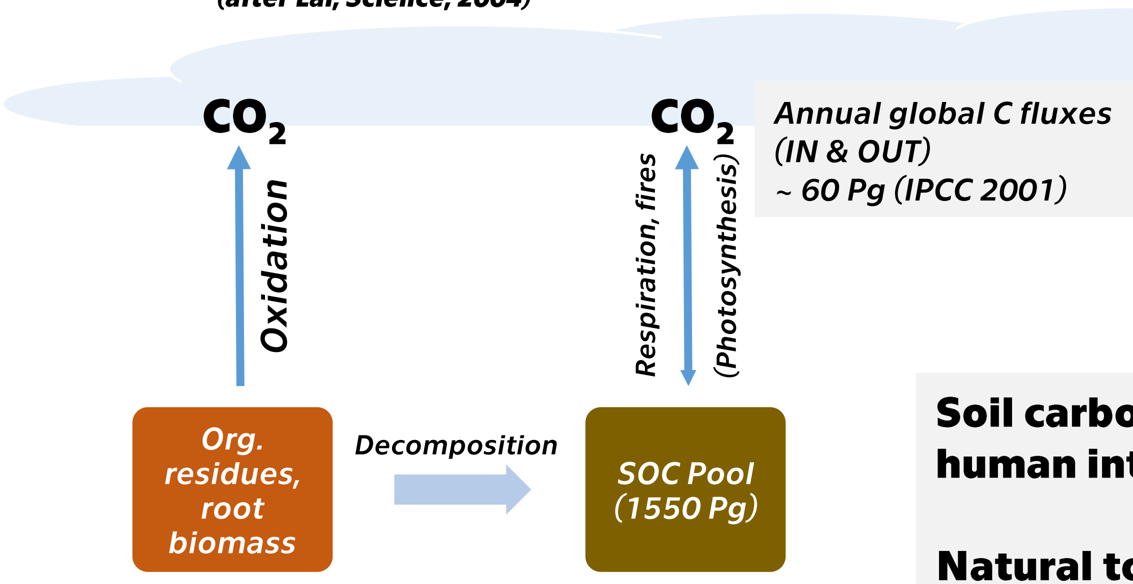
SOIL ORGANIC CARBON DYNAMICS

(after Lal, Science, 2004)



SOIL ORGANIC CARBON DYNAMICS

(after Lal, Science, 2004)



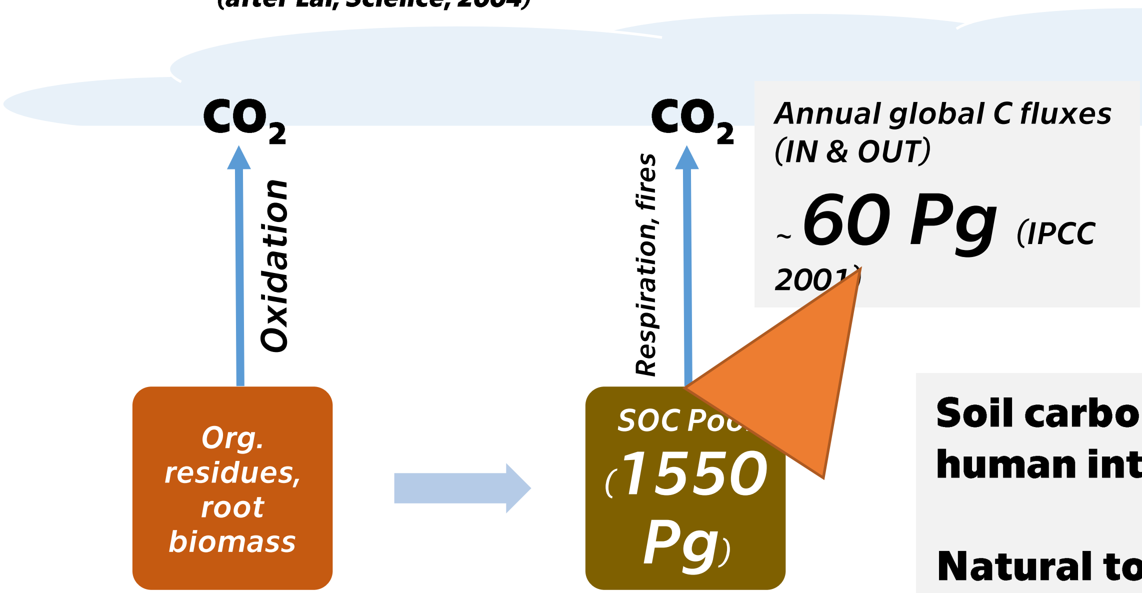
Soil carbon pools are smaller than before human intervention *(Smith, COES, 2012)*

Natural to agricultural landuse conversion causes SOC depletion (60 – 80%)

- *Outputs exceed Inputs*
- *Severe soil degradation*

SOIL ORGANIC CARBON DYNAMICS

(after Lal, Science, 2004)



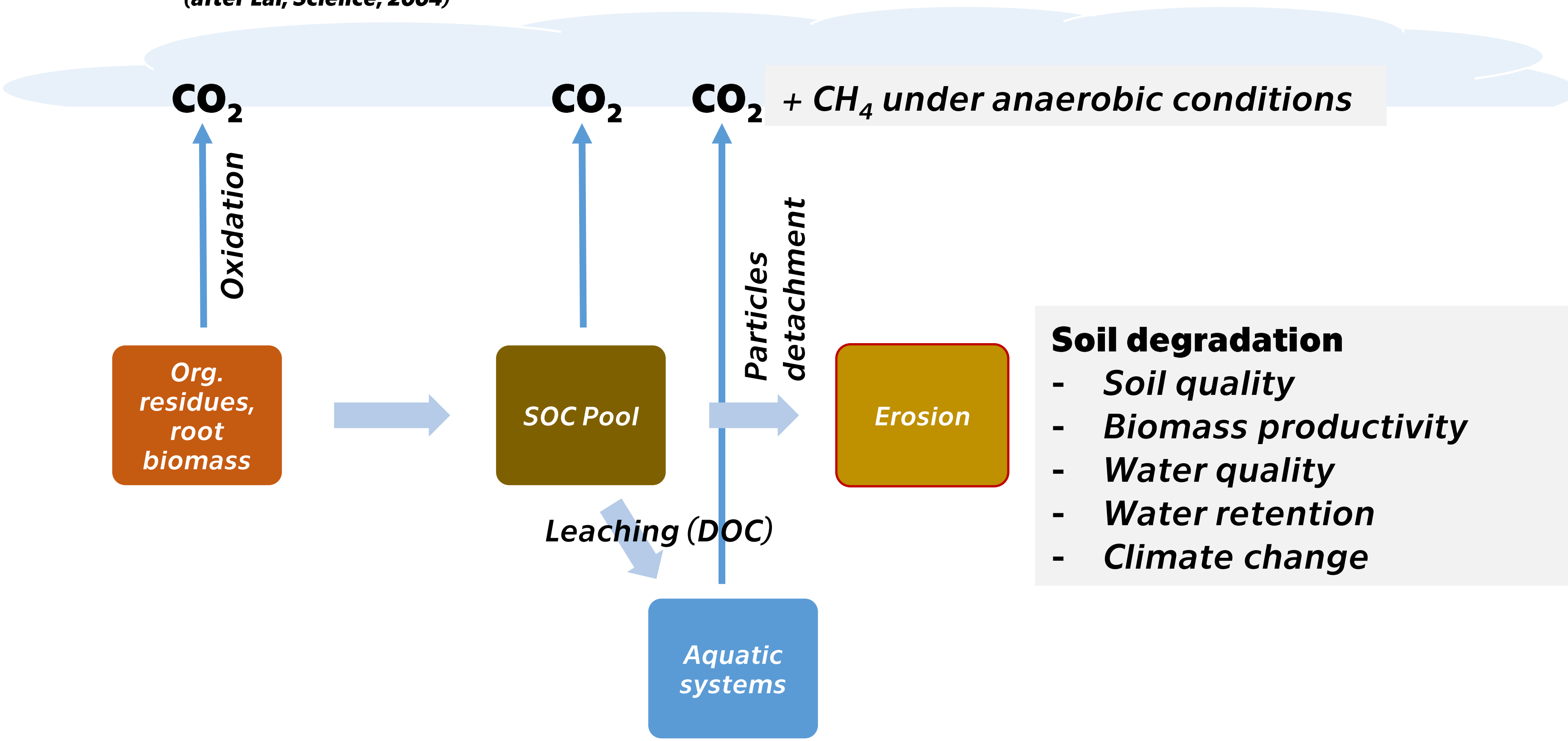
Soil carbon pools are smaller than before human intervention *(Smith, COES, 2012)*

Natural to agricultural landuse conversion causes SOC depletion (60 – 80%)

- *Outputs exceed Inputs*
- *Severe soil degradation*

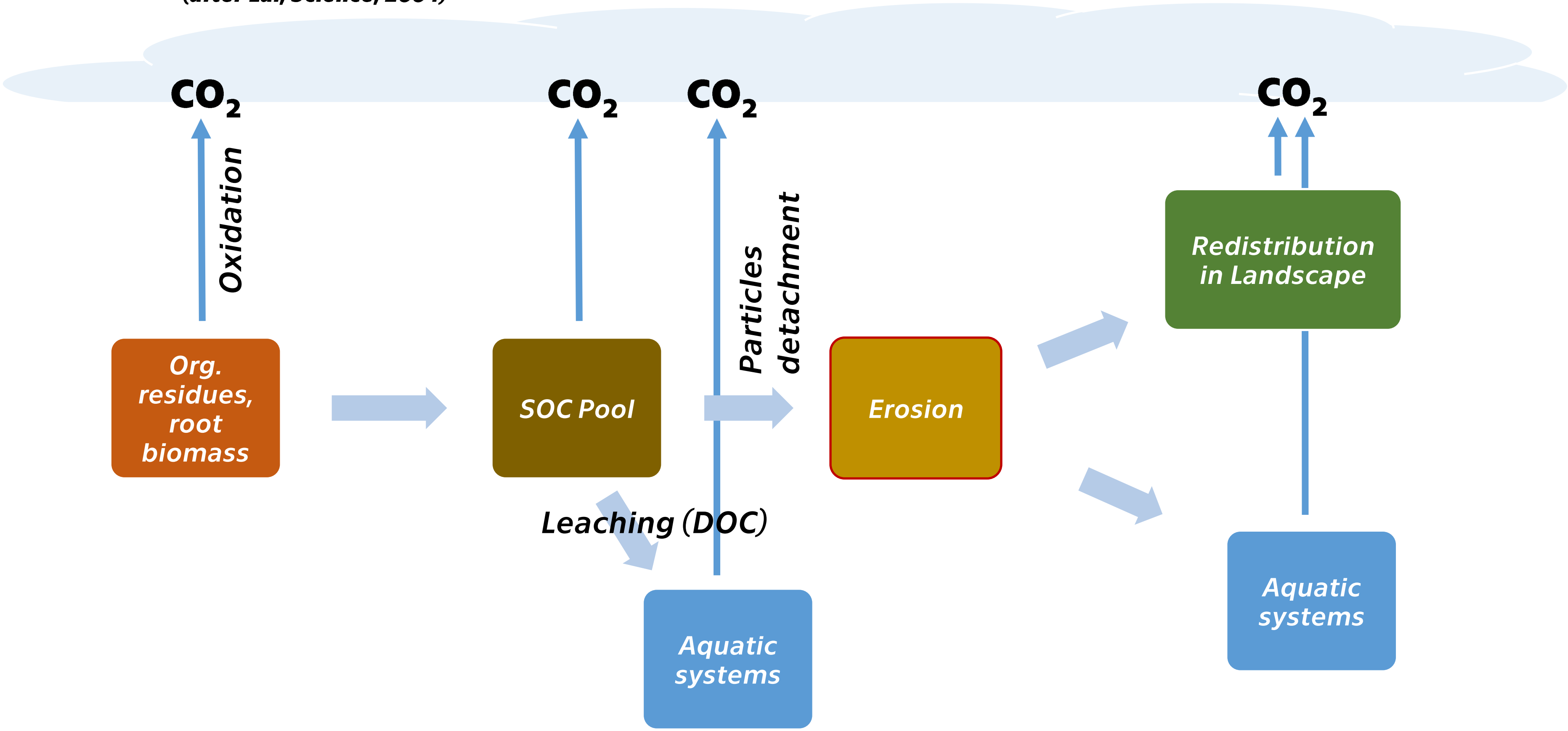
SOIL ORGANIC CARBON DYNAMICS

(after Lal, Science, 2004)



SOIL ORGANIC CARBON DYNAMICS

(after Lal, Science, 2004)



CTU
CZECH TECHNICAL UNIVERSITY IN PRAGUE

CARBON STORAGE & FUTURE CLIMATE

ACCELERATED LOSS

Temperature rise

Faster decomposition

Org. matter inputs

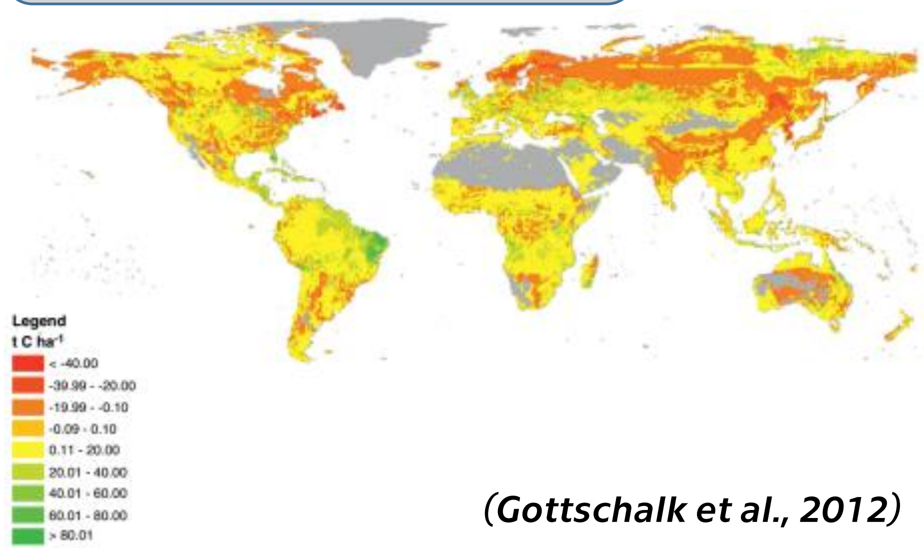
SLOWER LOSS

Dry conditions

Low decomposition

*In **Europe** SOC stocks will change little to 2080* *(Smith 2005)*

Globally *similar projections*



(Gottschalk et al., 2012)

SOILS MITIGATING CLIMATE CHANGE
Carbon sequestration

Carbon stocks can be increased by optimal management

"best management practices"

Positive side effects: *soil fertility, workability, water holding capacity, reduced soil erosion, nutrients cycling* *(Lal, 2004)*

Therefore ***reduced soil degradation and vulnerability to future global warming***

Globally *– loss of C from permafrost and peatlands offsets the potential sequestration* *(Joosten et al., 2012)*

RECENT AND FUTURE RAINFALL EROSIVITY IN CZECH REP. AND ITS IMPACT ON EROSION RISKS

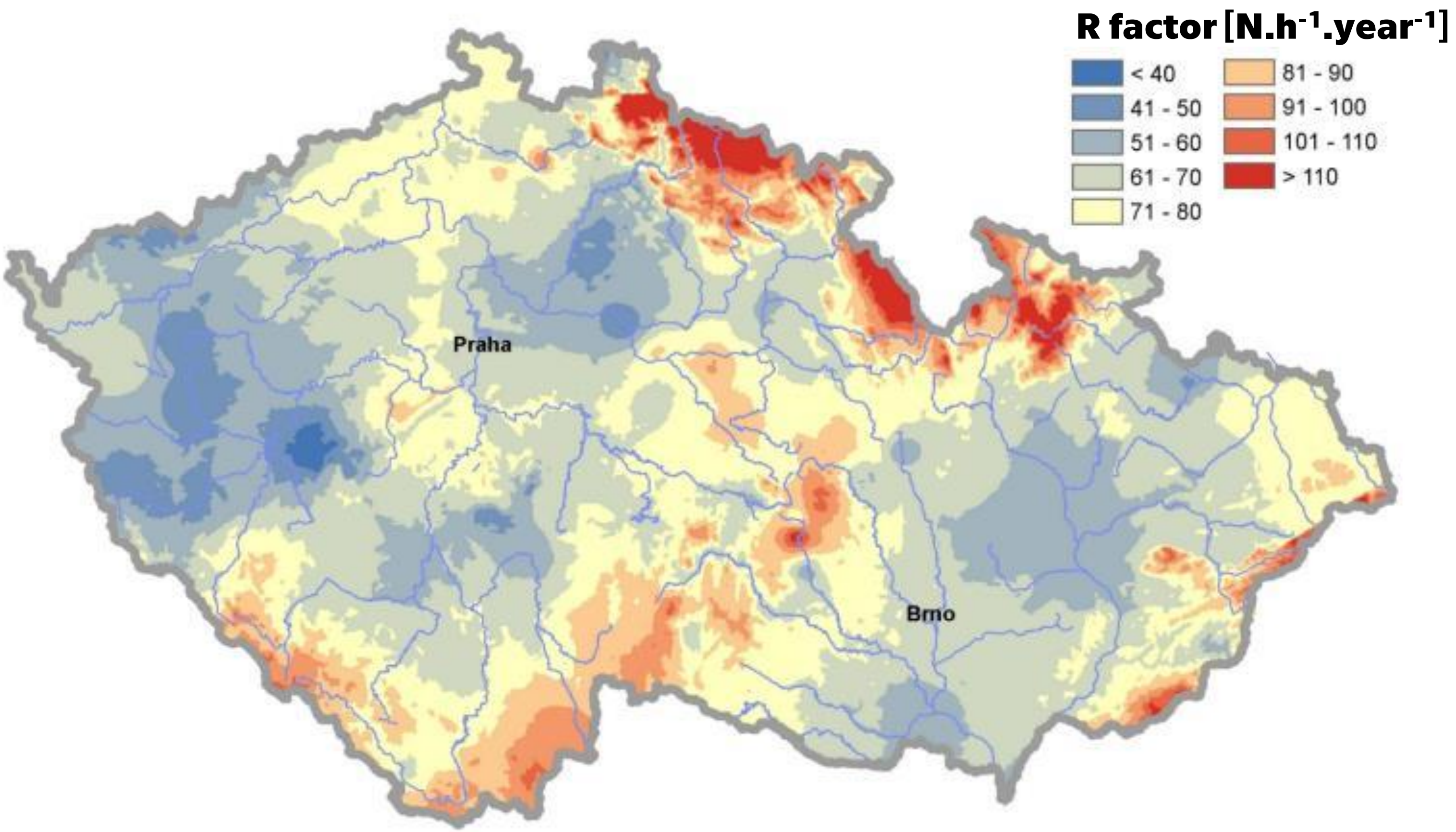
In the Czech Republic – COLLECTIVIZATION of Agriculture → Soil Erosion

Increased soil erosion due to **landscape matrix changes**

1954

1984

R FACTOR DATA AND RECENT EROSIVITY ASSESSMENTS IN THE CR



Publication	Data period	stations	min/max R	Average R
Rožnovský et al. 2013	2003-2012	106/245	37/110	69

- 10 km resolution ALADIN/CZ regional climate model.
- FP6 project CECILIA, coupled with GCM ARPEGE,
- IPCC A1B emission scenario.

Four model periods (based on IPCC A1B)	
1962 – 1990	historical reference period
2003 – 2012	recent period
2021 – 2050	close future scenario
2071 – 2100	distant future scenario

FUTURE

Days exceeding limiting 12.5 mm rainfall threshold:

Period	Minimum number of days	Minimum number of days	Average number of days	Standard deviation	Average number of erosive rains
1961 - 1990	2.79	28.23	8.91	2.42	7.93
2003 - 2012	4.64	27.00	9.61	2.48	8.56
2021 - 2050	3.29	28.55	9.77	2.62	8.69
2071 - 2100	2.41	26.37	8.90	2.10	7.92

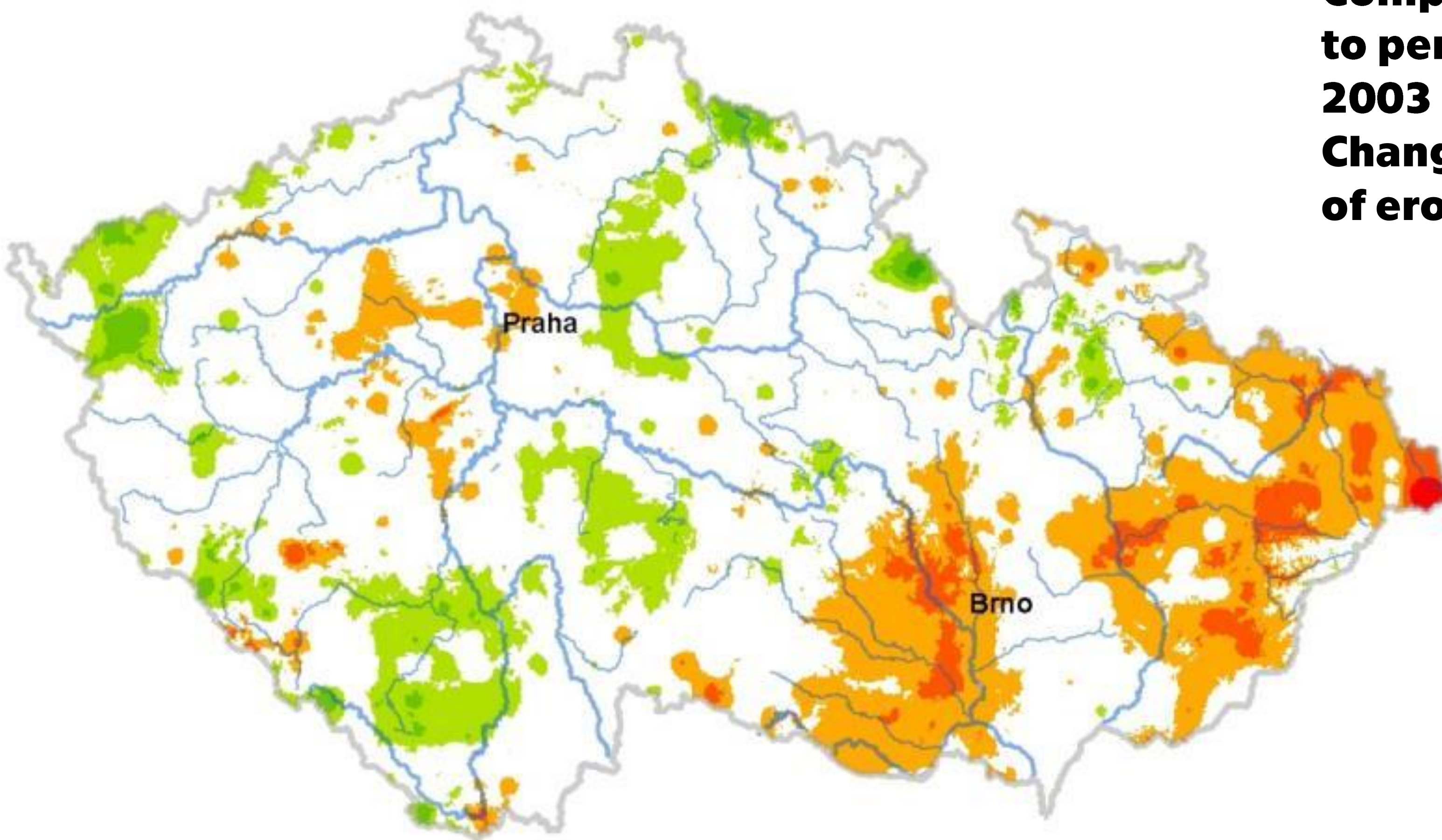
R factor characteristics for model periods:

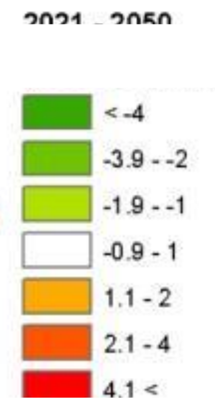
Period	MIN	MAX	EXTENT	AVERAGE	RMSE
1961 - 1990	31	216	185	65.1	14.85
2003 - 2012	34	242	207	70.2	15.16
2051 - 2070	31	208	177	71.5	16.15
2071 - 2100	32	191	159	65.4	14.03

Average annual rise (+) or decrease (-) of number of erosive rains

2021 - 2050

Comparison to period 2003 -2012 Change in no. of erosive rains

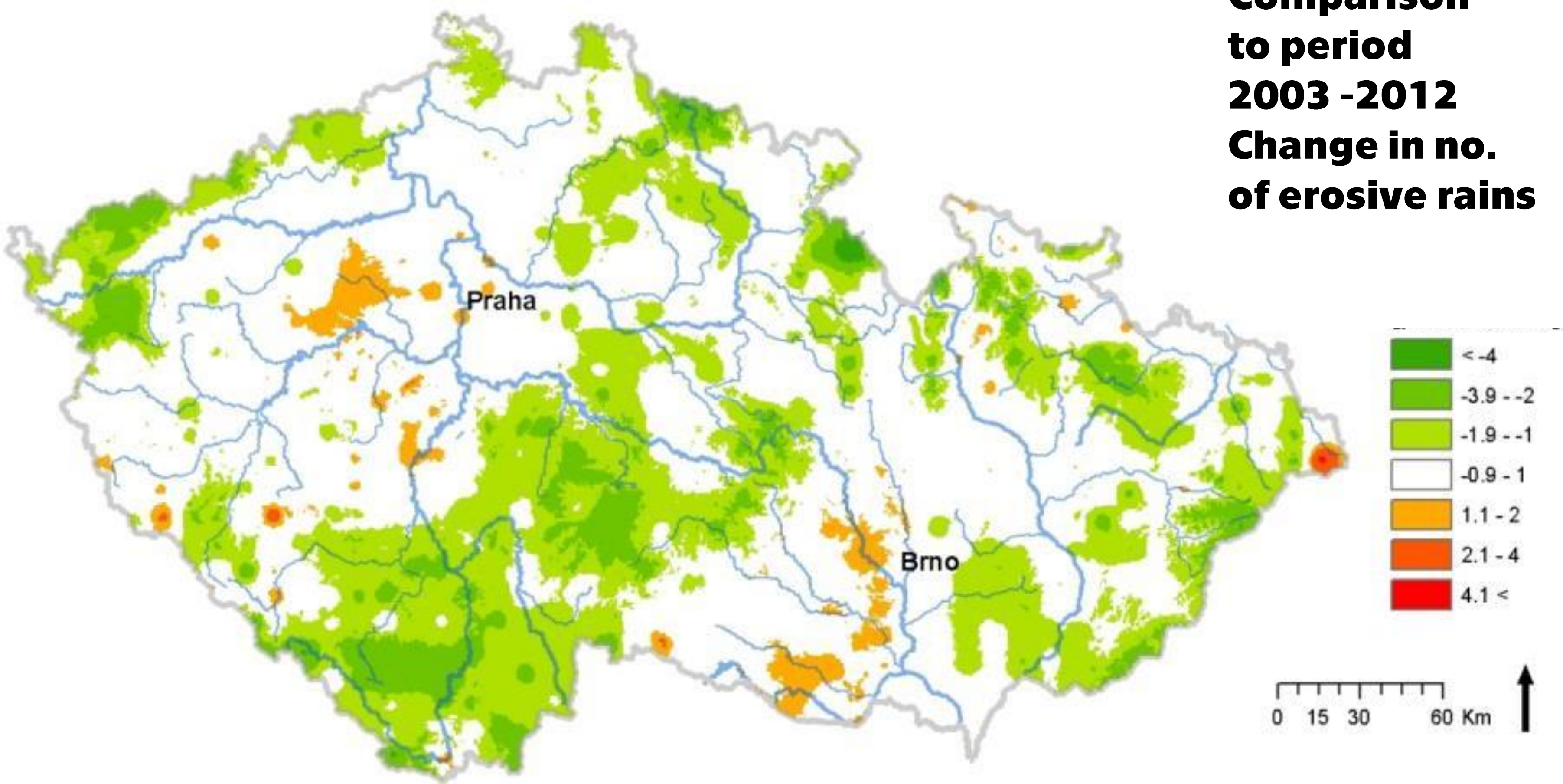




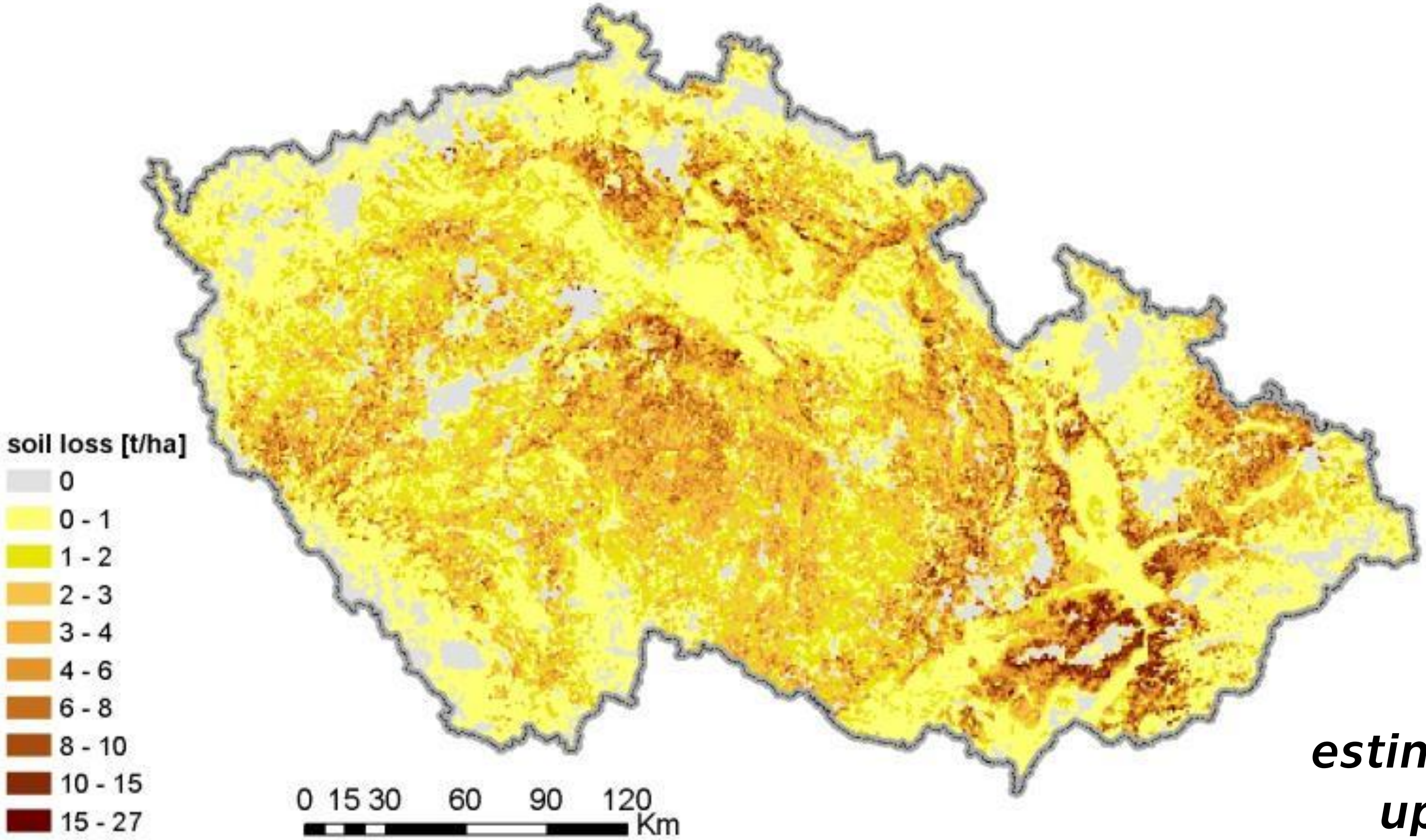
Average annual rise (+) or decrease (-) of number of erosive rains

2071 - 2100

Comparison to period 2003 -2012
Change in no. of erosive rains



SOIL EROSION – ACTUAL STATE (USLE)

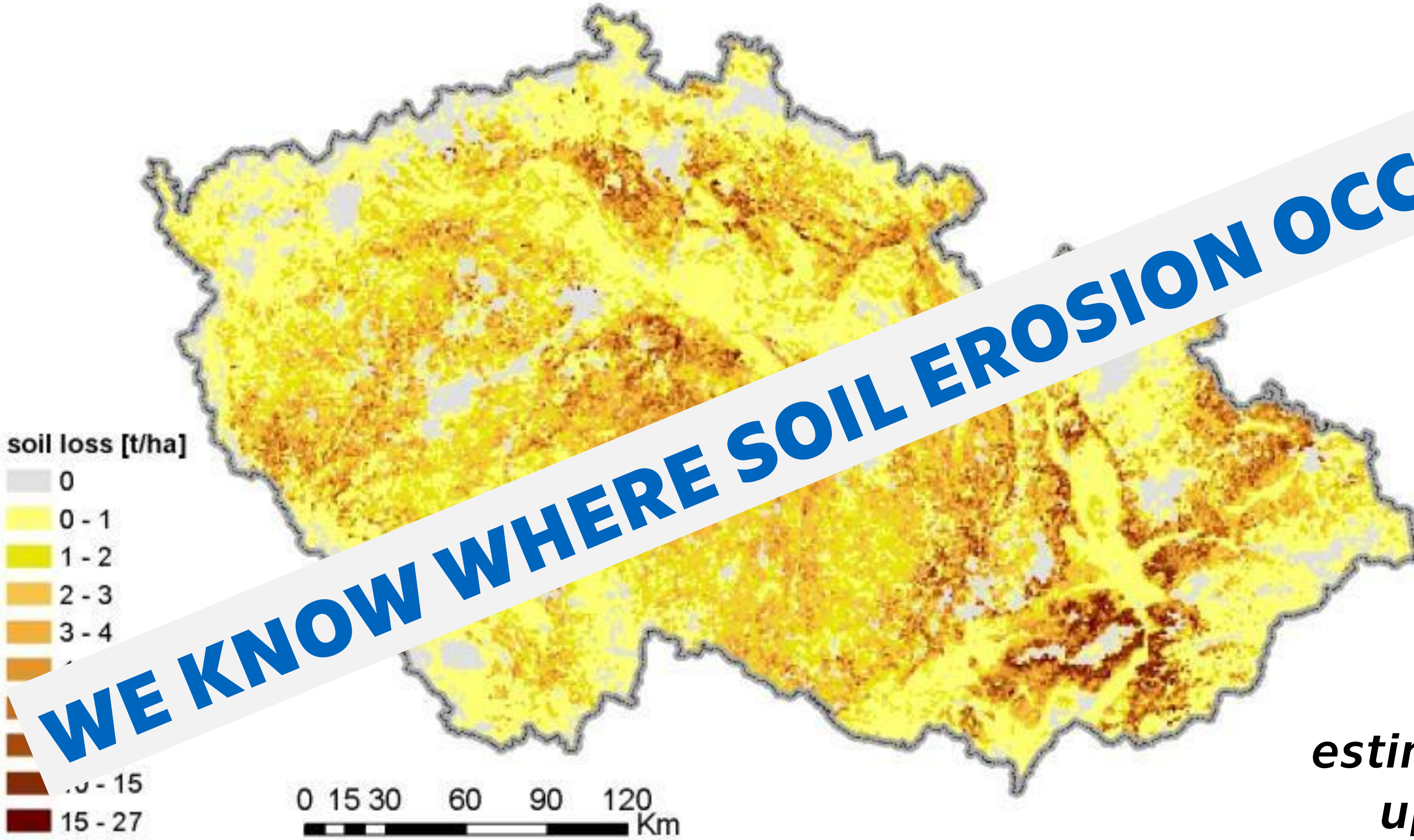


Annual tolerable rate 4 t/ha

x

estimated rates up to 30 t/ha

SOIL EROSION – ACTUAL STATE (USLE)



WE KNOW WHERE SOIL EROSION OCCURS

Annual tolerable rate 4 t/ha

x

estimated rates up to 30 t/ha

TEMPORAL RAINSTORMS DISTRIBUTION

Soil & Water Res., 4, 2009 (4): 131–141 Kubatova et al. (2009)

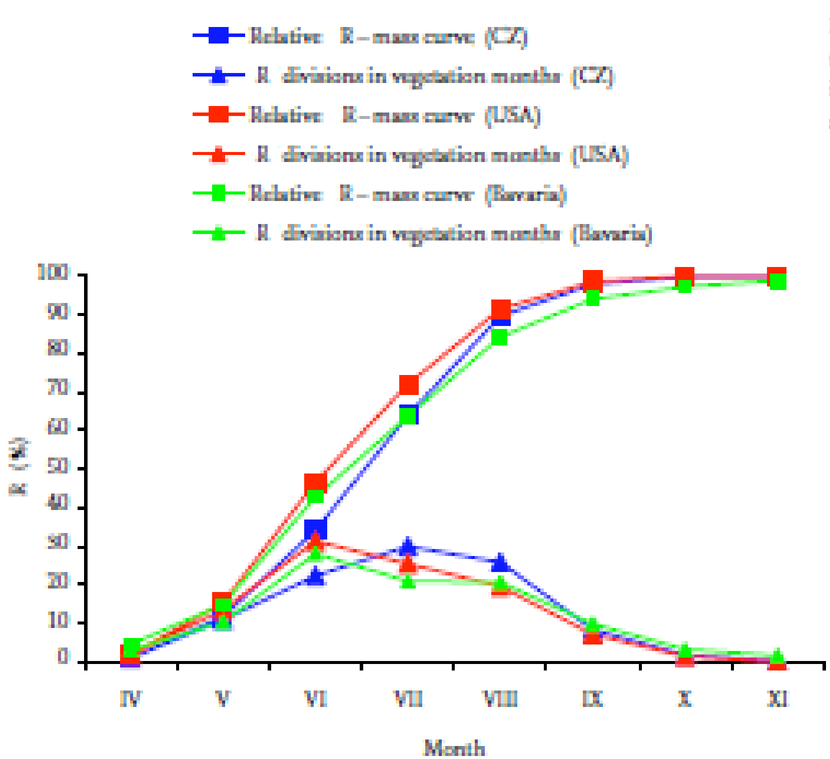


Figure 11. Long term evolution of the average R-factor by months in the Czech Republic, the USA, and Bavaria

in

June
July
August

TEMPORAL RAINSTORMS DISTRIBUTION

Soil & Water Res., 4, 2009 (4): 131–141 Kubatova et al. (2009)

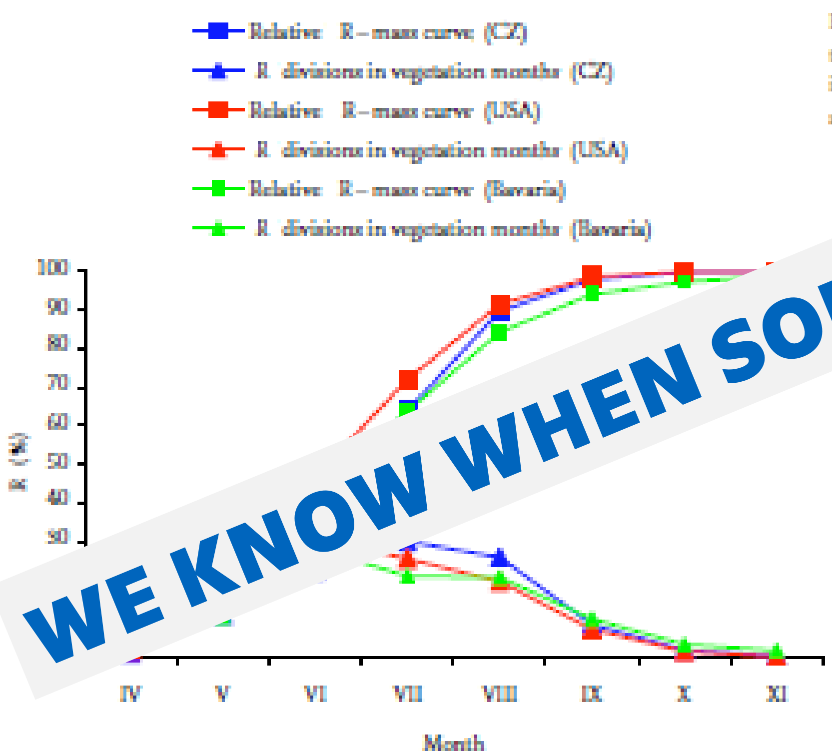


Figure 11. Long term evolution of the average R-factor by months in the Czech Republic, the USA, and Bavaria

WE KNOW WHEN SOIL EROSION OCCURS

in

June

July

August

WE CAN PROPOSE MEASURES
and simulate its effectivity

Best management practices…

CTU
CZECH TECHNICAL UNIVERSITY IN PRAGUE

APRIL 2013

Soil erosion within a single event of 250 t/ha

CTU CZECH TECHNICAL UNIVERSITY IN PRAGUE

CONCLUSIONS

We are aware of soil importance

Soil erosion is the major thread

We know spatial and long term R factor distribution (we can model/predict soil erosion)

BUT we still operate with average values, probabilities

We don’t know when and where the storm comes

THANK YOU !