

1. Introduction

RECENT TRENDS IN CROP ROTATION IN THE CZECH REPUBLIC AND ASSOCIATED SOIL EROSION RISKS

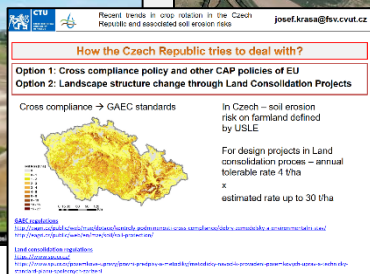
Abstract

In an era when several trends have been visible in agricultural land use in the Czech Republic, production was raised (mostly in last 15 years) and maize production was enlarged in a vast area. However, this was not only a result of crop rotation changes but also of soil erosion and sediment transport. Soil erosion is generally considered as a negative soil process. It is a natural process, but its intensity is increasing due to human activities. Soil erosion is associated with soil loss, which is a negative soil process. It is a natural process, but its intensity is increasing due to human activities. Soil erosion is associated with soil loss, which is a negative soil process. It is a natural process, but its intensity is increasing due to human activities.



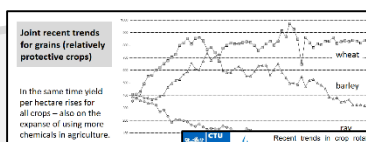
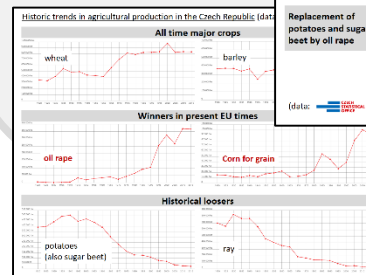
3. Policy tools in Czech Republic

We know – soil erosion and sediment flux are severe

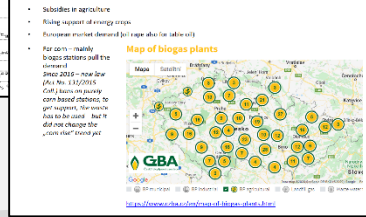


The trend is positive – single data are implemented and more erosion control is in place. The limits are definitely not sharp enough for serious protection.

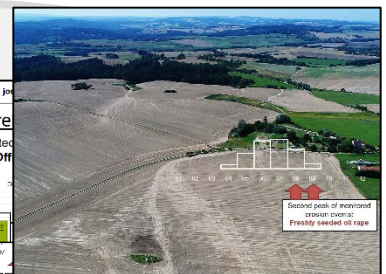
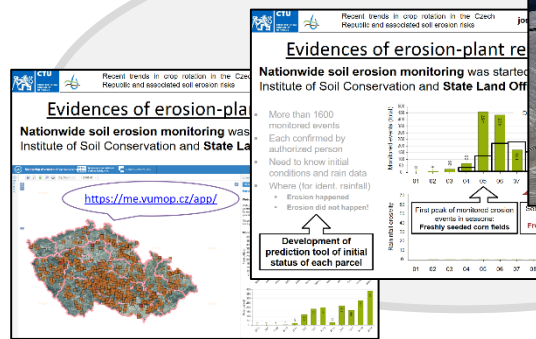
2. Historic trends



Drivers of the above mentioned trends?



4. State monitoring

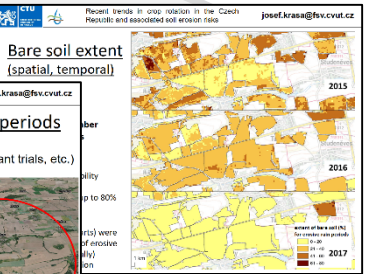
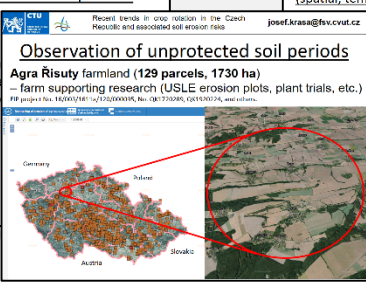


5. Bare soil study

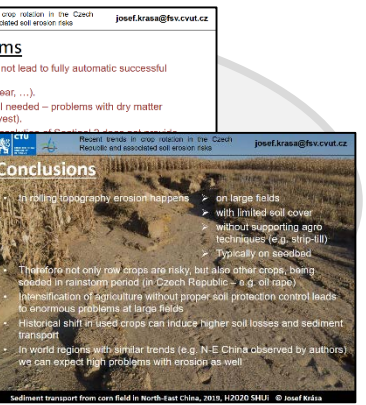
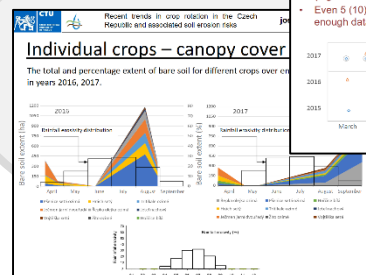
Observation of unprotected soil periods

Study focus

- Soil loss modelling (USLE, V)
- Bare soil temporal changes vs
- Bare soil extent (spatial, temp



6. Conclusions



Use hyperlinks for different chapters, or go through the presentation by page order!

RECENT TRENDS IN CROP ROTATION IN THE CZECH REPUBLIC AND ASSOCIATED SOIL EROSION RISKS

Josef Krása, Tomáš Dostál, David Zumr, Adam Tejkl, and Miroslav Bauer

Faculty of Civil Engineering, Czech Technical University in Prague,
Thákurova 7, 166 29 Praha 6 – Dejvice, e-mail: josef.krasa@fsv.cvut.cz

The contribution was prepared in the frame of projects No. **QK1920224** (Possibilities of anti-erosion protection on farms to avoid the use of glyphosate), and **H2020 SHUI** (Soil Hydrology research platform underpinning innovation to manage water scarcity in European and Chinese cropping systems).

Abstract

In last decades several trends have been visible in agricultural land use in the Czech Republic. Among all oil rape production was raised (mainly in last 15 years) and maize production was enlarged in some regions where bio-fuel stations have been newly built. As a row crop, maize without proper management control leads to accelerated water erosion and sediment transport. Oil rape is generally considered as a relatively soil preserving crop, supporting also infiltration by a root system. But seeding period of oil rape in the Czech Republic starts in August still in the peak period of erosive rainstorms. Recent risks associated with both crops will be presented by data from field rainfall-runoff simulations, targeted on developing actual crop protection factor (C-factor) of USLE for Czech conditions. The second source of the data for presenting risk trends is Czech soil erosion monitoring database of State Land Office (<https://me.vumop.cz/>), where many occurrences of erosion damages were identified on both crops. Finally, study focused on bare soil remote sensing via Landsat 8 and Sentinel 2 in recent years showed link between erosion risks and the two above mentioned crops.

National implementation of European cross compliance policy in the Czech Republic targeted the protection also to fight these risky trends, but the power of the agricultural policy, as will be presented, is limited in this scope. We see similar threats in other European countries and we were able to visit North East China regions with intensive corn production where soil erosion by water is causing serious soil and water degradation. Therefore, shared knowledge on strategies how to prevent risky soil managements could lead to benefits in both European and Chinese conditions.

The contribution was prepared in the frame of projects No. QK1920224 (Possibilities of anti-erosion protection on farms to avoid the use of glyphosate), and H2020 SHUi (Soil Hydrology research platform underpinning innovation to manage water scarcity in European and Chinese cropping systems).



Historic trends in agricultural production

Since 1920, when the area of sown areas began to be monitored, over 1,353 thousand hectares of sown land have decreased in the territory of Czech Republic. Over the past century, however, it has been far from a steady decline; several jumps clearly stand out in the chart - for example, after World War II or after 2000. But still we keep about 58 % of agricultural land, and 30 years ago original state farms started converting to grasslands – in mountain regions.

On the other hand – structure (fragmentation) of land remains destroyed after collectivization of 1960s' and was only very little transformed back.



Historic trends in agricultural production

For most of the period under review, rapeseed was rather a rarity in the Czech lands (for example, in 1933 we would find it on only 298 hectares), which, apart from the production of vegetable oils, was not very widely used. However, the number of yellow fields gradually began to increase in the 1970s, and we can literally talk about the boom after 1990. **The area of land on which rape is grown has increased almost fourfold and today represents almost 393 thousand hectares.** In recent years, rapeseed cultivation has also recorded its purchase price. While the sales of Czech farmers are falling due to low prices of milk, pork or grain, the price of rapeseed in our country is still at the European level and demand for this crop is even expected to increase in the future. And today, **Czech farmers produce the second highest amount of rapeseed in all of Europe.**

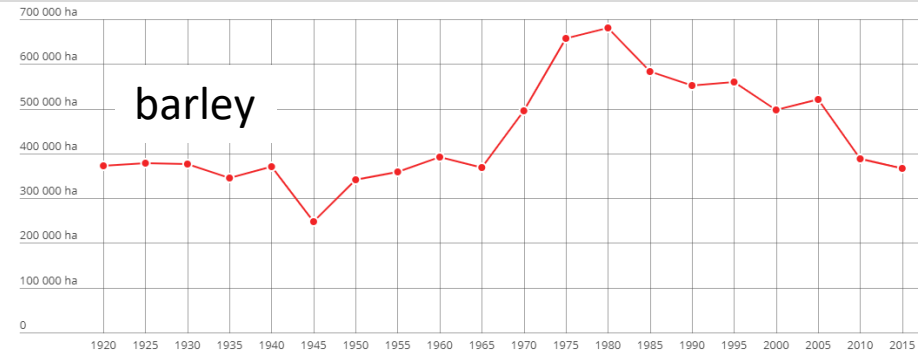
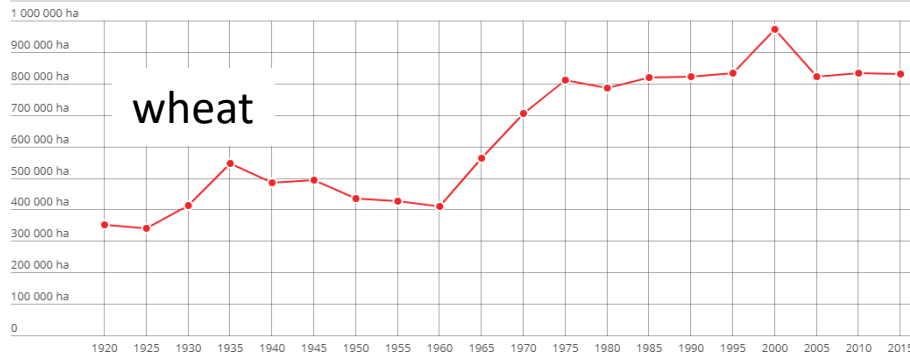
In the case of most other crops, however, the sown areas decreased. Compared to 2005, we grow half as much rye and barley is also significantly declining (from 521,527 to 325,725 hectares). However, the decrease in areas sown with cereals can be described as a pan-European trend and the Czech Republic is far from exceptional in it.

Between 2000 and 2013, on the other hand, **maize for grain increased significantly - by almost 284%.** In recent years, however, the decline has also affected maize, and currently its sown area is at a level comparable to 2005. According to the Agrarian Chamber of the Czech Republic, **the construction of biogas plants has significantly contributed to the expansion of maize areas. It is also a crop that is sown in the spring, so corn has replaced some spring crops in the seed sequence, such as potato or sugar beet root crops.**

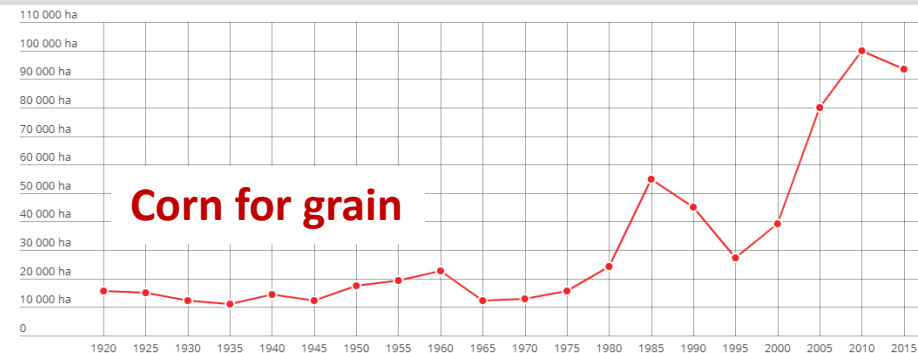
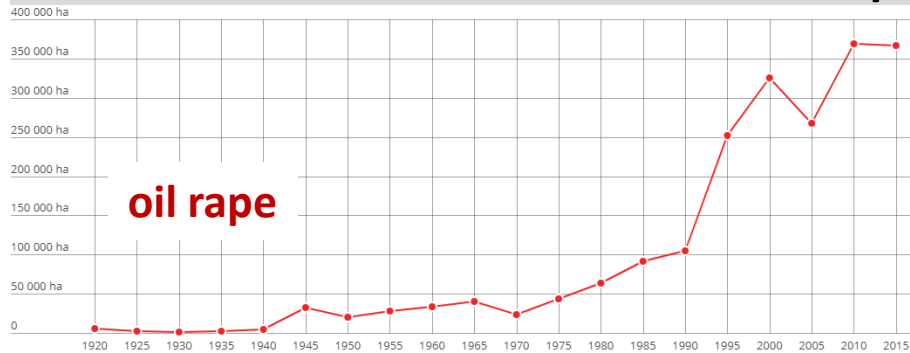
(agricultural chamber, <https://www.ceskovdatech.cz/clanek/52-v-cesku-ubyva-osevnich-ploch-jde-ale-o-dusledek-prirozeneho-vyvoje/>)

Historic trends in agricultural production in the Czech Republic (data:

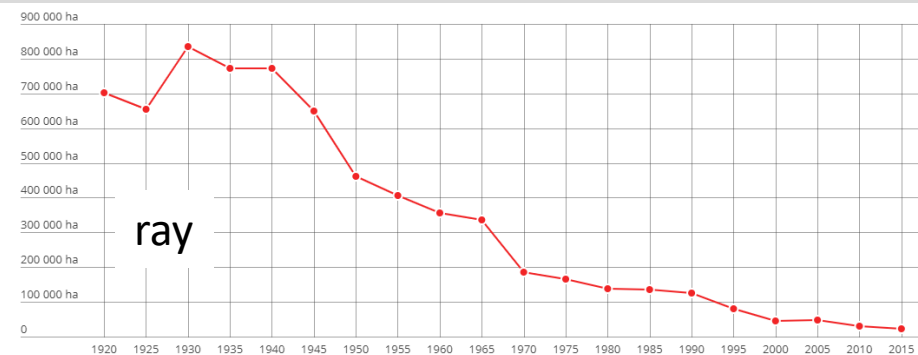
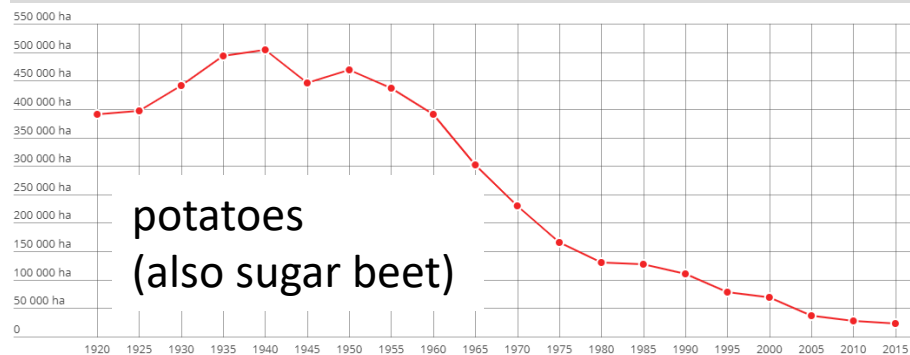
All time major crops



Winners in present EU times

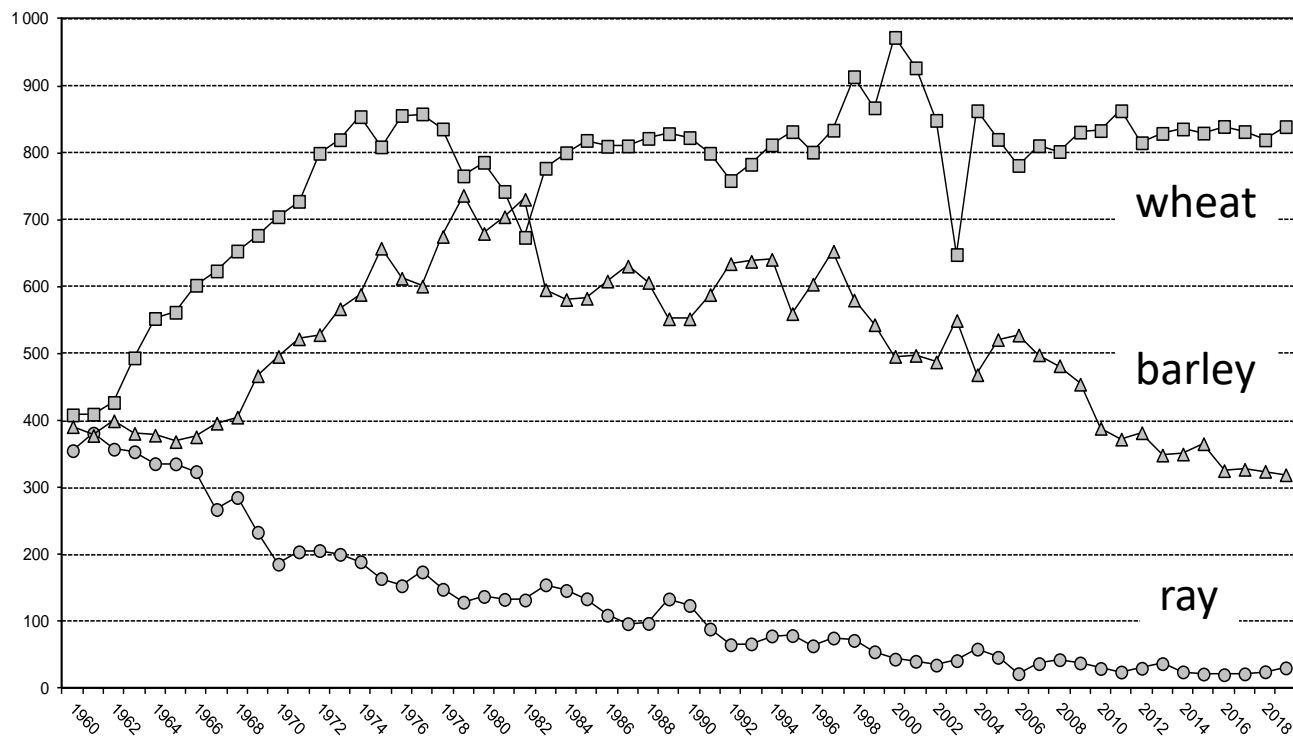


Historical losers

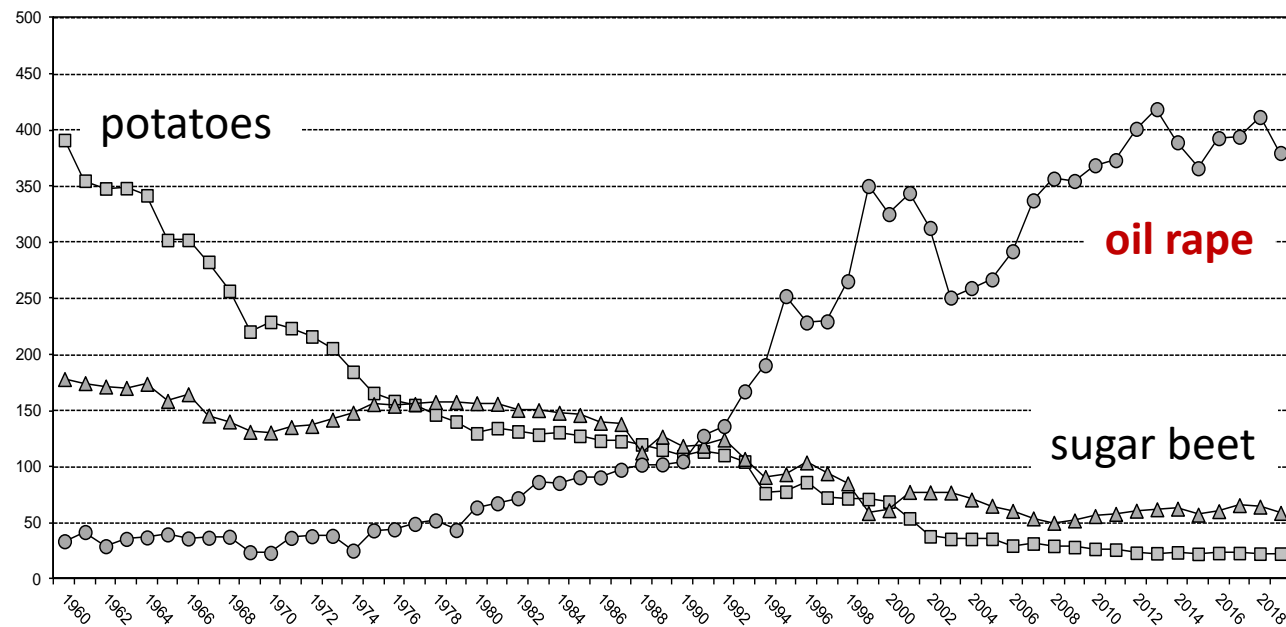


Joint recent trends for grains (relatively protective crops)

In the same time yield per hectare rises for all crops – also on the expense of using more chemicals in agriculture.



Replacement of potatoes and sugar beet by oil rape



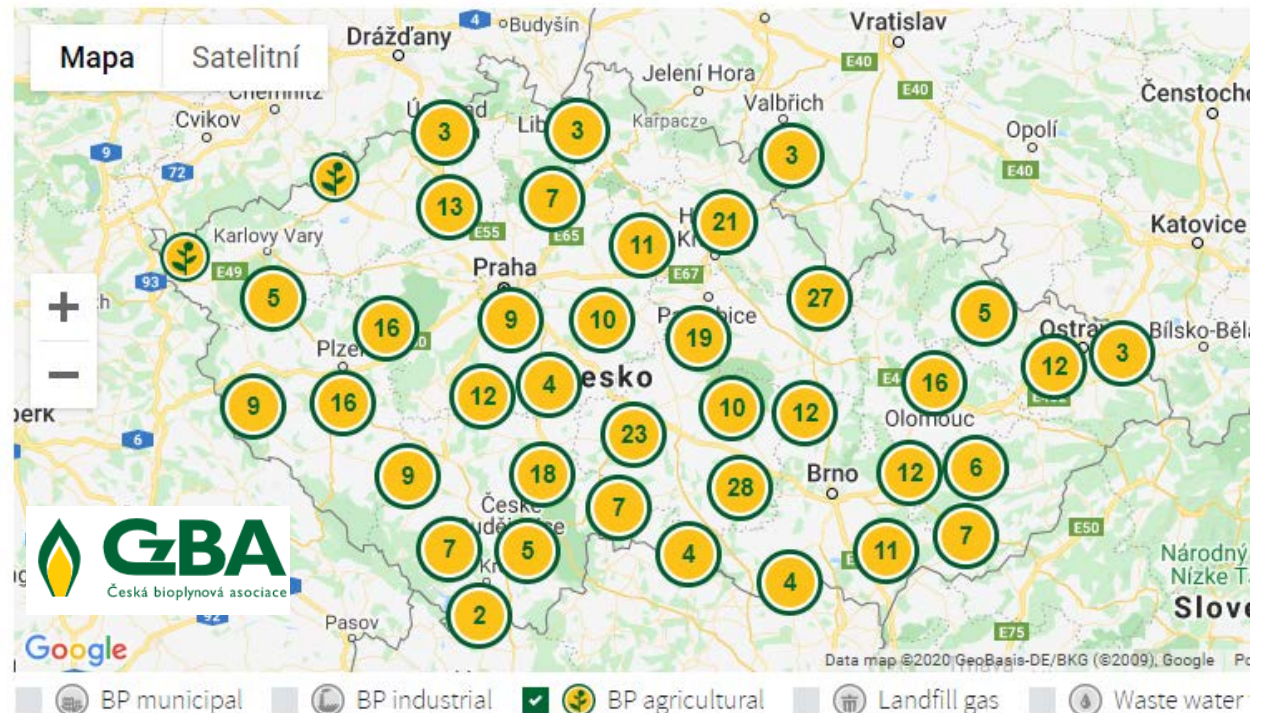
(data: )

Drivers of the above mentioned trends?

- Subsidies in agriculture
- Rising support of energy crops
- European market demand (oil rape also for table oil)
- For corn – mainly biogas stations pull the demand

Since 2016 – new law (Act No. 131/2015 Coll.) bans on purely corn based stations, to get support, the waste has to be used – but it did not change the „corn rise“ trend yet

Map of biogas plants



<https://www.czba.cz/en/map-of-biogas-plants.html>

We know – soil erosion and sediment flux are severe



Water erosion event in seeded oil rape and associated sediment transport – 11.8.2017, © Josef Krása

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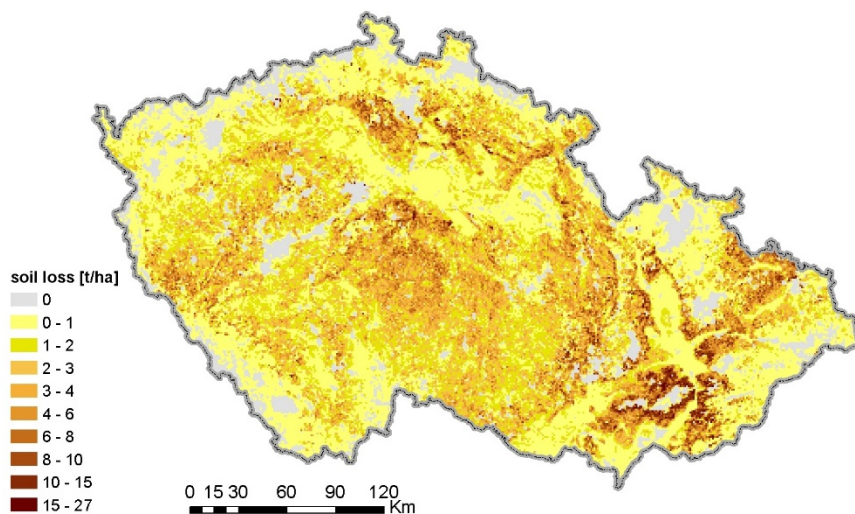


How the Czech Republic tries to deal with?

Option 1: Cross compliance policy and other CAP policies of EU

Option 2: Landscape structure change through Land Consolidation Projects

Cross compliance → GAEC standards



In Czech – soil erosion risk on farmland defined by USLE

For design projects in Land consolidation proces – annual tolerable rate 4 t/ha

X

estimated rate up to 30 t/ha

GAEC regulations

<http://eagri.cz/public/web/mze/dotace/kontroly-podminenosti-cross-compliance/dobry-zemedelsky-a-environmentalni-stav/>

<http://eagri.cz/public/web/en/mze/soil/soil-protection/>

Land consolidation regulations

<https://www.spucr.cz/>

<https://www.spucr.cz/pozemkove-uprav-y/pravni-predpisy-a-metodiky/metodicky-navod-k-provadeni-pozemkovych-uprav-a-technicky-standard-planu-spolecnych-zarizeni>

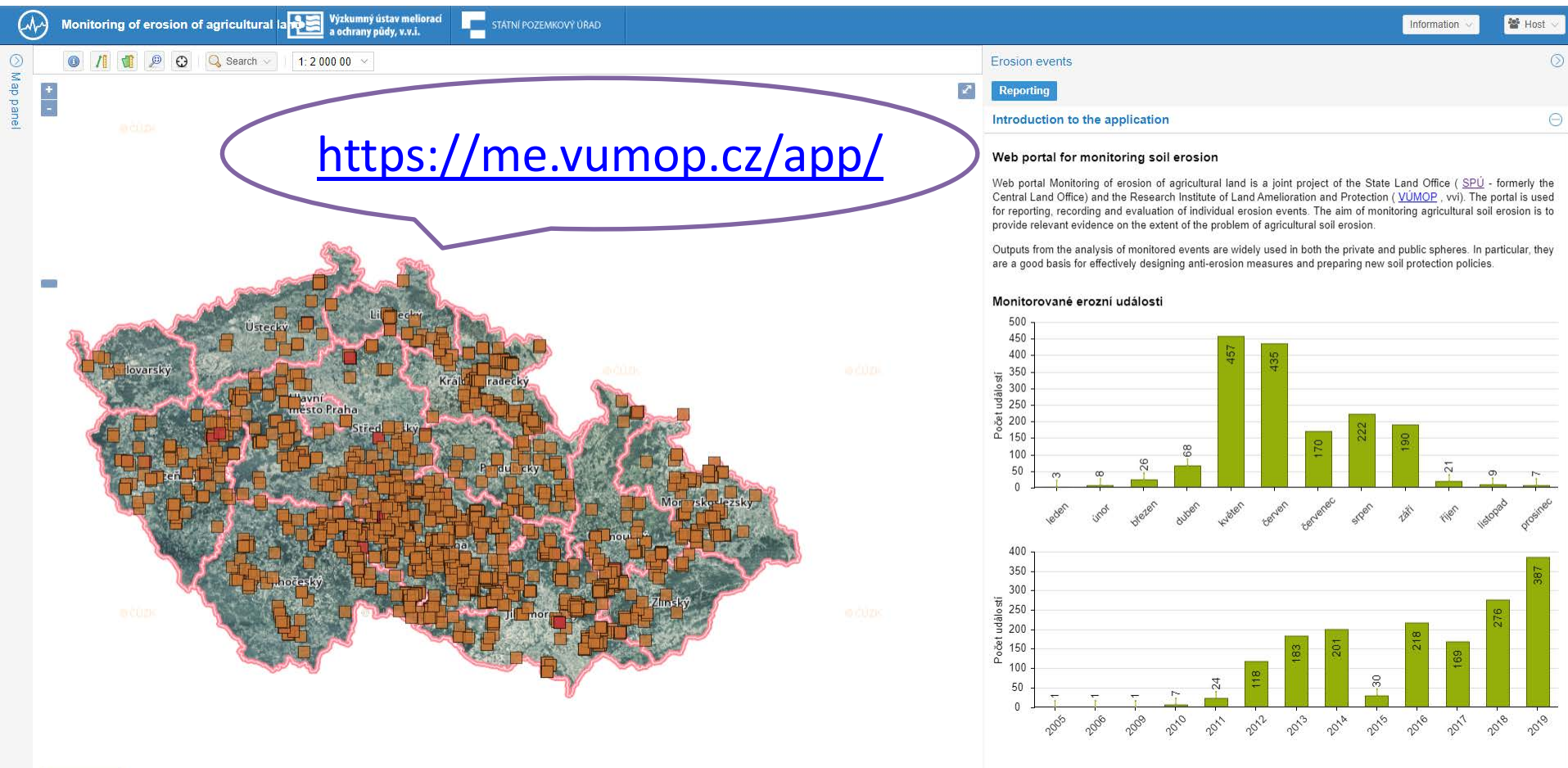
- The trend is positive – regulations are implemented and new rules are coming (such as 30 ha field size limit from 2020).
- But soil protection Act is not strict and responsibilities for damages are not defined.
- Measures are set to be easily checked (strip width, field size) – not to respect the nature rules (e.g. contour orientation).

The limits are definitely not sharp enough for serious protection



Evidences of erosion-plant relations

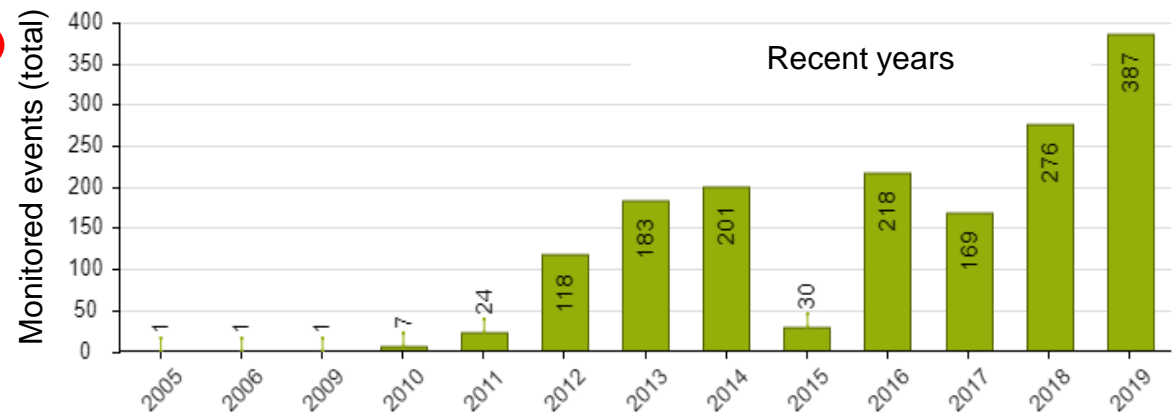
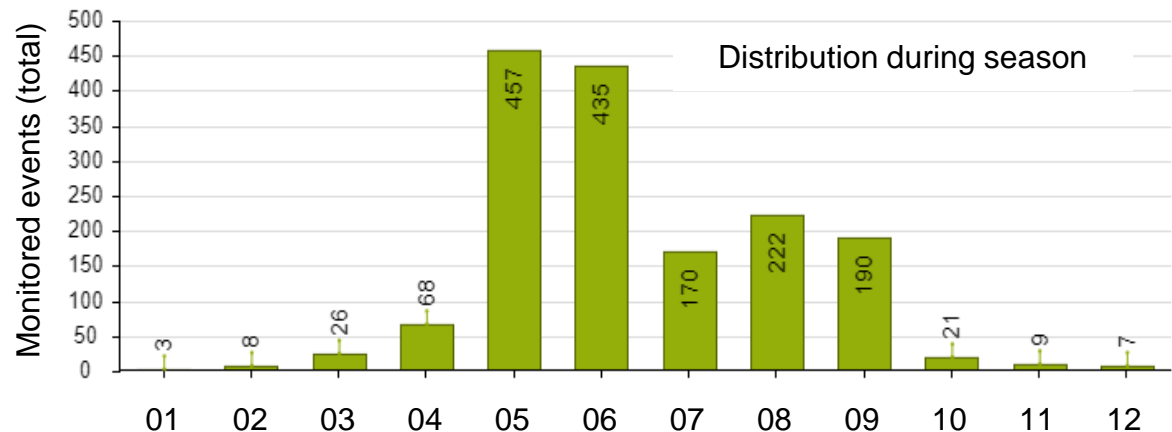
Nationwide soil erosion monitoring was started by Research Institute of Soil Conservation and **State Land Office** in 2012



Evidences of erosion-plant relations

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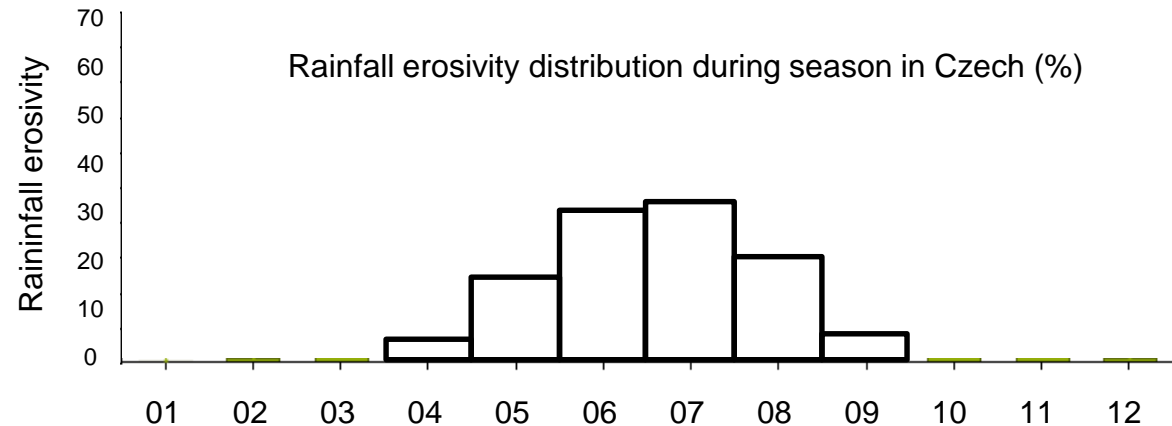
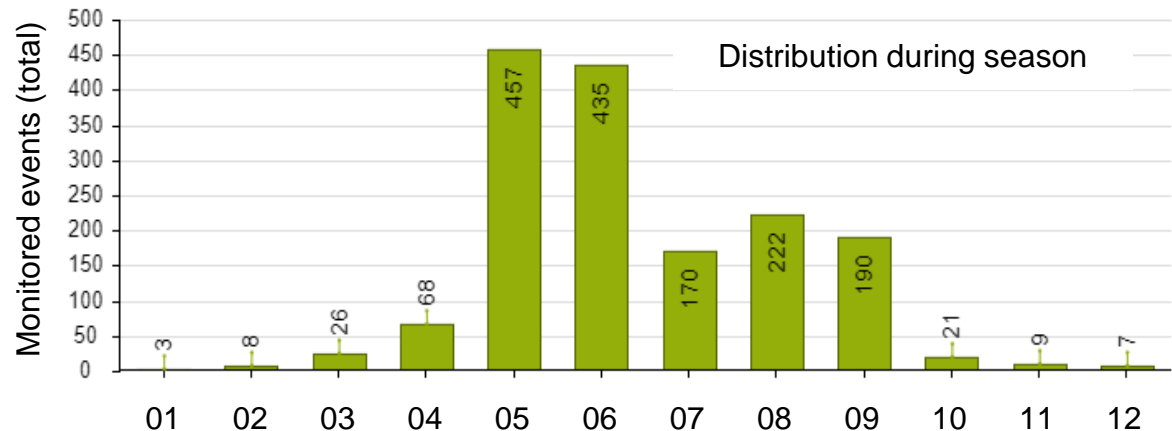
- More than 1600 monitored events
- Each confirmed by authorized person
- Need to know initial conditions and rain data
- Where (for ident. rainfall)
 - Erosion happened
 - Erosion did not happen!



Evidences of erosion-plant relations

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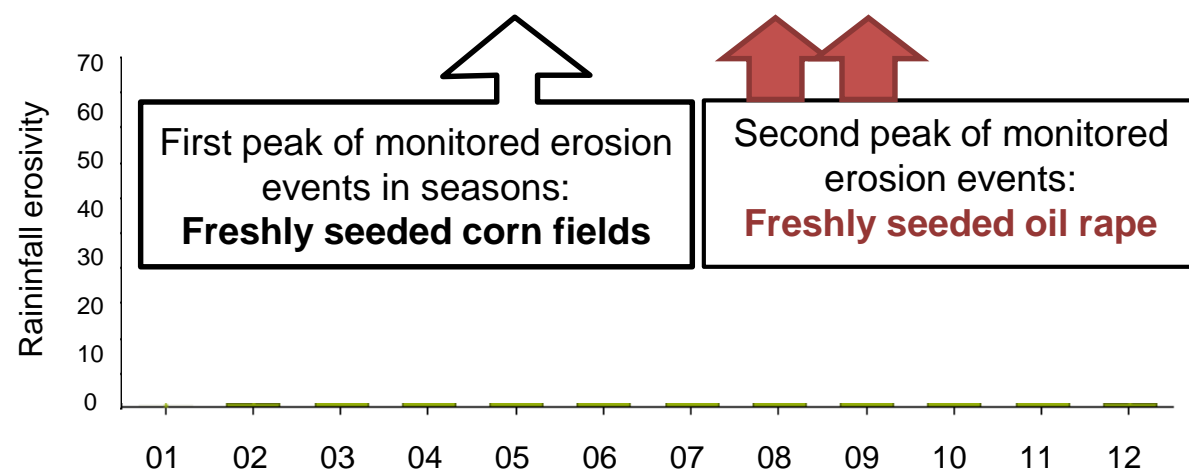
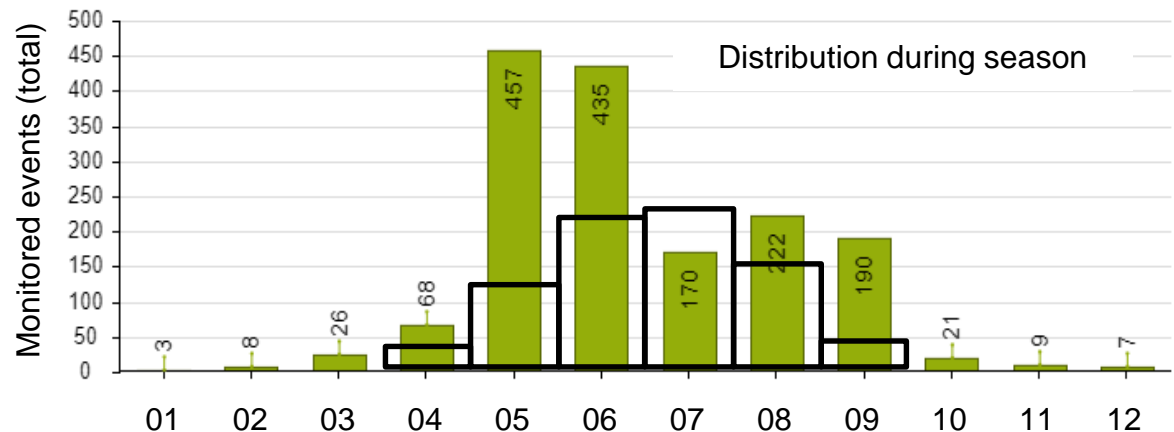
Development of
prediction tool of initial
status of each parcel

Evidences of erosion-plant relations

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Development of prediction tool of initial status of each parcel





01 02 03 04 05 06 07 08 09 10 11 12



Second peak of monitored
erosion events:
Freshly seeded oil rape

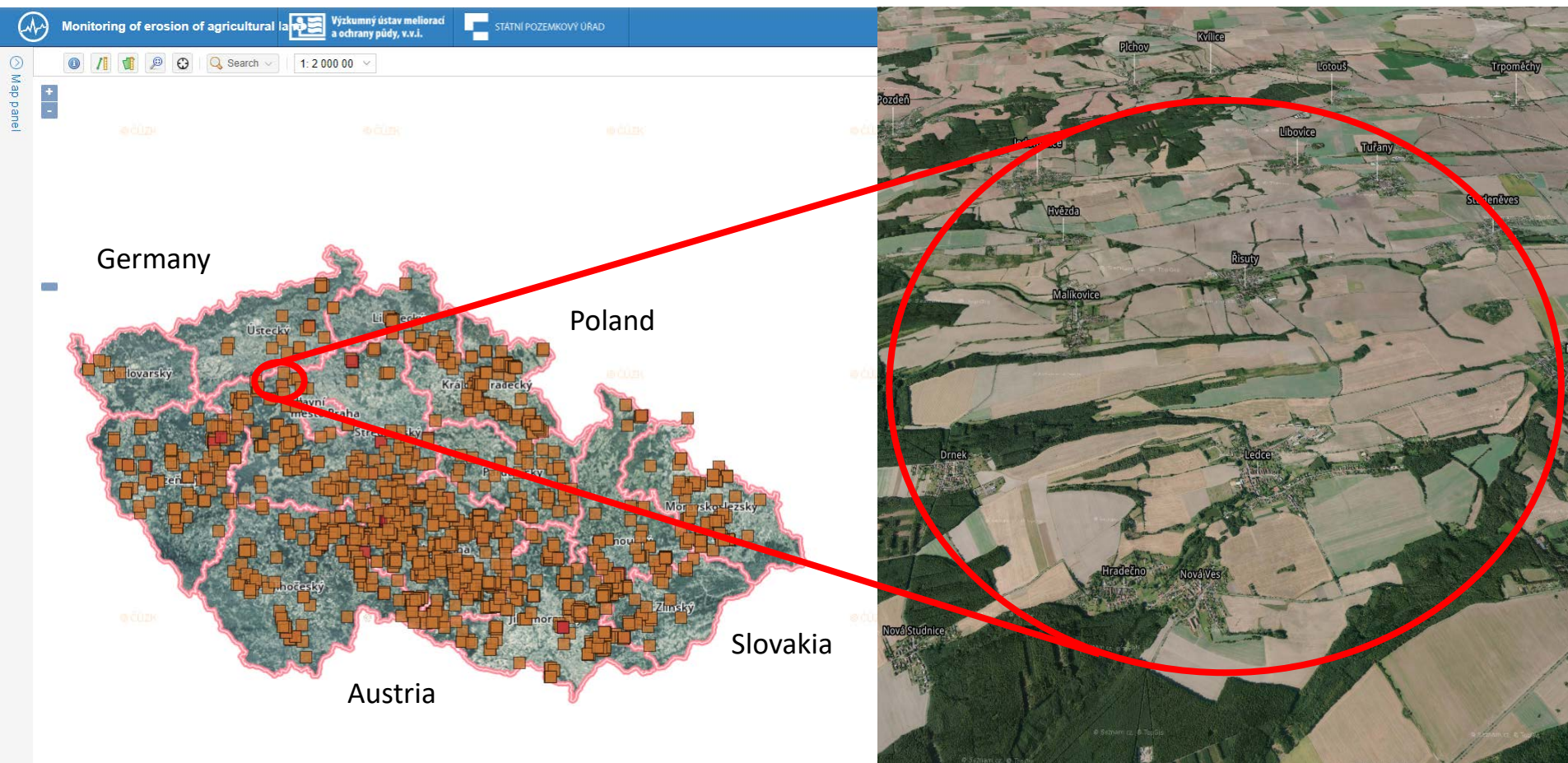


Observation of unprotected soil periods

Agra Řisuty farmland (129 parcels, 1730 ha)

– farm supporting research (USLE erosion plots, plant trials, etc.)

EIP project No. 16/003/1611a/120/000095, No. QK1720289, QK1920224, and others.



Observation of unprotected soil periods

Study focus

- Soil loss modelling (USLE, WaTEM/SEDEM)
- **Bare soil temporal changes vs. agricultural management**
- **Bare soil extent (spatial, temporal) in recent years**

Bare soil extent (spatial, temporal)

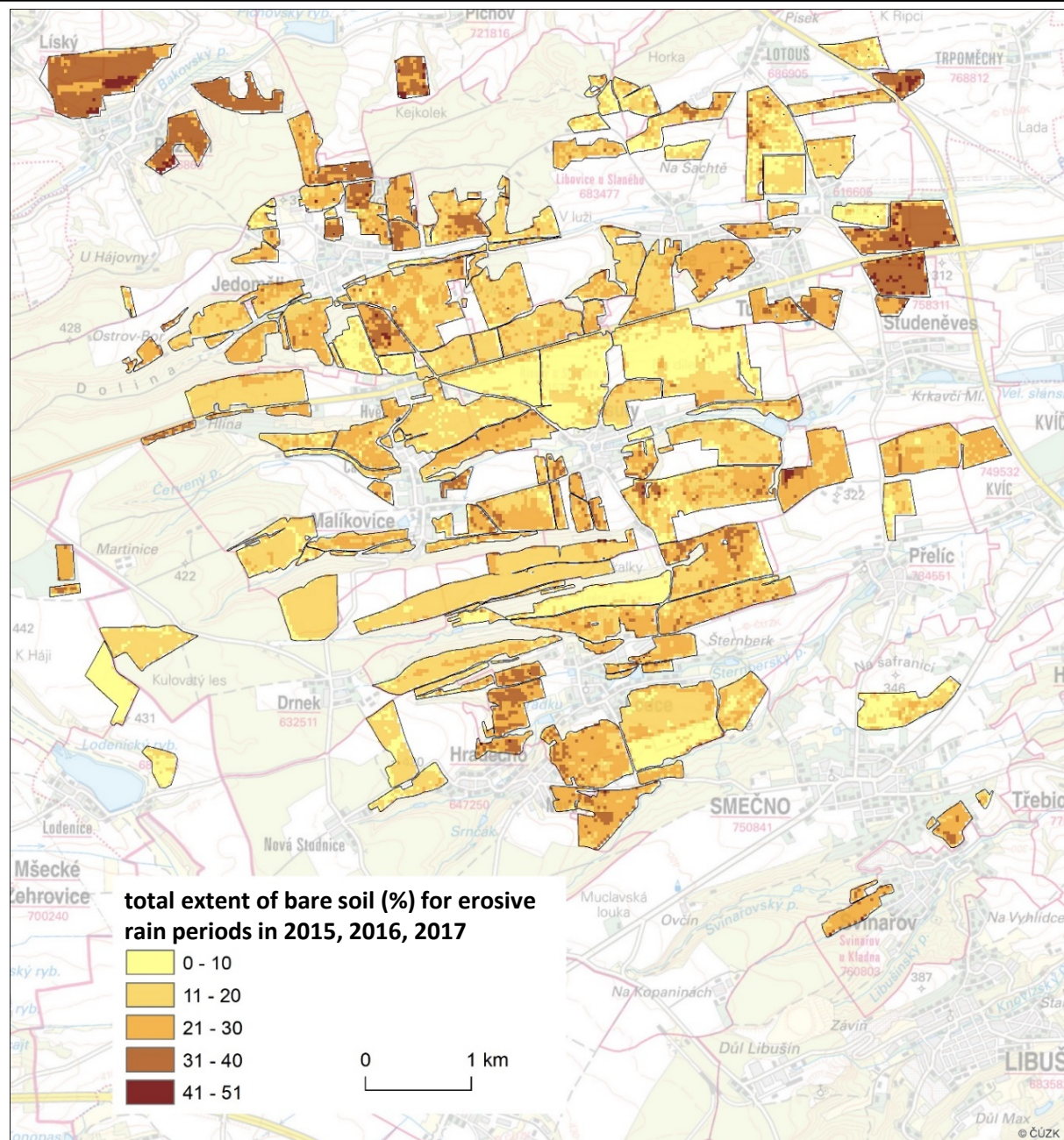
Combined total extent of bare soil (%)

- April to September
- 2015, 2016, 2017
- entire farm

- The spatial variability is rather high
- The differences up to 50%



Some fields (field parts) were exposed up to 50% of erosive rainstorms (potentially) without any protection



Bare soil extent (spatial, temporal)

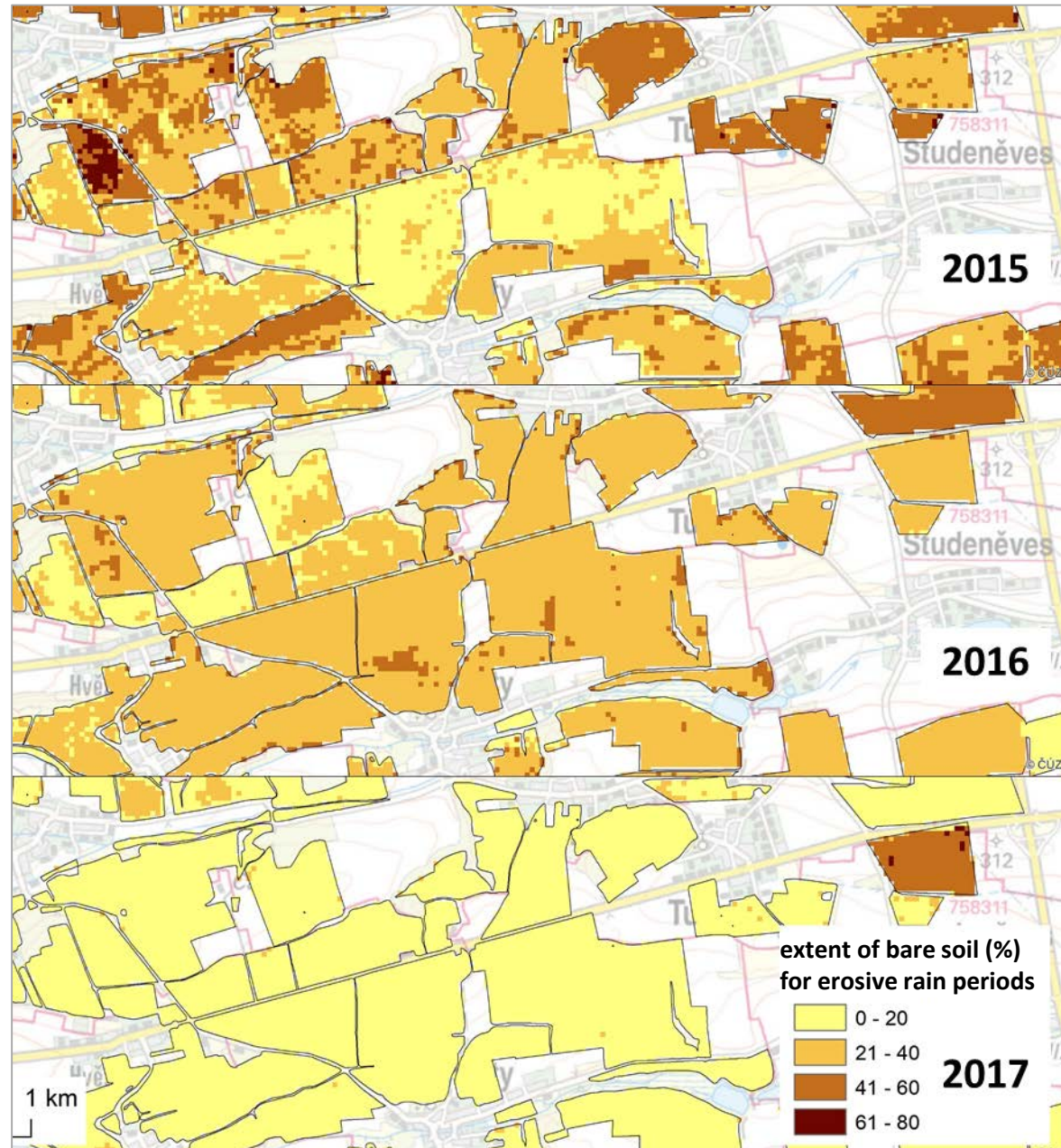
Average extent
of bare soil (%)

- April to September
- individual years
- detailed view

- The spatial variability is rather high
- The differences up to 80%

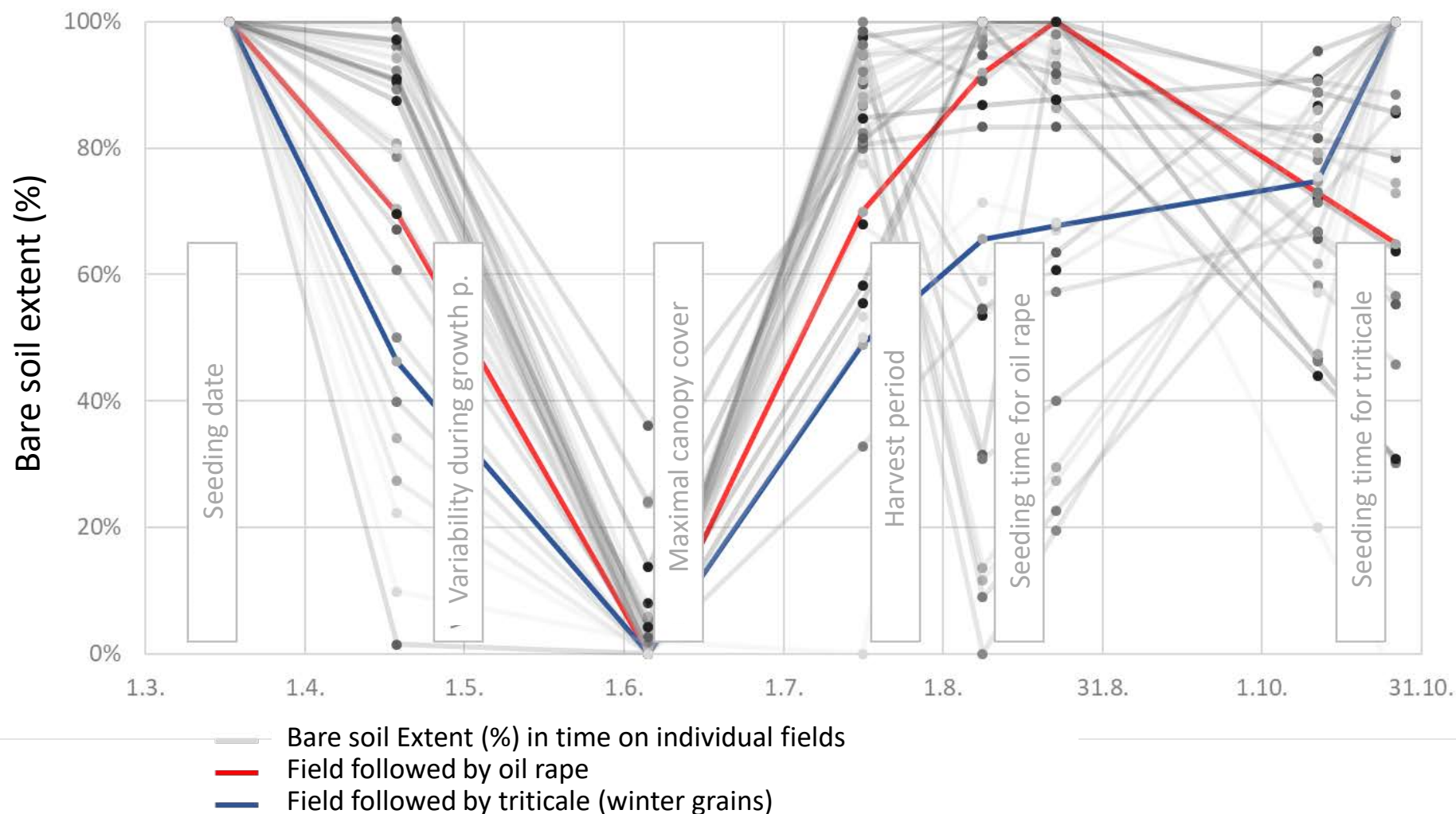


Some fields (field parts) were
exposed up to 80% of erosive
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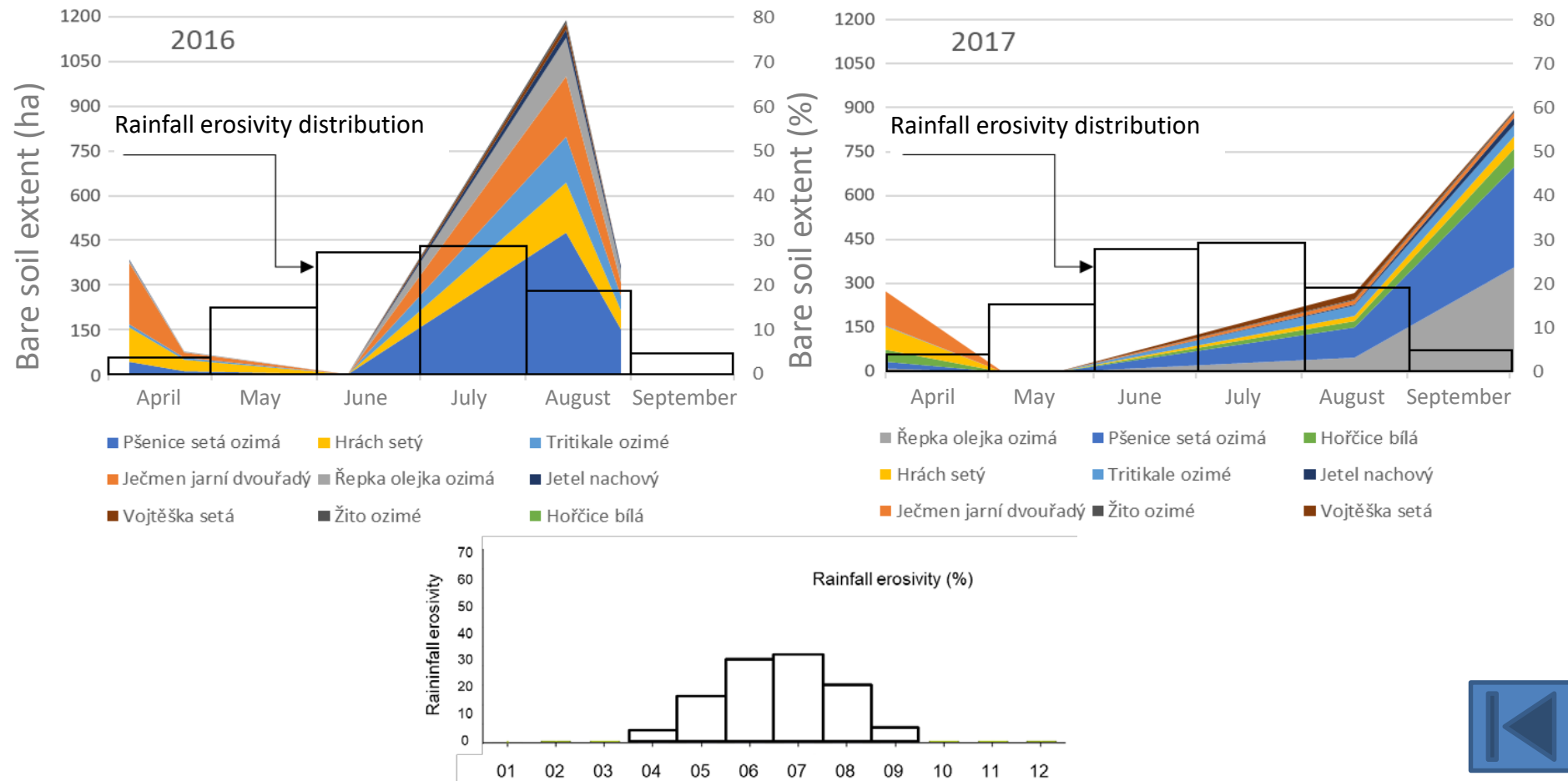
Individual parcels – canopy cover in time

The variability of the bare soil extent on the parcels seeded by **spring barley** in 2015.



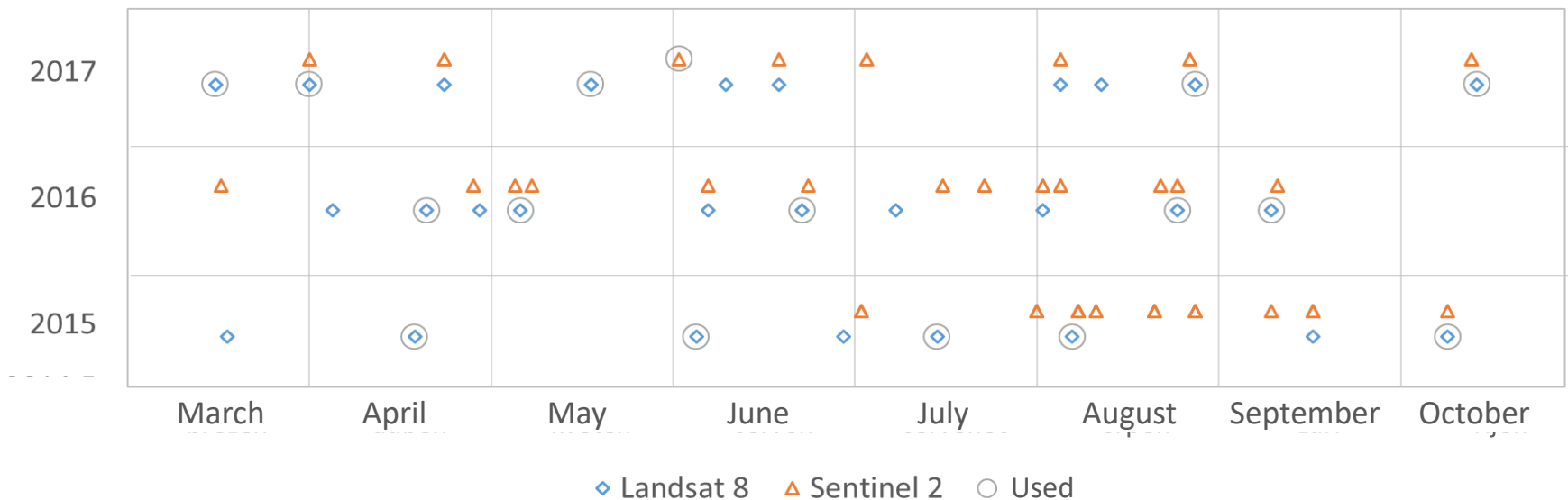
Individual crops – canopy cover in time

The total and percentage extent of bare soil for different crops over entire target area in years 2016, 2017.



Unsolved Problems

- Using various indexes does not lead to fully automatic successful determination of bare soils (different crops, periods of year, ...).
- Supervised classification still needed – problems with dry matter (e.g. field residues after harvest).
- Even 5 (10) days temporal resolution of Sentinel 2 does not provide enough data for cloudy rain periods to be „in time“.



Conclusions

- In rolling topography erosion happens
 - on large fields
 - with limited soil cover
 - without supporting agro techniques (e.g. strip-till)
 - Typically on seedbed
- Therefore not only row crops are risky, but also other crops, being seeded in rainstorm period (in Czech Republic – e.g. oil rape)
- Intensification of agriculture without proper soil protection control leads to enormous problems at large fields
- Historical shift in used crops can induce higher soil losses and sediment transport
- In world regions with similar trends (e.g. N-E China observed by authors) we can expect high problems with erosion as well

