

Monitoring agricultural drought and its impacts

*Czech and DriDanube
experience*



PAST
500 BC - 2016

PRESENT
2016

FUTURE
2016~ 2100+

UNDERSTANDING PAST CLIMATE

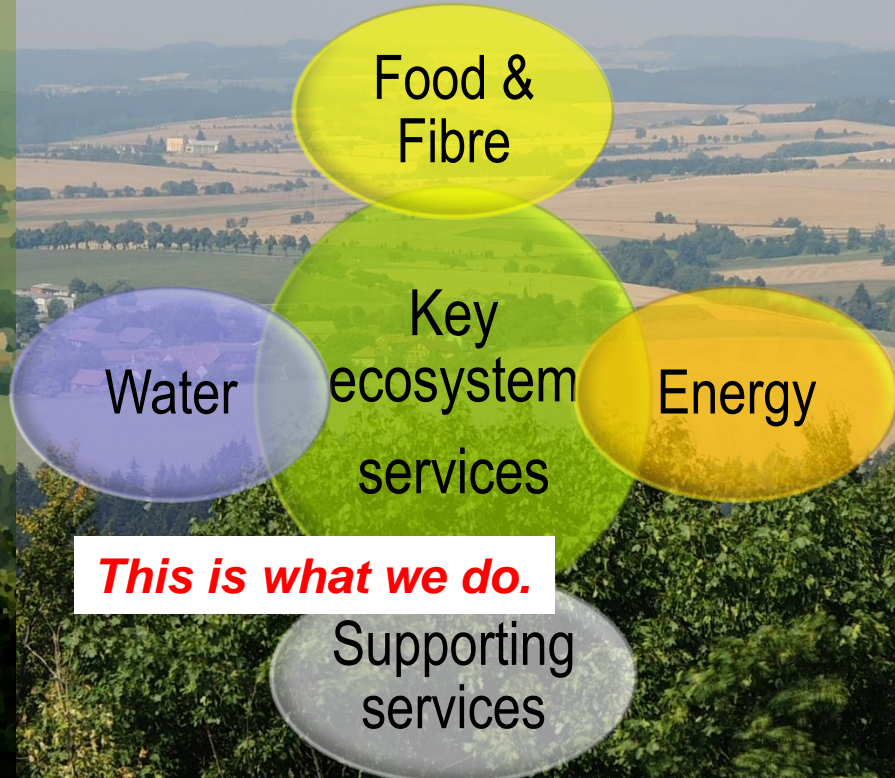
PRESENT STATUS, FORECASTS & WARNING

TRENDS & RISKS

Natural proxies,
documents, models,
instrumental records,

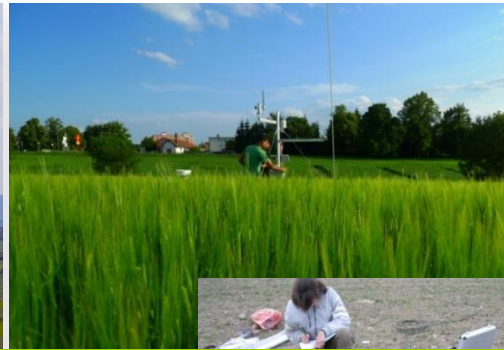
Field and landscape scale experiments
Models
Observations & Monitoring & Forecast

Models & experiments
Forecasts & projections



This is what we do.

Marchfeld



RESOURCES = RESPONSIBILITY TO SOCIETY

Team motto: From interesting to usable

Irdning

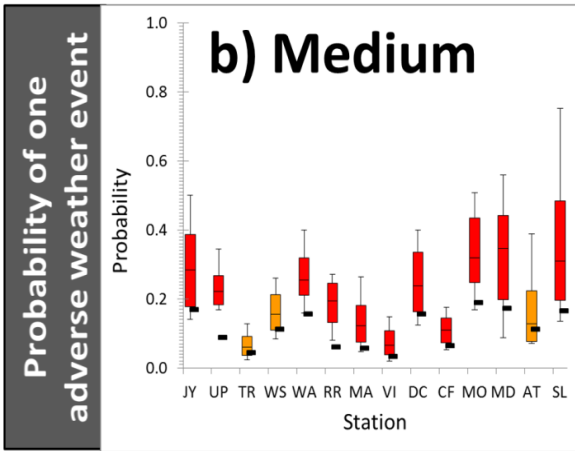


HIGH INTENSITY sites – from Alps to semi-arid lowlands

Field crops & bioenergy experiments



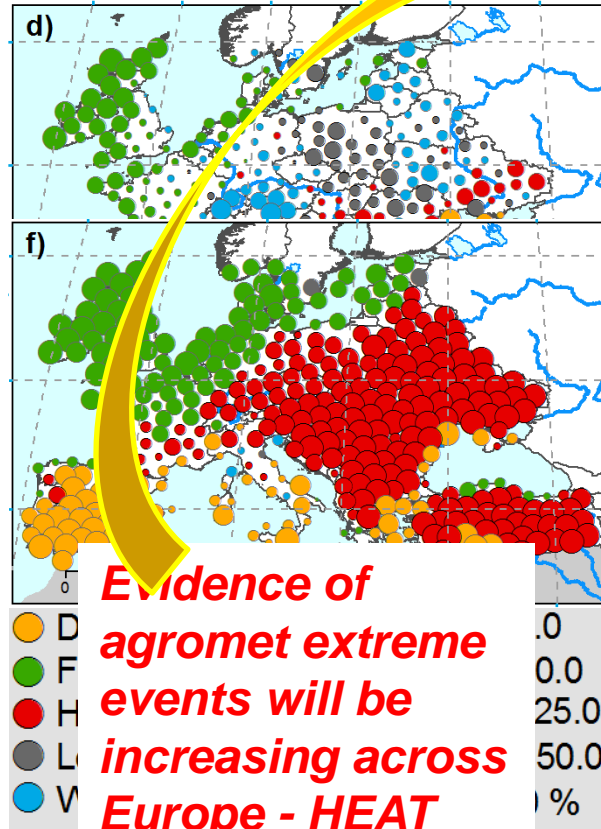
STEP 1 – SMALL SCALE MODELLING



Nature Climate Change, 2014

Evidence of agromet extreme events will be increasing at site level

STEP 2 – EUROPEAN SCALE MODELLING

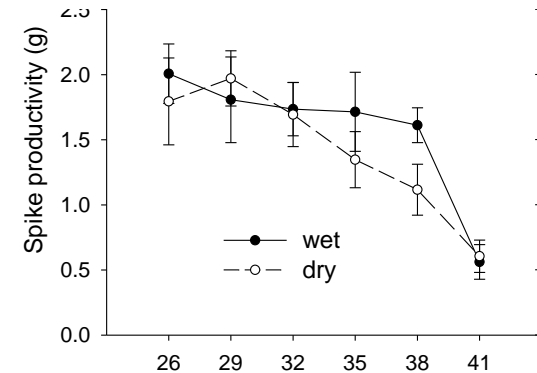


Royal Soc. Interf., 2015

Novel adaptation technique development – in planning

STEP 3 – MANIPULATION KROK 6 – NEW EXPERIMENTS

Selecting cultivars according to drought resilience+ Description of the drought stress response



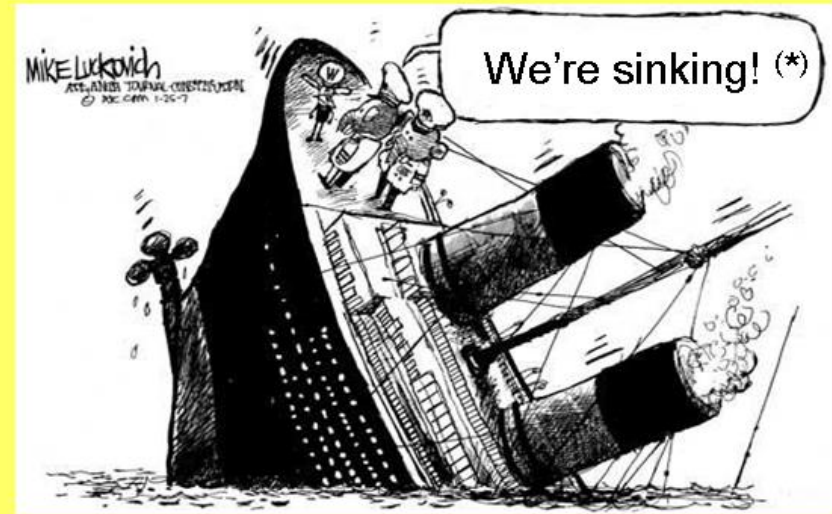
Results as now

Climate Change – Actors have the same data but different responses

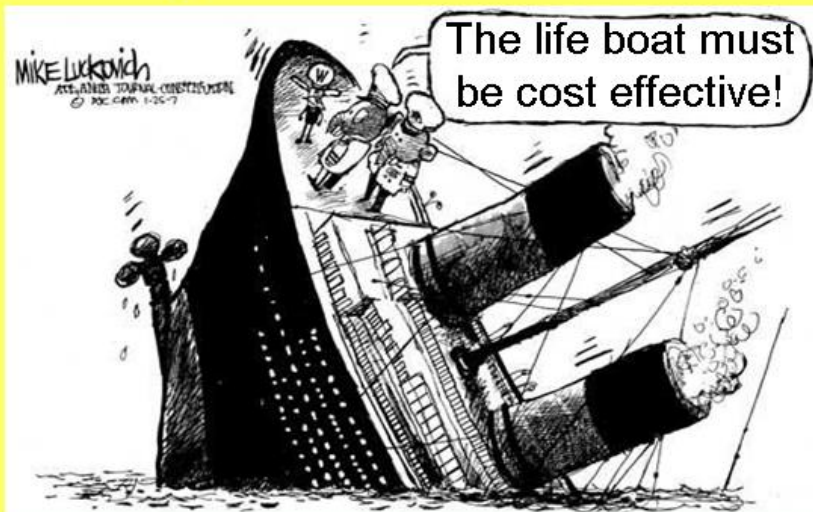
Contrarians



Climate scientists



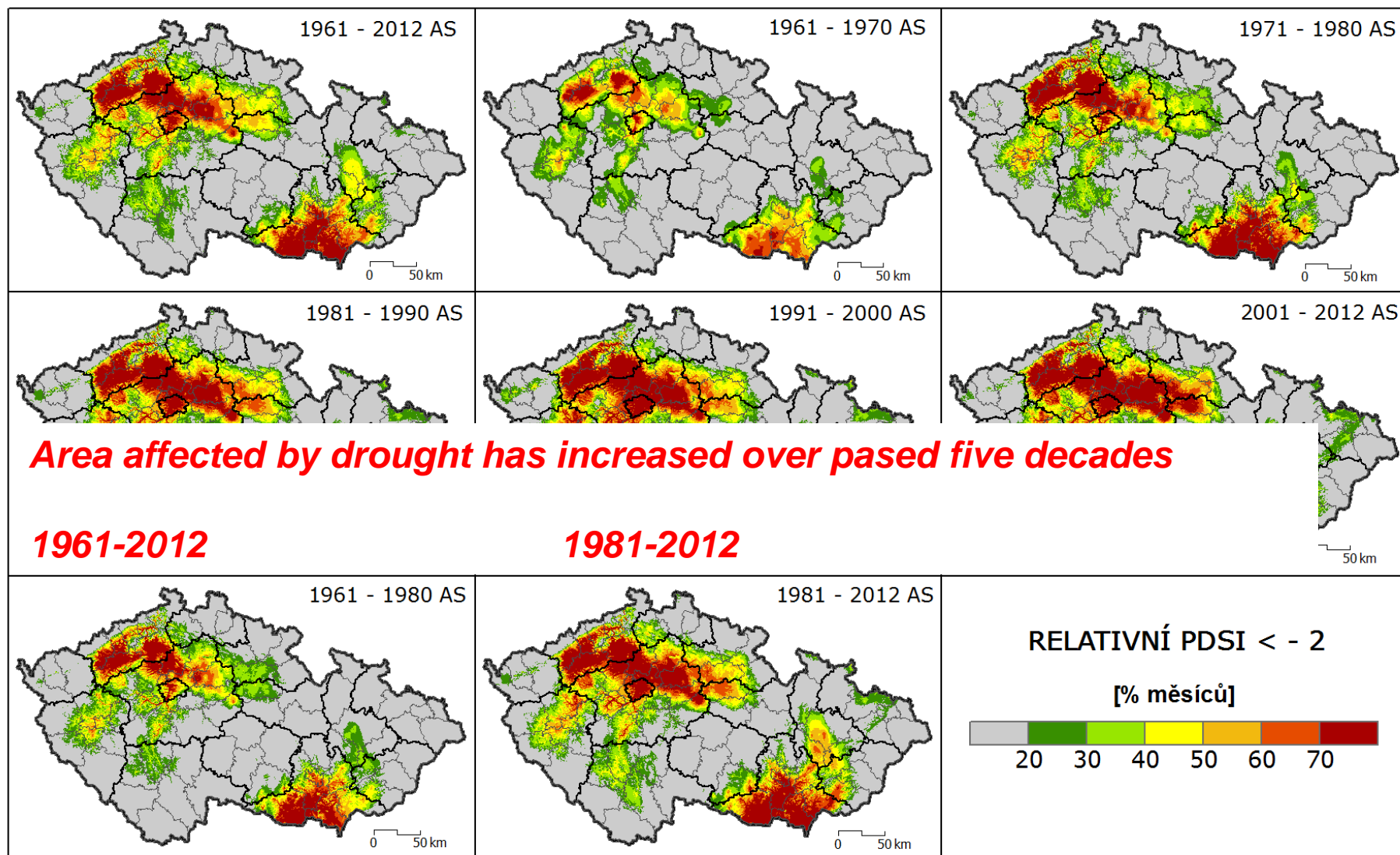
No regret



Environmentalists



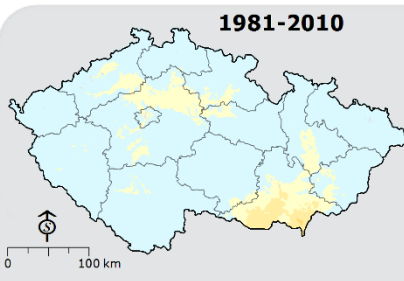
How serious are problems in Czechia?



Education,
awareness,
dissemination

Droughts in
the past

Real time
drought
monitoring

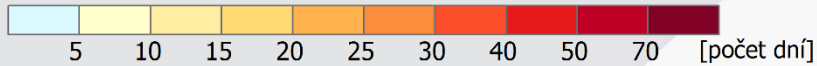


1981-2010

RIZIKO VÝSKYTU HORKÝCH A SUCHÝCH PERIOD

Průměrný počet dní se stresem suchem (půdní vlhkost pod 30 %) A SOUČASNĚ s výskytem horké vlny (období s průměrnou Tmax je 30 °C nebo vyšší, přičemž denní Tmax je aspoň tři dny po sobě nad 30 °C, ale neklesne pod 25 °C).

Odhad budoucího vývoje na základě očekávaných klimatických podmínek pro 3 časové horizonty. Rozpětí očekávaných klimatických podmínek reprezentuje 5 vybraných globálních cirkulačních modelů (v popisku kód modelu a jeho zjednodušená charakteristika na základě odhadu změny teploty a srážek pro území ČR) a 2 scénáře vývoje koncentrací skleníkových plynů (RCP 4.5 = stabilizace koncentrace CO2 na nižší úrovni; RCP 8.5 = bez omezení emisí CO2).

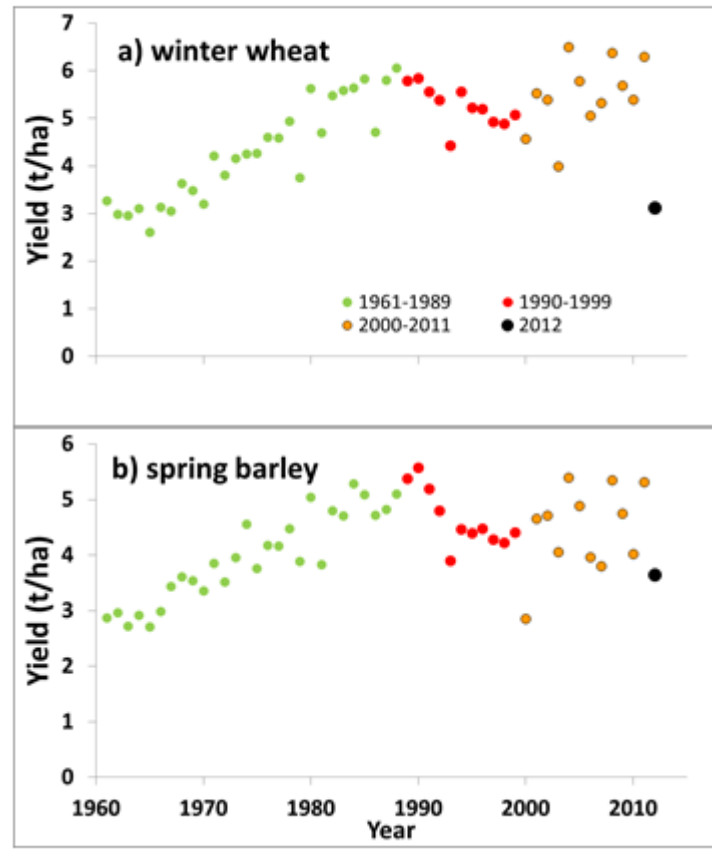
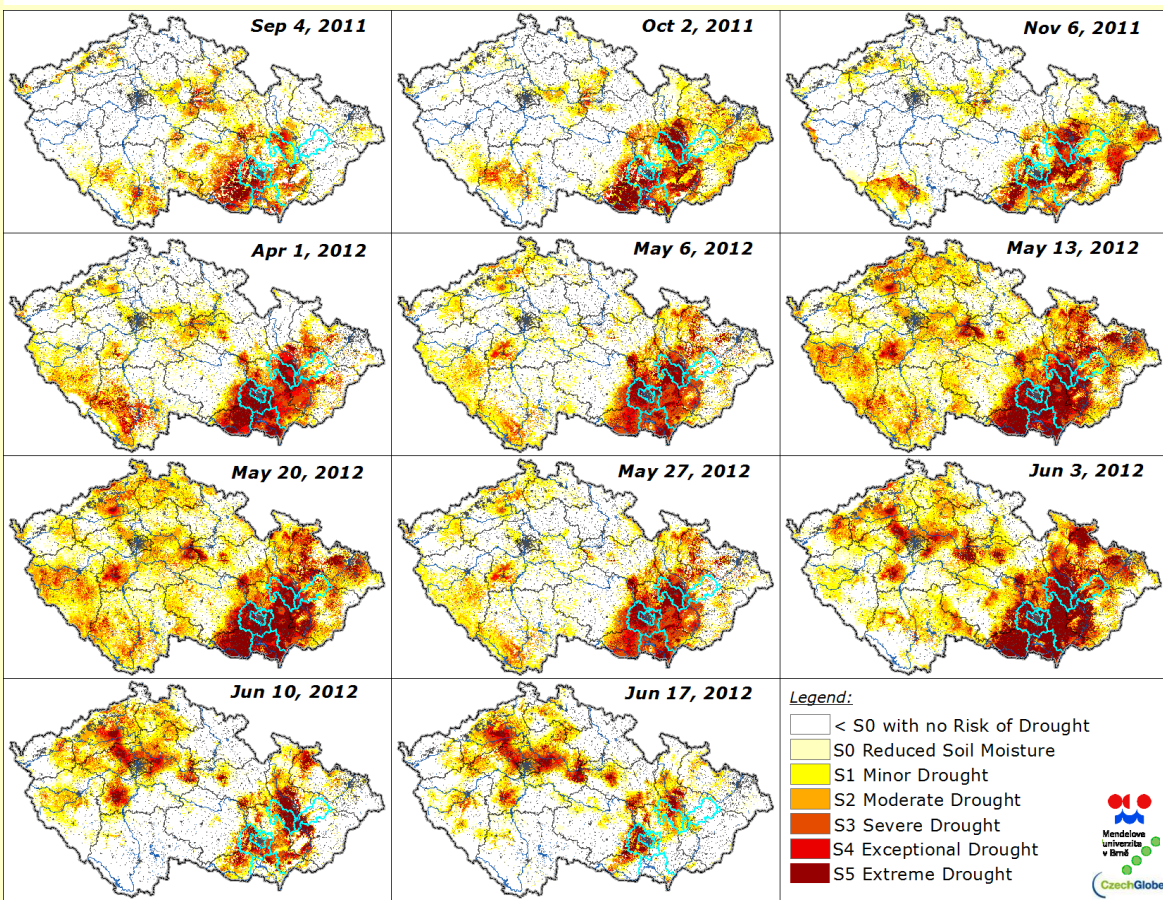


státní hranice
 hranice kraje

NO ROCKET SCIENCE - The impact of the combined heat and drought stress on the crops/forests will be greater than each stress factor alone☹

Why to bother?

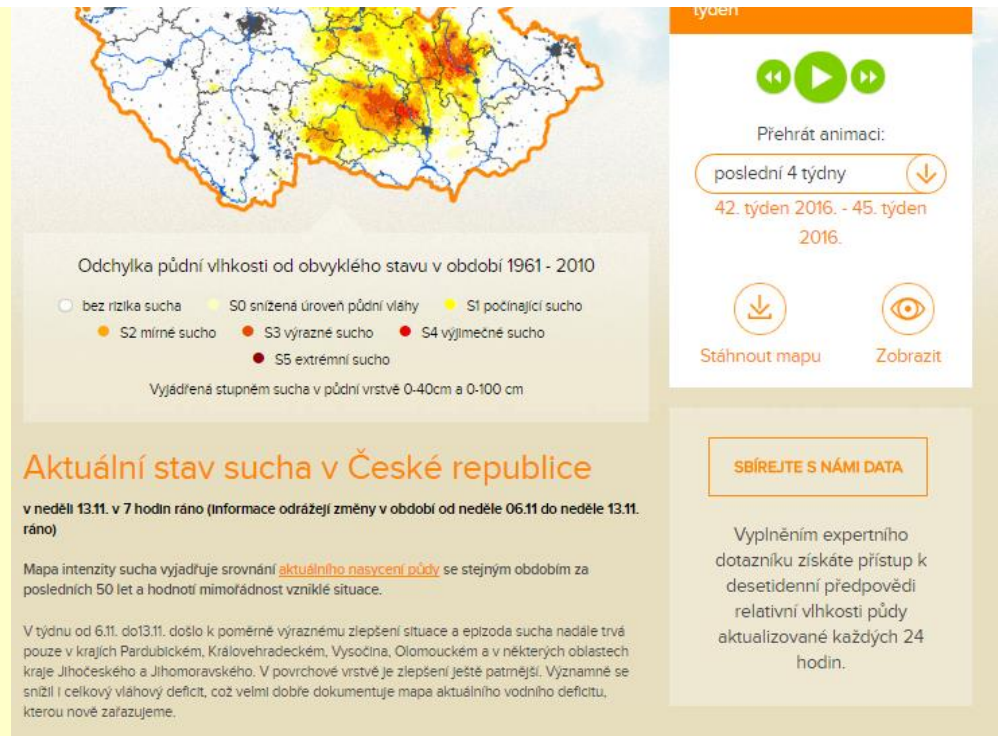
Droughts but also other agrometeorological extremes can be local and can be devastating.....



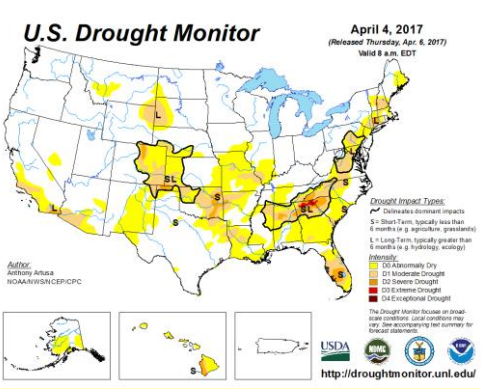
Farms are large and great deal dependent on the field crop production ...

Example of our work – how have we started?

CzechGlobe in collaboration with the Czech Hydrometeorological Institute lead the way in development of agricultural drought monitoring and forecasting tool & are developing more advanced systems.

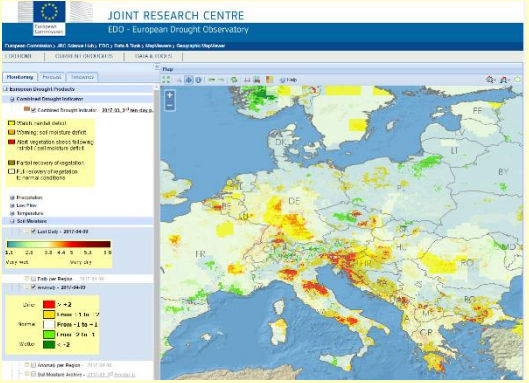


www.intersucho.cz



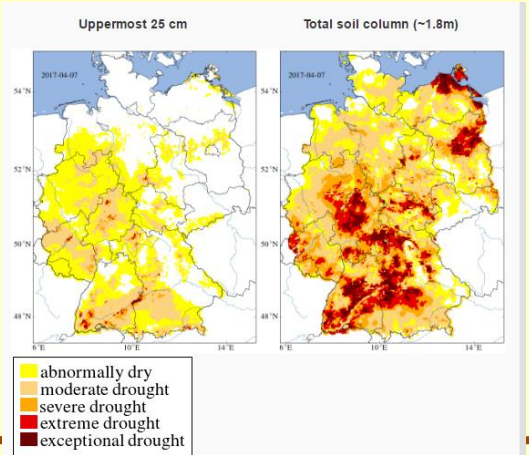
USA

1. Since 1995 - resolution cca 20 km;
2. Convergence of evidence approach - subjective
3. Feedback from reporters on the ground



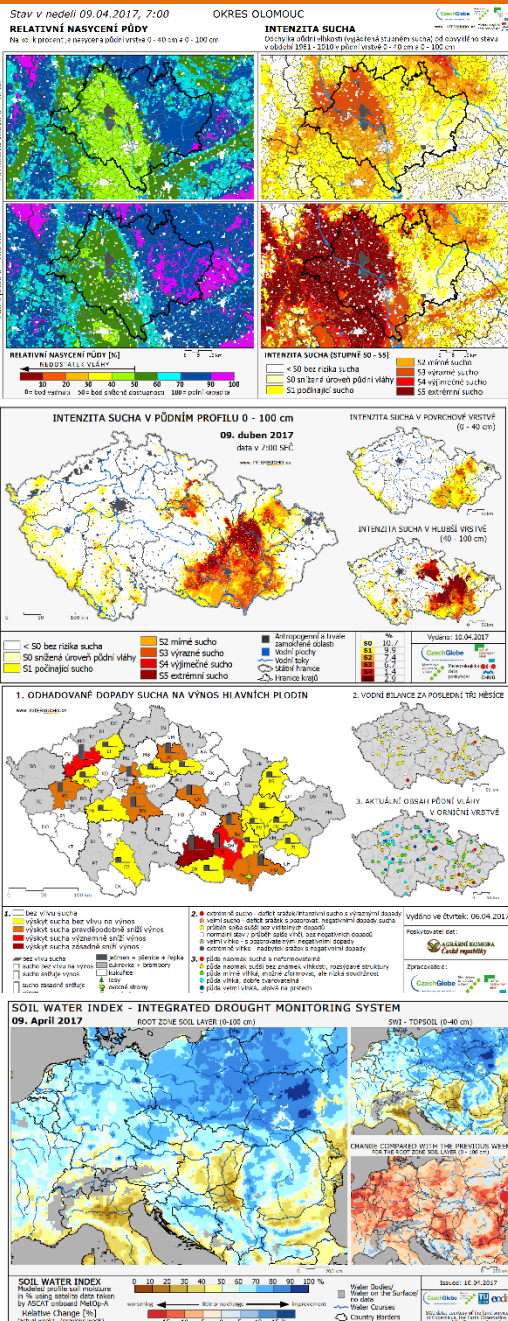
EU - EDO

1. Since 2011/resolution cca 5 km;
2. Multiple methods – objective
3. NO feedback from reporters



Germany

1. Since 2014/resolution cca 4 km;
2. Single soil moisture and hydrology model - objective
3. NO feedback from reporters

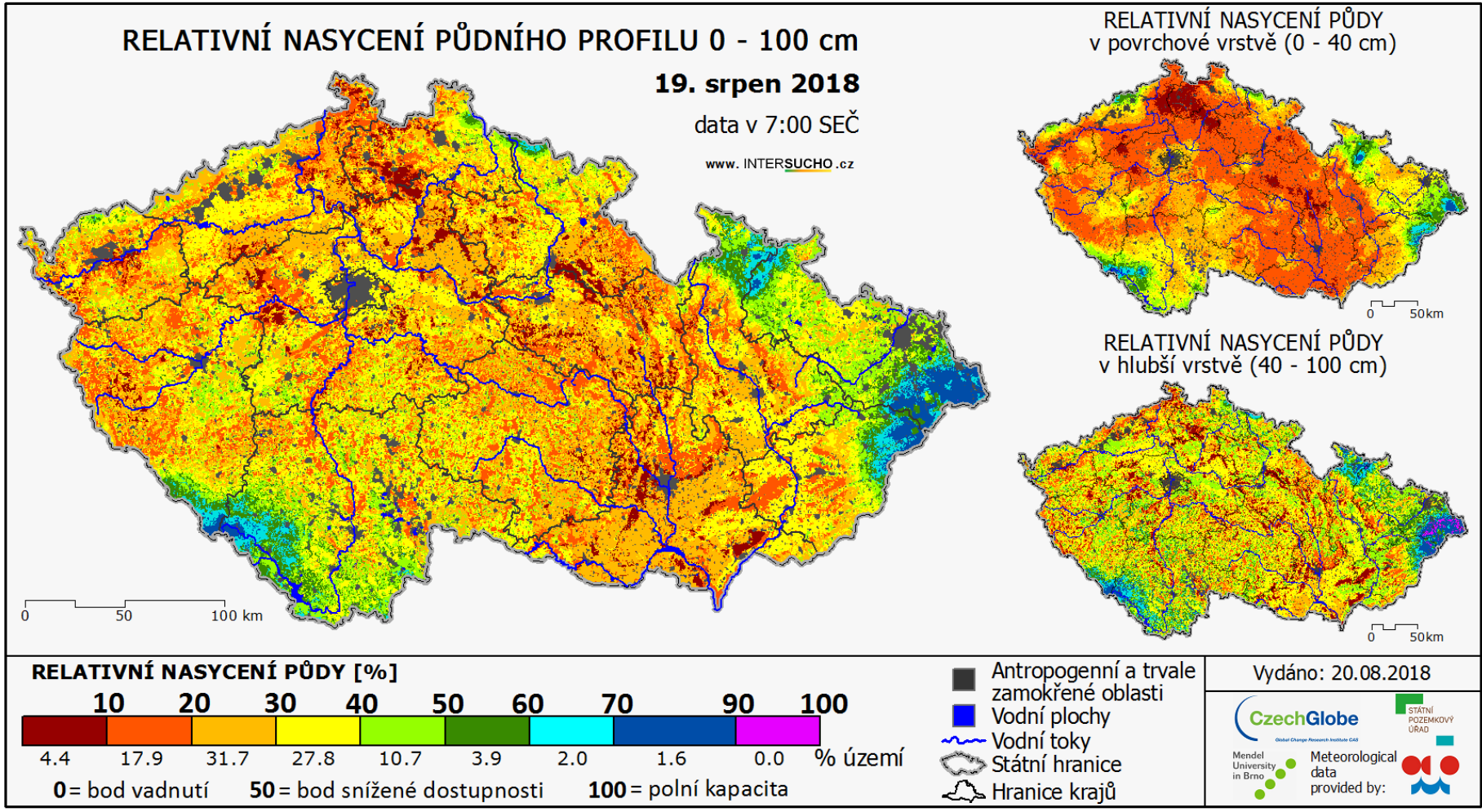


Czech Republic

1. Since 2014/ resolution 0,5 km
2. 200 climate sites + 400 raingauges of the Czech Hydrometeorological institute + ecosystem sites (CzechGlobe) – daily interpolated to 500 m grid
3. Then soil moisture modeled by SoilClim model and compared to 1961-2016 soil moisture status
4. PLUS two independent satellite systems
 - Meteosat soil moisture estimate through microwave radar 8 km (from TUW)
 - Condition of vegetation Terra – 250 m – 5 km aggregate
 - Comparison with EDO product
5. Real time validation with soil moisture measurements (CHMI + CzechGlobe – 55 sites)
6. Drought forecasting (daily)
7. 600+ registered reporters up to 230-240 active each week

Consortium of Czech Academy of Sciences, Mendel University and State Land Office with support of Czech Hydrometeorological Institute

Pilar I: Soil moisture content



It uses daily soil water balance model in 500m resolution with real soil and terrain, dynamic canopy and high number of weather stations to do the trick! Every week and every day....for free.

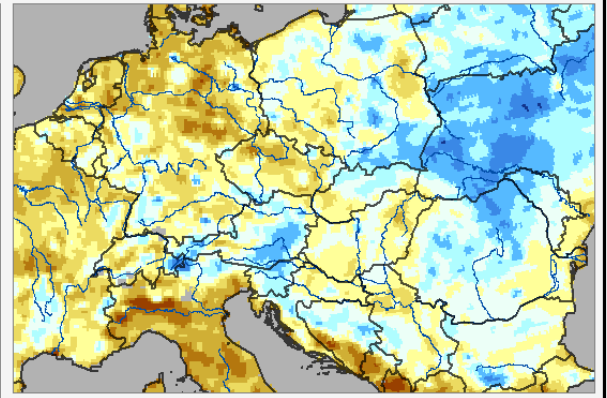
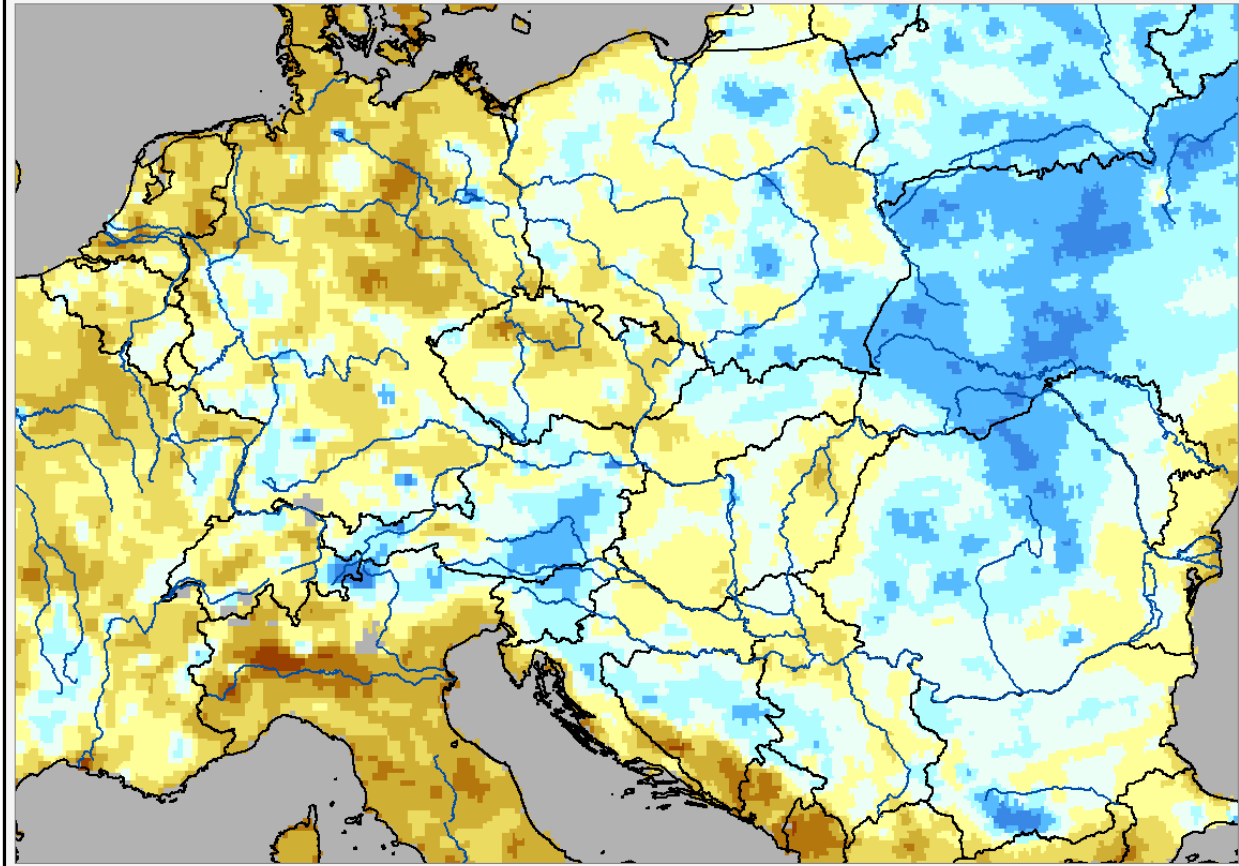
Microwave radar soil moisture estimate

SOIL WATER INDEX - INTEGRATED DROUGHT MONITORING SYSTEM

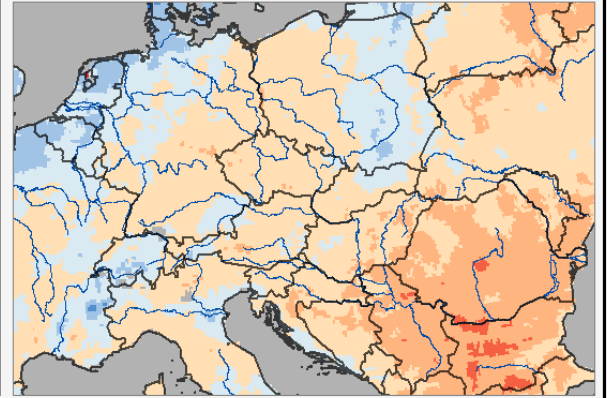
19. August 2018

ROOT ZONE SOIL LAYER (0-100 cm)

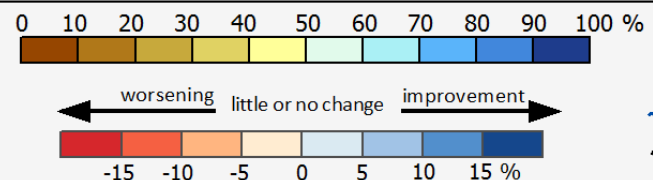
SWI - TOPSOIL (0-40 cm)



CHANGE COMPARED WITH THE PREVIOUS WEEK FOR THE ROOT ZONE SOIL LAYER (0 - 100 cm)



SOIL WATER INDEX
 Modeled profile soil moisture in % using satellite data taken by ASCAT onboard MetOp-A
 Relative Change [%]
 (actual week) - (previous week)

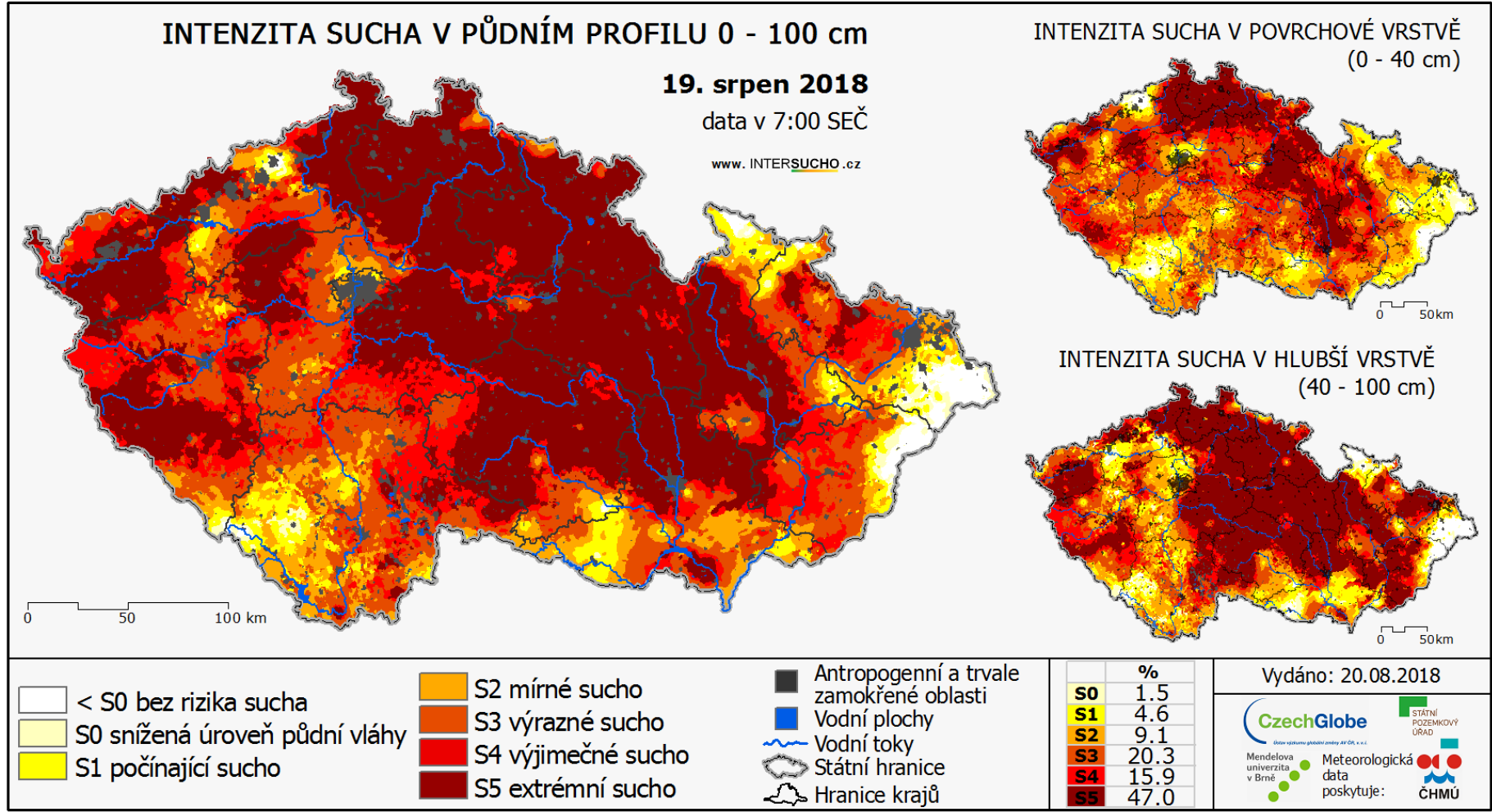


- Water Bodies/
Water on the Surface/
no data
- Water Courses
- Country Borders

Issued: 20.08.2018
 SWI data, courtesy of the land service of Copernicus, the Earth Observation programme of the European Commission

Project co-funded by European Union funds (ERDF, IPA, ENI)

Pilar I: Soil moisture content deficit



It uses daily soil water balance model in 500m resolution with real soil and terrain, dynamic canopy and high number of weather stations to do the trick! Every week and every day....for free.

Pilar II: Drought intensity in high resolution

Stav v nedeli 18.06.2017, 7:00

OKRES ZNOJMO

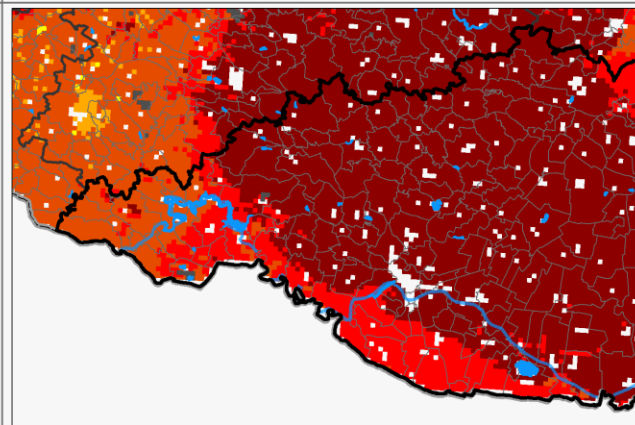
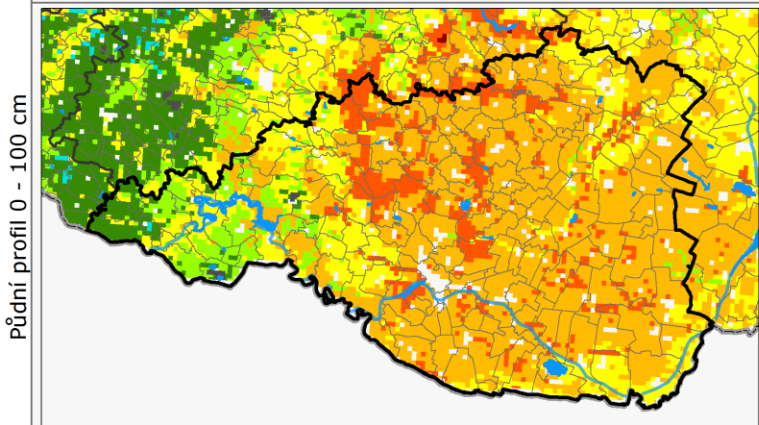
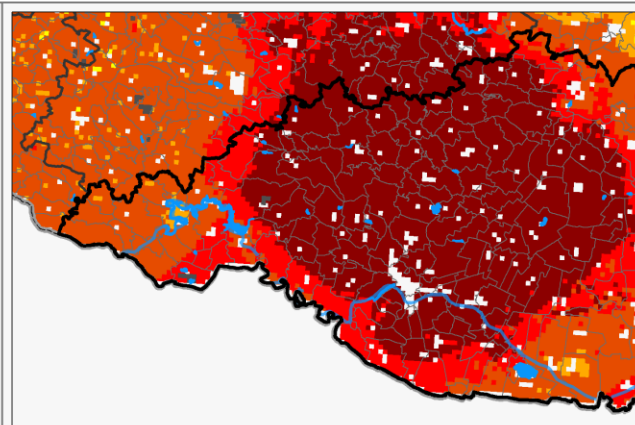
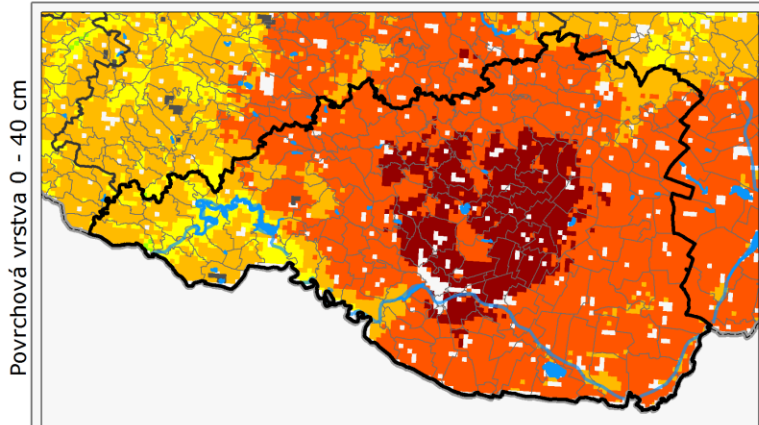


RELATIVNÍ NASYČENÍ PŮDY

Na kolik procent je nasycena půdní vrstva 0 - 40 cm a 0 - 100 cm

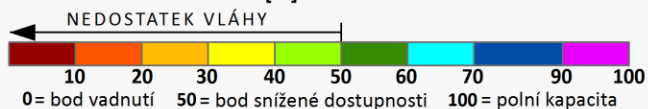
INTENZITA SUCHA

Odchylka půdní vlhkosti (vyjádřená stupněm sucha) od obvyklého v období 1961 - 2010 v půdní vrstvě 0 - 40 cm a 0 - 100 cm



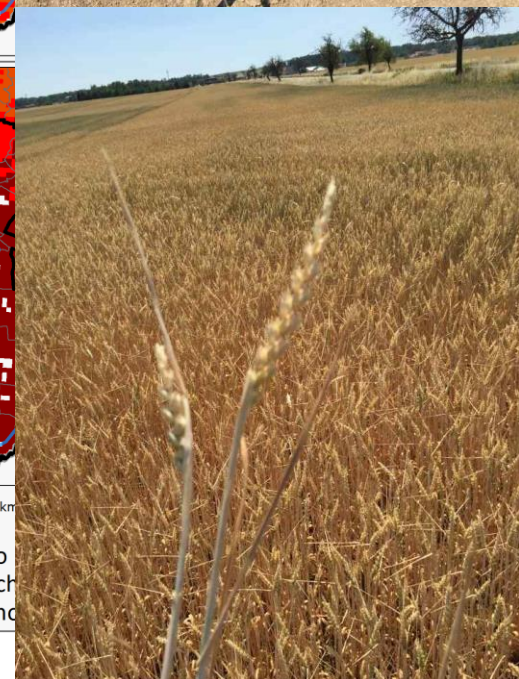
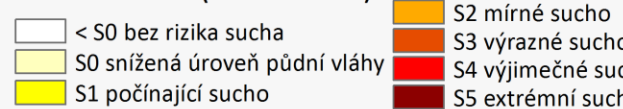
RELATIVNÍ NASYČENÍ PŮDY [%]

0 5 10 km



INTENZITA SUCHA (STUPNĚ S0 - S5)

0 5 10 km



This allows farmers to find their territory in a quick way....

Pilar II: Drought intensity in high resolution

Dopady změny klimatu

Aktuální vývoj

Časová řada

Intenzita sucha
19. srpen 2018 | 33. týden

ZMĚNIT VRSTVU

Přehrát animaci pro 45. týden 2017. - 44. týden 2018.

Zobrazit mapy za

Posledních 12 měsíců

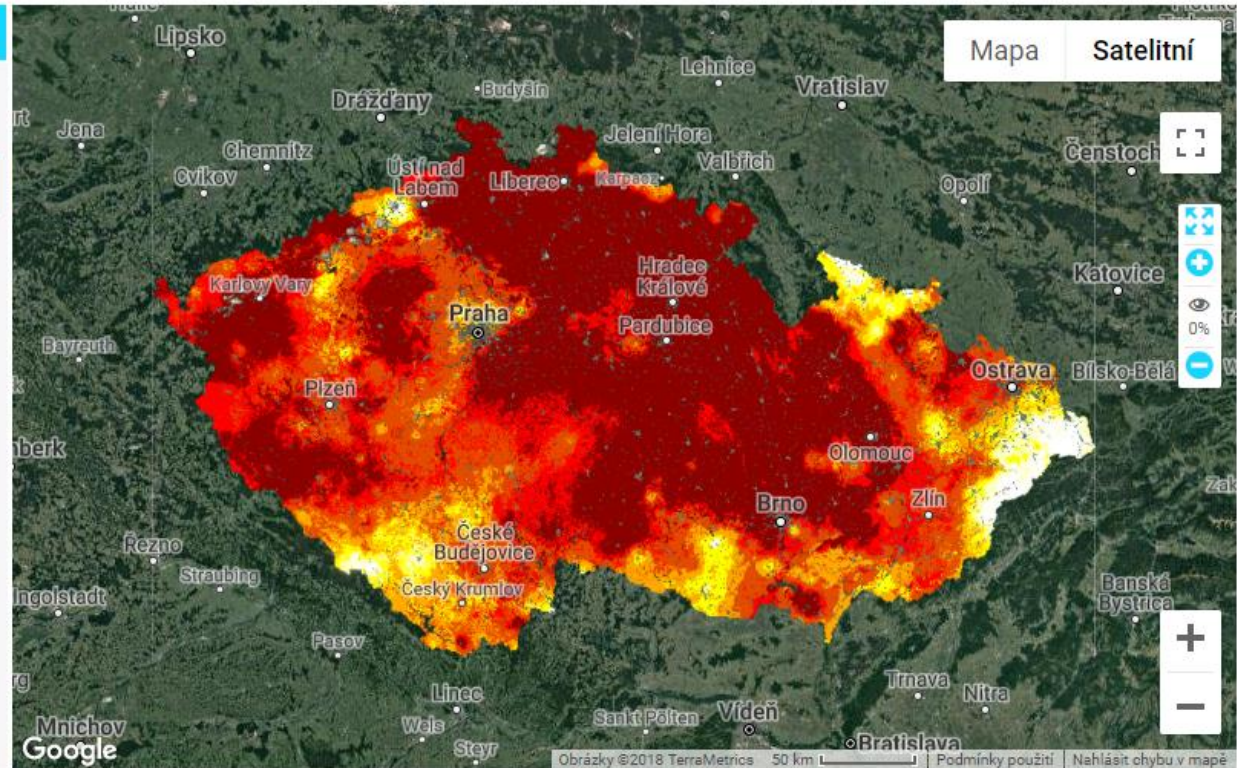


Zobrazit mapu ČR

Odchylka půdní vlhkosti od obvyklého stavu v období 1961–2010

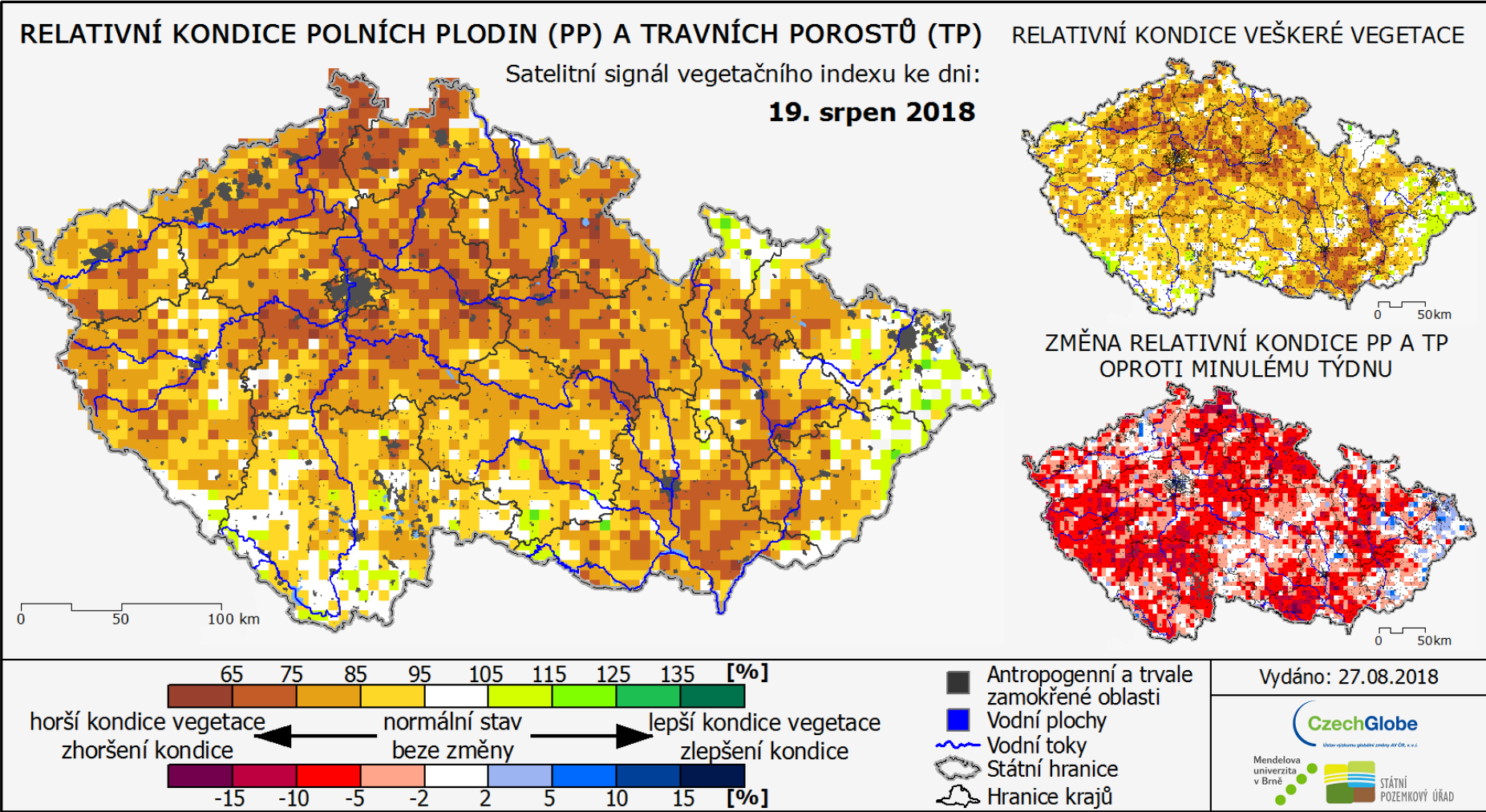


Vyřádná stupněm sucha v půdní vrstvě 0–40 cm a 0–100 cm.



**Or google maps could be used as well on the different portal....
CONNECTING WEATHER & CLIMATE WEBSITES**

Pilar III: Near real time vegetation status monitoring



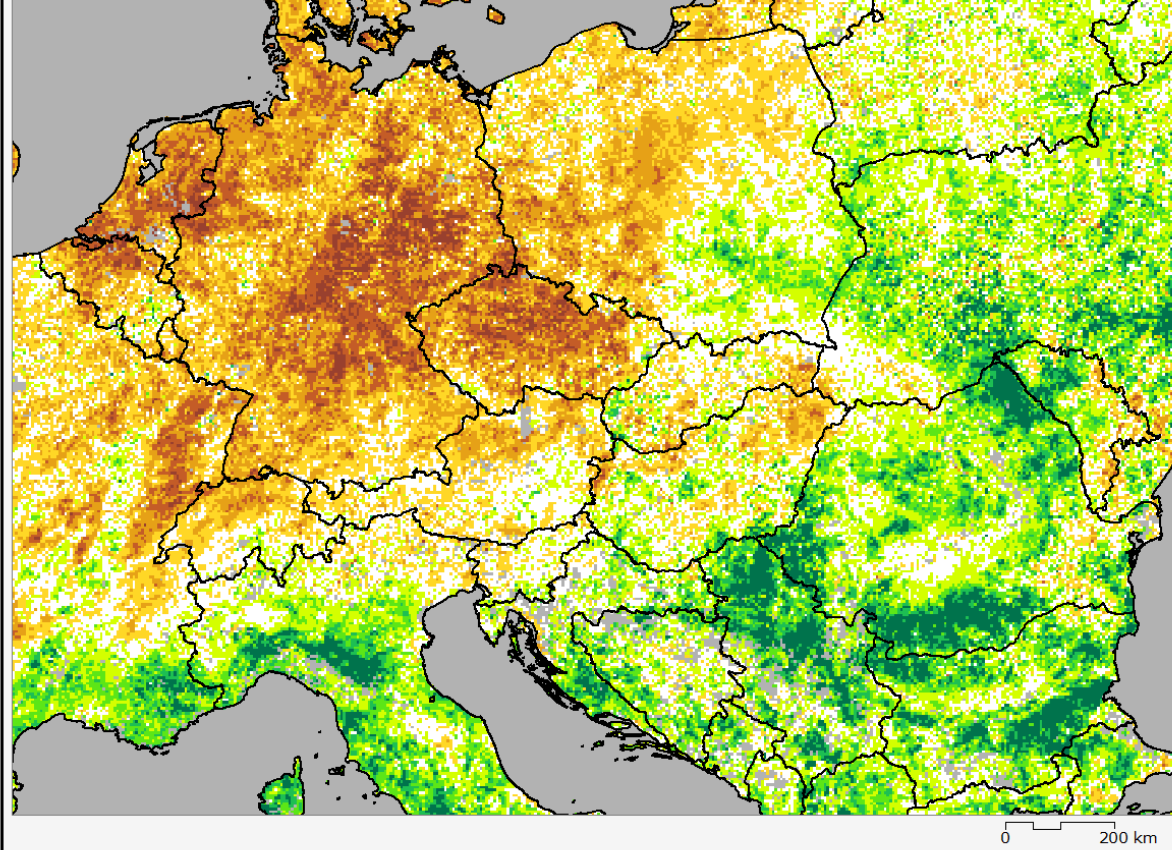
Soil moisture modelling is coupled with EVI index from Terra satellite indicating Status of vegetation on agricultural land and over the country in 5 km resolution to suppress noise.

Pilar III: Central European view

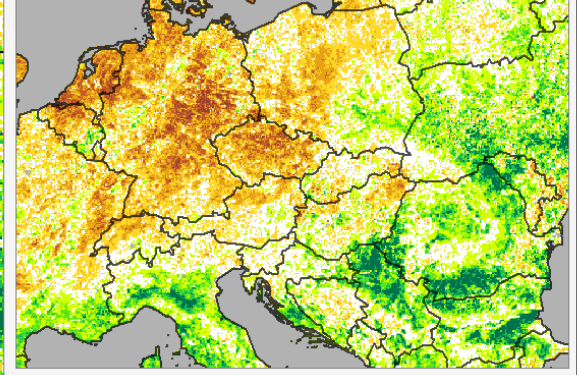
August 19, 2018

INTEGRATED DROUGHT MONITORING SYSTEM

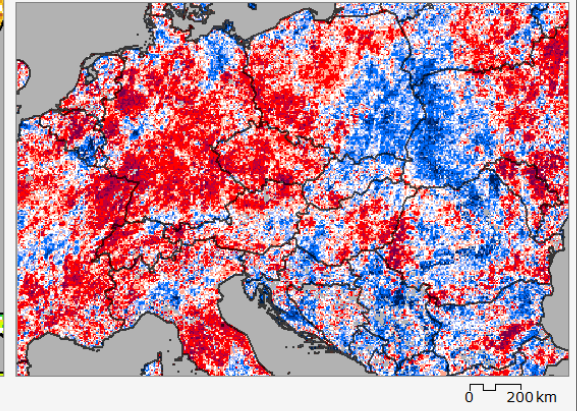
CROP- AND GRASSLANDS



ALL VEGETATION TYPES

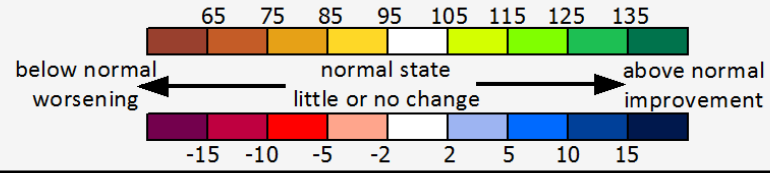


CHANGE COMPARED WITH THE PREVIOUS WEEK for crop- and grasslands



RELATIVE VEGETATION CONDITION [%]

Relative Change [%]
(actual week) - (previous week)



Issued: 27.08.2018

The MODIS MOD09GQ.005 data product, courtesy of the NASA EOSDIS LP DAAC, USGS EROS Center

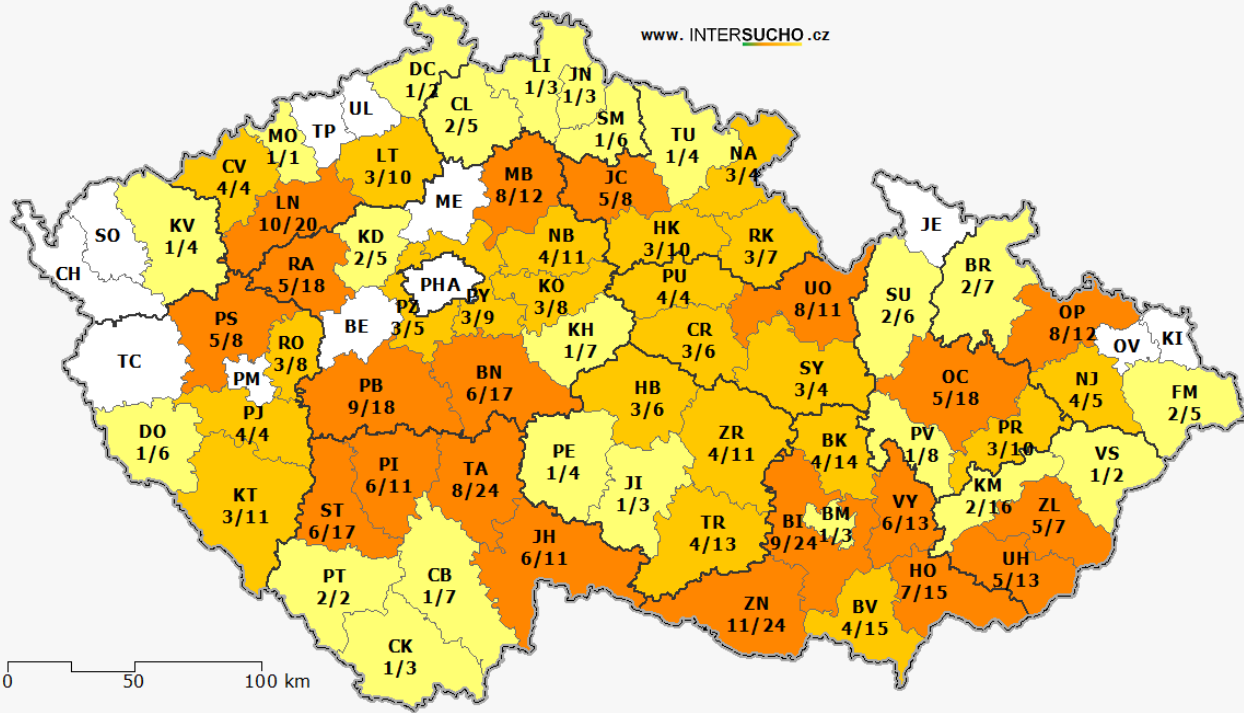
Project co-funded by European Union funds (ERDF, IPA, ENI)

And we hope to initiate networking for presented domain....including – regional monitoring would be valuable....

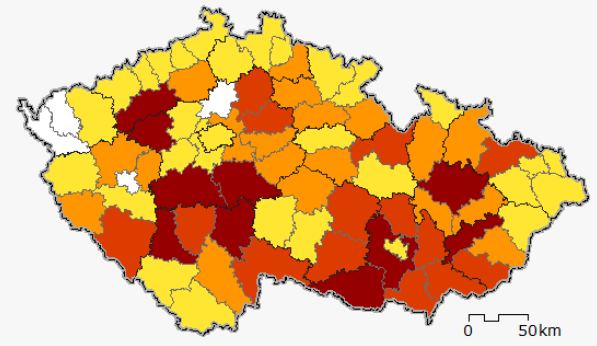
Pilar IV: Reported drought impacts

POČET RESPONDENTŮ A HLÁŠENÍ ZA OBDOBÍ: 21.10. - 28.10.2018

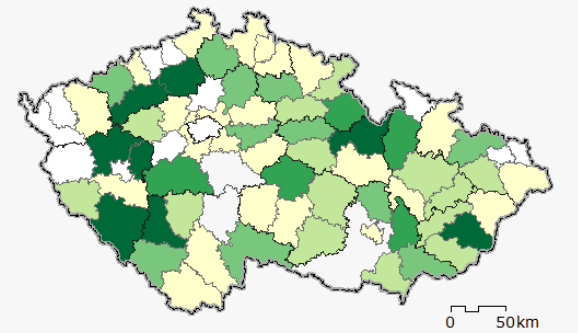
a) Aktuální počet aktivních respondentů



b) Celkový počet všech respondentů



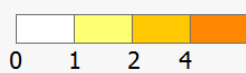
c) Aktuální počet jednotlivých hlášení



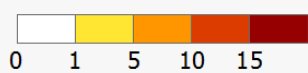
Aktivních: 243 respondentů
z/ze 65 okresů

Celkově: 610 respondentů
Počet hlášení: 728

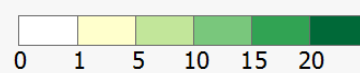
a) Počet aktivních respondentů



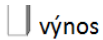
b) Celkový počet respondentů



c) Počet hlášení



01.11.2018



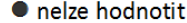
výnos



vinná réva



pudá veimi vinka, uřpiva na prstech



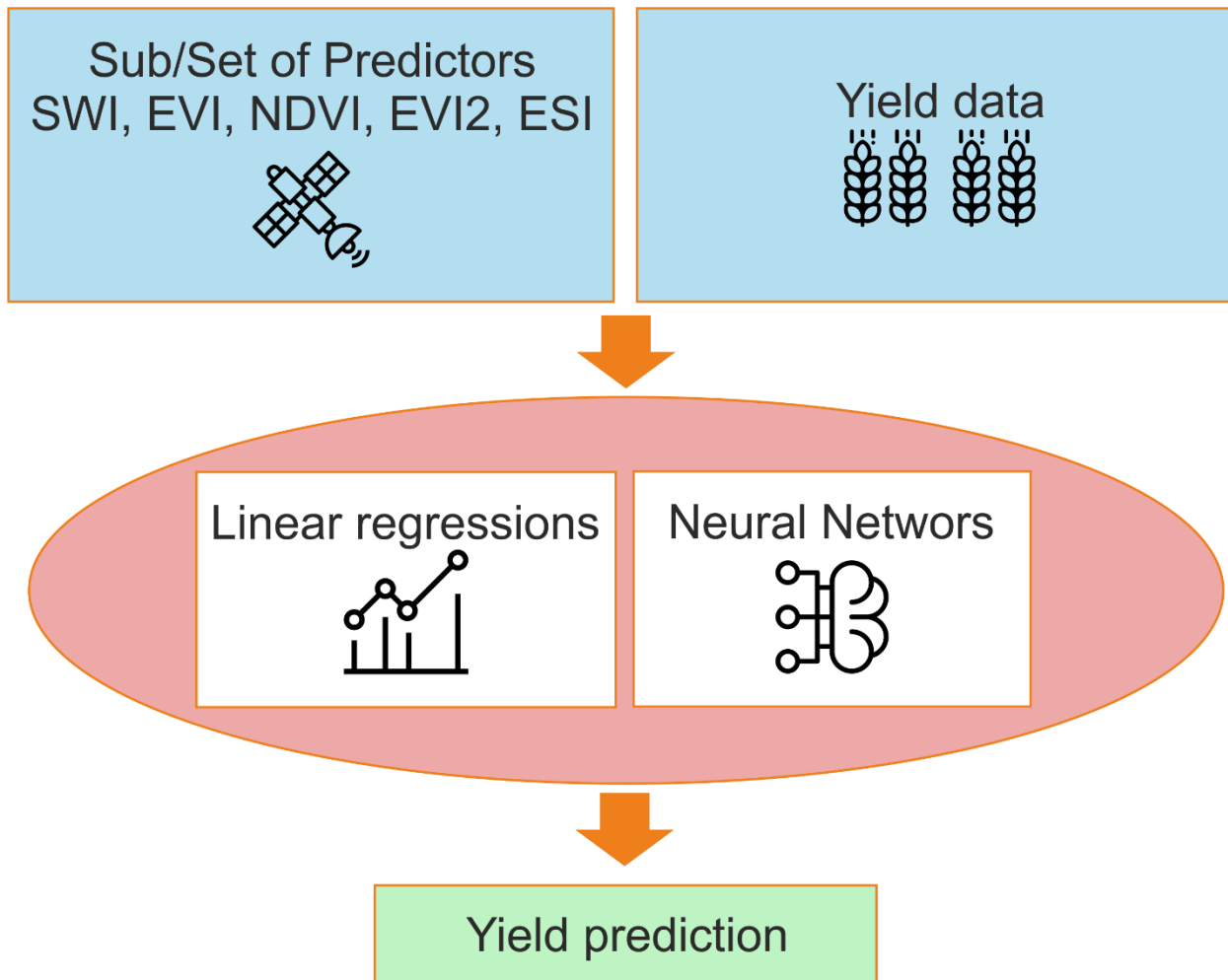
nelze hodnotit



Interreg Danube Transnational Programme DriDanube

Every week over 200+ reporters are reporting back the moisture and crop status – aim is to have network of 700+ trained farmers + „super-reporters“

Pillar IV: Estimated Yield Impacts

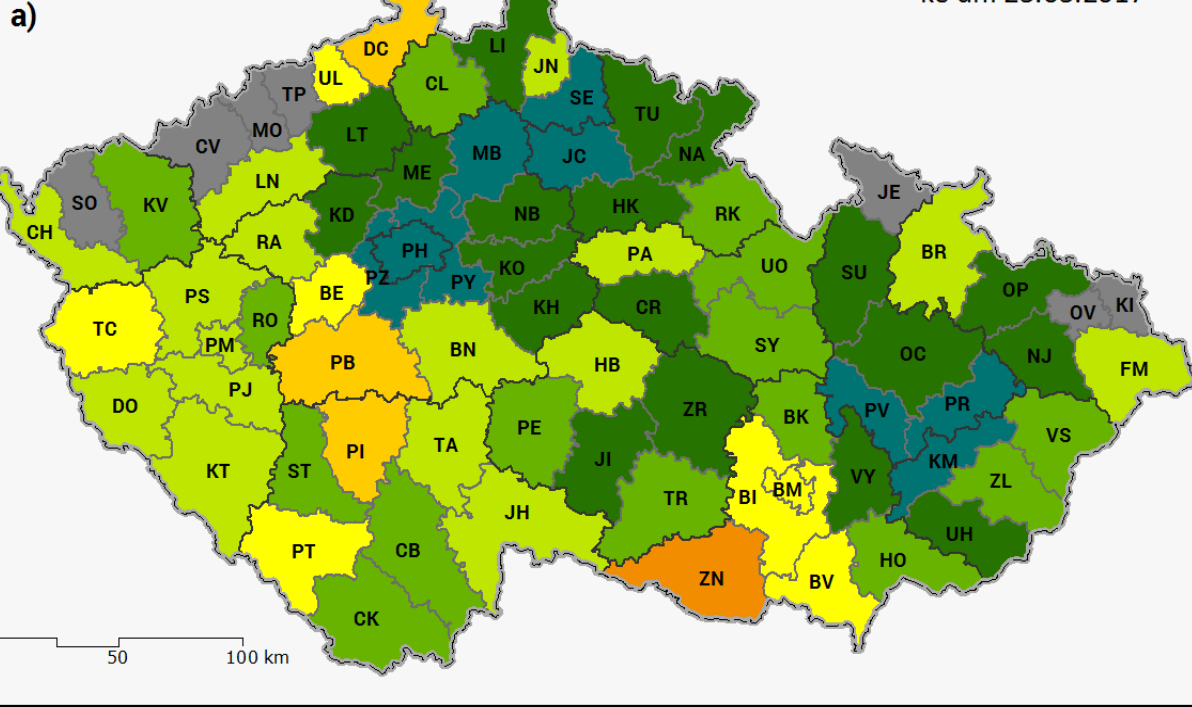


- Relation between predictors and actual yield is processed by linear regressions and neural networks
- Best results of both methods are combined into final prediction

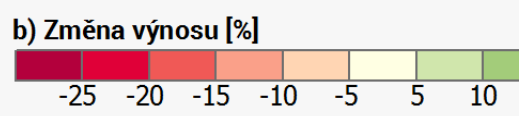
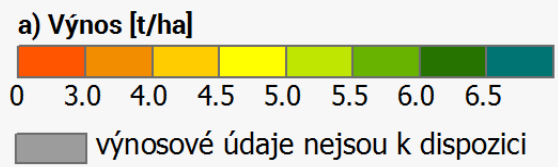
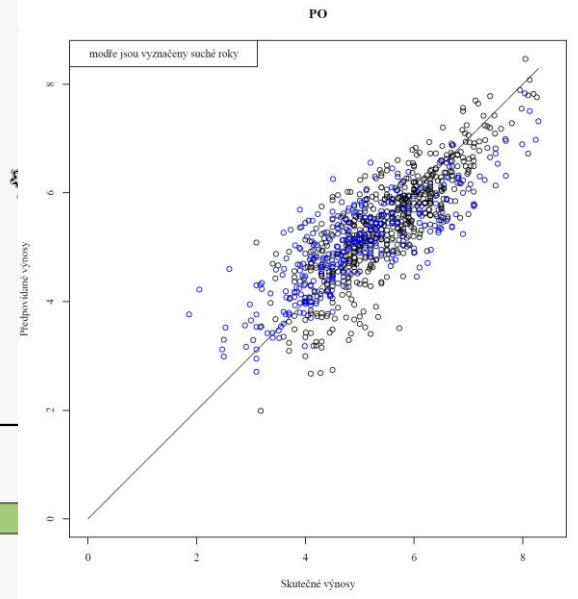
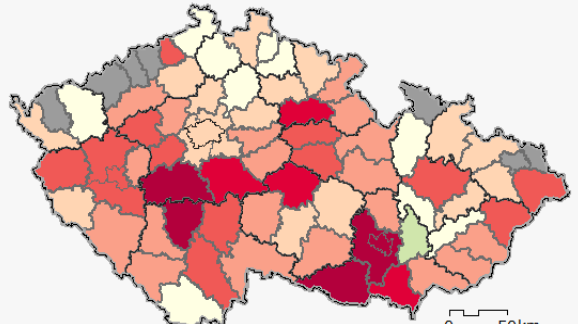
Pilar IV: Estimated Yield Impacts

ODHAD VÝNOSU PŠENICE OZIMÉ

na základě mapování dosavadního vývoje vegetace s využitím družicových snímků
ke dni 25.05.2017

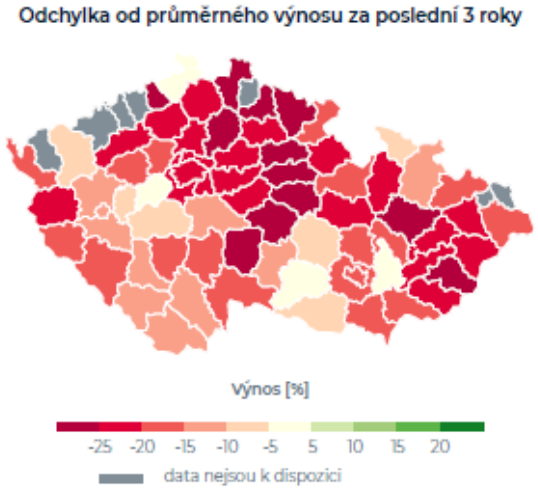
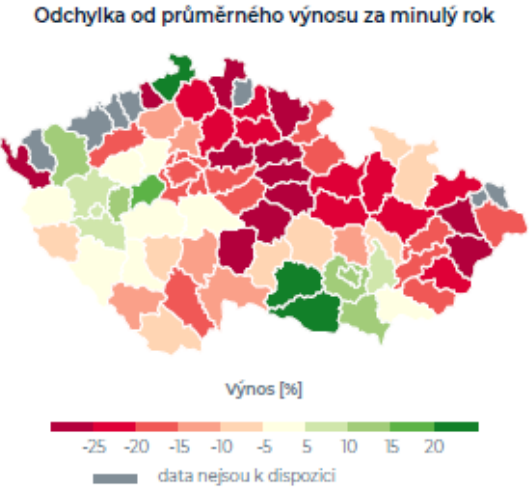
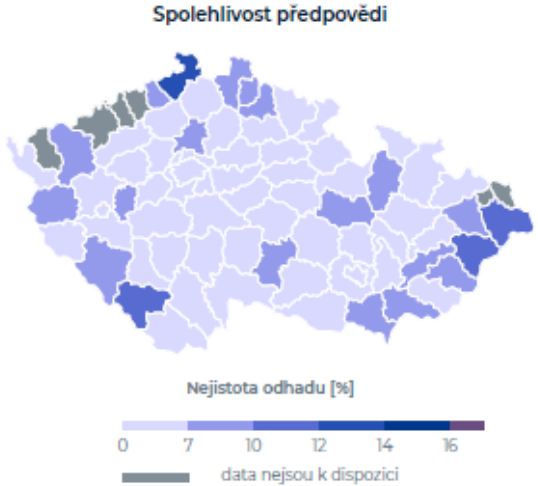
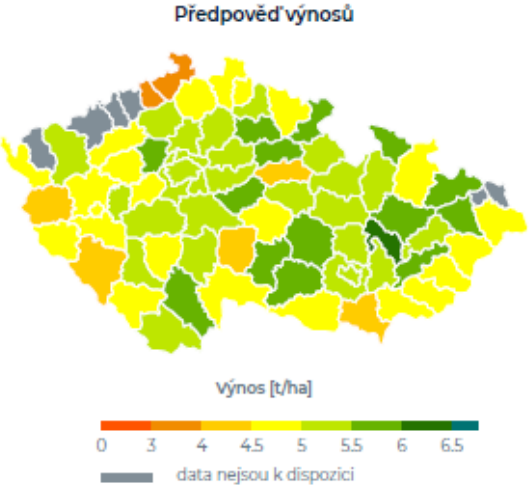


b) ODCHYLKA OD VÝNOSU V ROCE 2016



Yield impact estimates for 8 crops based on ensemble of statistical models.

Pilar IV: Estimated Yield Impacts



Česká republika menu

Stáhnout mapy Detailní popis

Okresy Kraje

Plodiny

- Ječmen jarní
- Pšenice ozimá
- Řepka ozimá
- Kukuřice na silaž
- Kukuřice na zrno
- Cukrová řepa
- Oves
- Zrno ozimé

Období

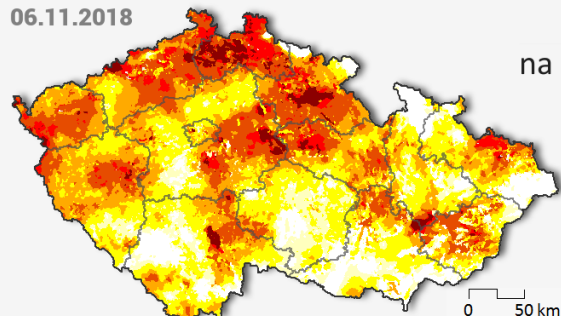
- 2017
- 2018

13. 7. 6. 7. 29. 6.

High resolution yied impact estimates for wheat, barely and oil-seed rape based on ensemble of statistical models + other 5 crops in lower resolution

Current products: 10 day IFS model based Forecast

06.11.2018



PŘEDPOVĚĚ SUCHA na základě evropského předpovědního modelu

Zdroj dat: ECMWF / IFS

Intenzita sucha v půdním profilu 0 - 100 cm

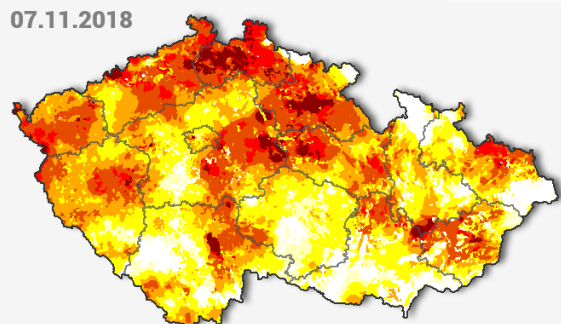
- < S0 bez rizika sucha
- S0 snížená úroveň půdní vláhy
- S1 počínající sucho

- S2 mírné sucho
- S3 výrazné sucho
- S4 výjimečné sucho
- S5 extrémní sucho

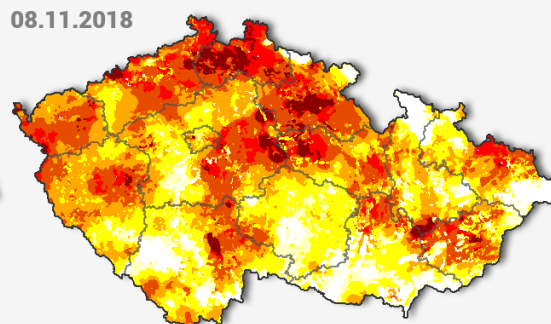
- Antropogenní a trvale zamokřené oblasti
- Vodní plochy
- Vodní toky
- Státní hranice
- Hranice krajů

CzechGlobe
Mendelova univerzita v Brně
STÁTNÍ POZEMKOVÝ ÚŘAD
www.INTERSUCHO.cz

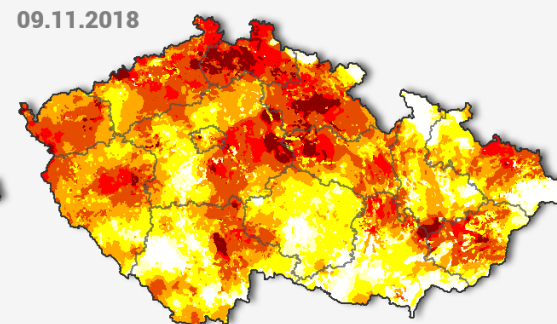
07.11.2018



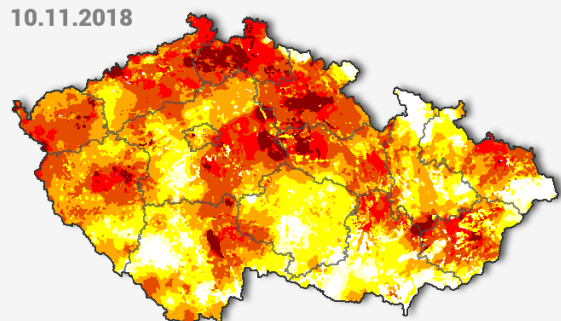
08.11.2018



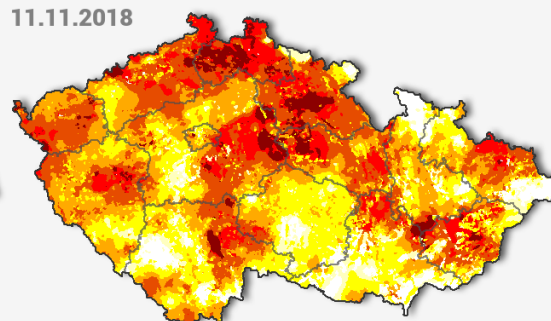
09.11.2018



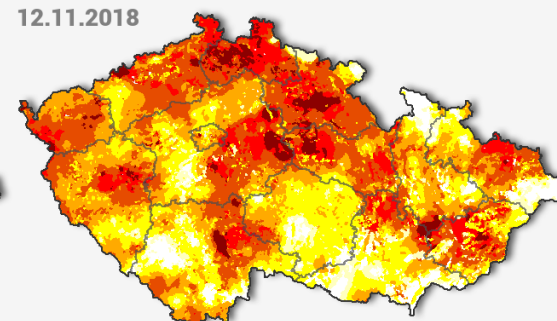
10.11.2018



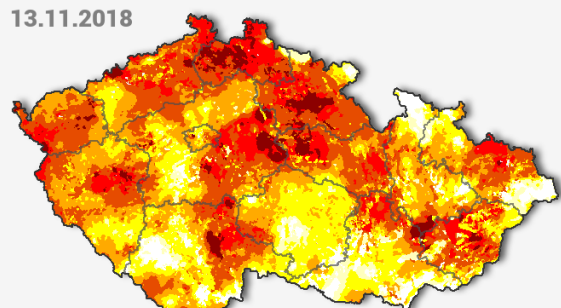
11.11.2018



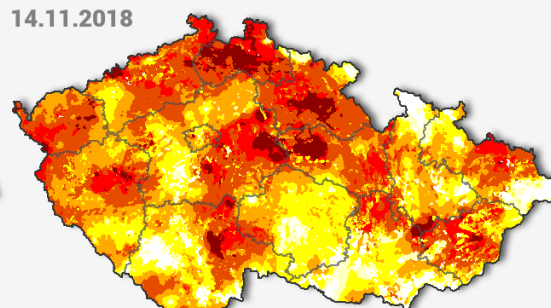
12.11.2018



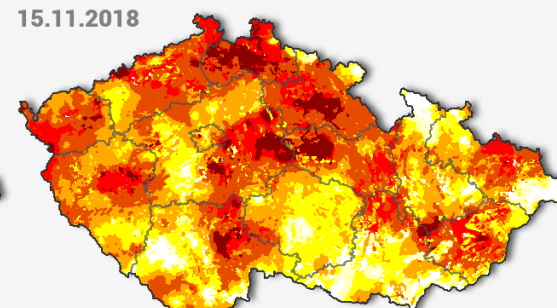
13.11.2018



14.11.2018



15.11.2018




Current products: 5 NWP models ensemble


PŘEDPOVĚĚ NA 9 DNÍ - přehled 5 předpovědních modelů


Vydáno: **6. 11. 2018** část: **3**


Intenzita sucha


v půdním profilu 0 - 100 cm


 < S0 bez rizika sucha


 S0 snížená úroveň půdní vláh

 S1 počínající sucho

 S2 mírné sucho

 S3 výrazné sucho

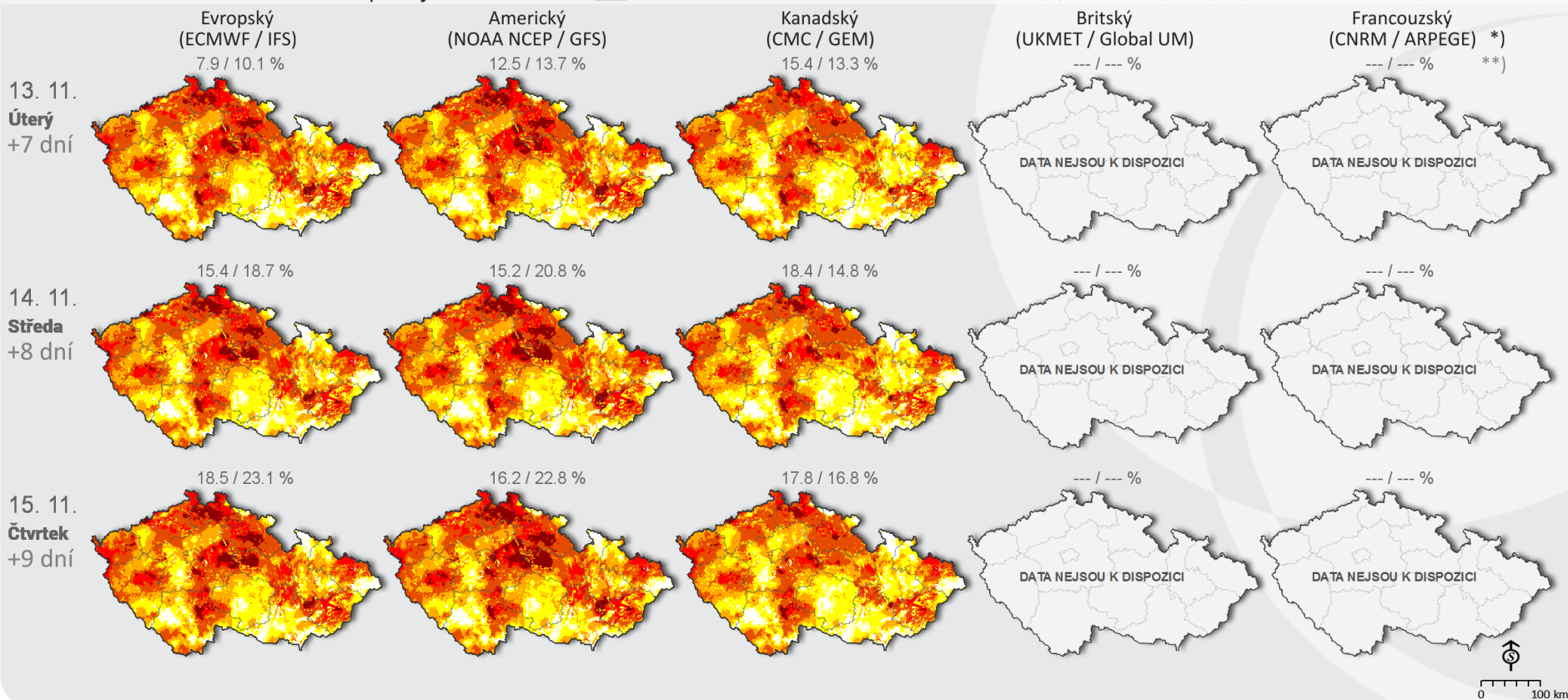
 S4 výjimečné sucho

 S5 extrémní sucho

*) Použitý PŘEDPOVĚDNÍ MODEL pro datový podklad (zdroj / zkratka)

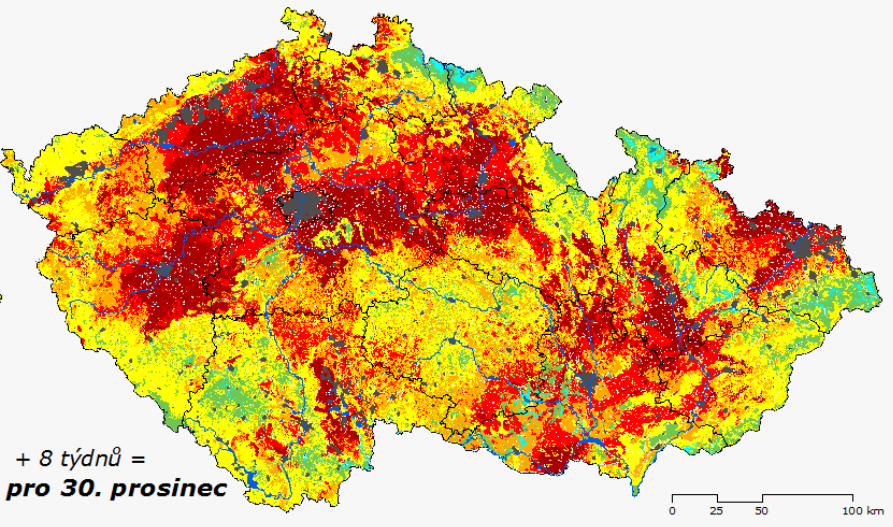
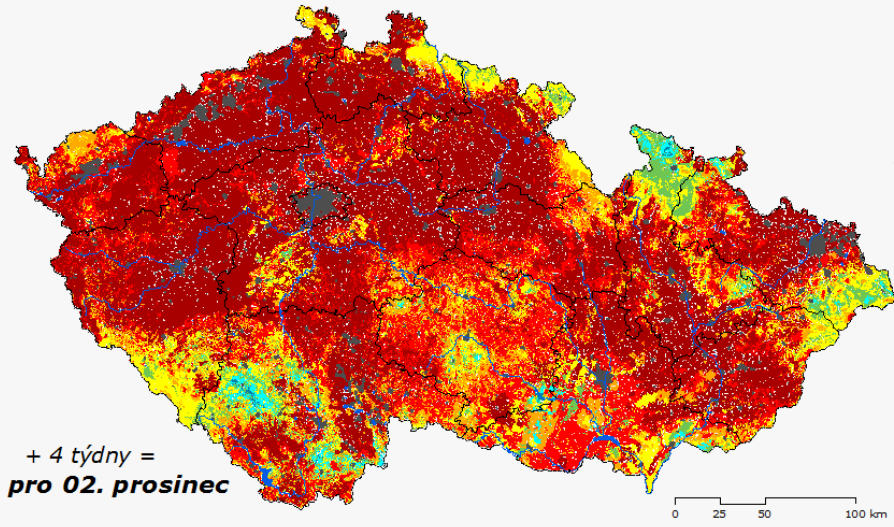
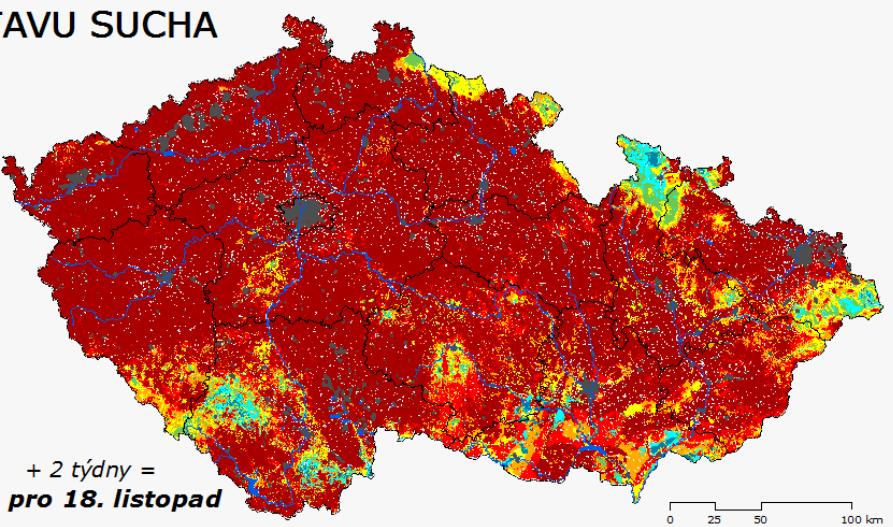
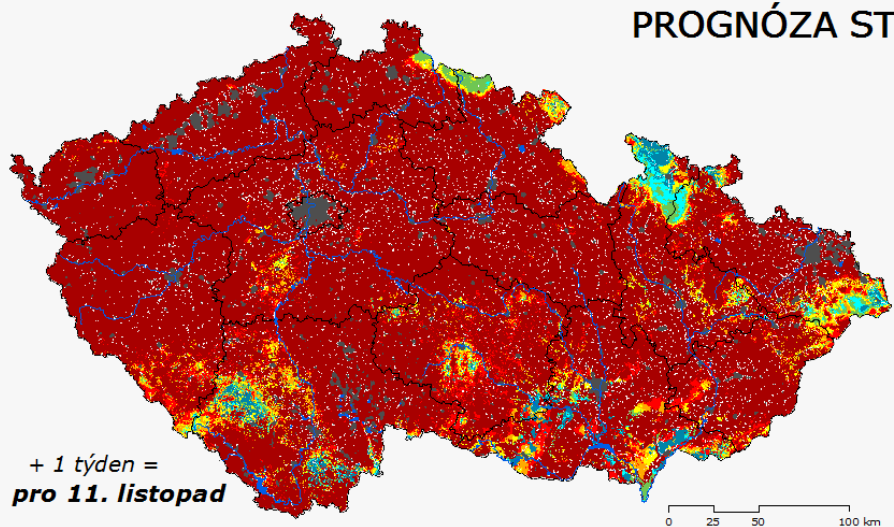
**) ÚSPĚŠNOST PŘEDPOVĚDI: za poslední 3 týdny / 1 týden

tj. jak velkou chybu v předpovědi lze očekávat v průměru

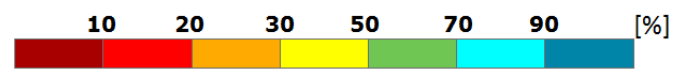


We try to extend it...using probabilistic forecast

PROGNÓZA STAVU SUCHA



Legenda: Praviděpodobnost dosažení normálních a vyšších hodnot půdní vlhkosti (pro horizont 0 - 100 cm)

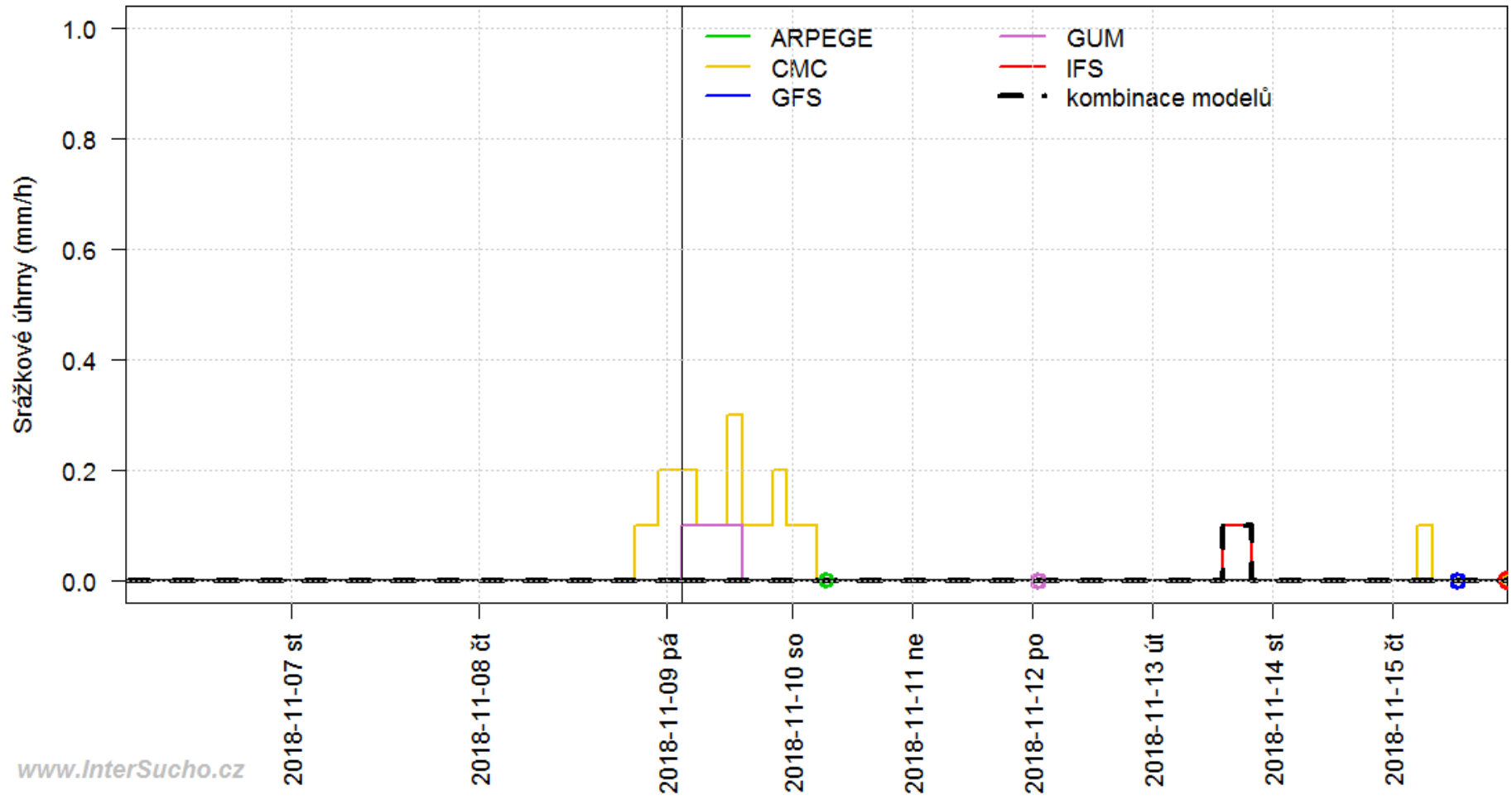


Vydáno v pondělí: 05.11.2018



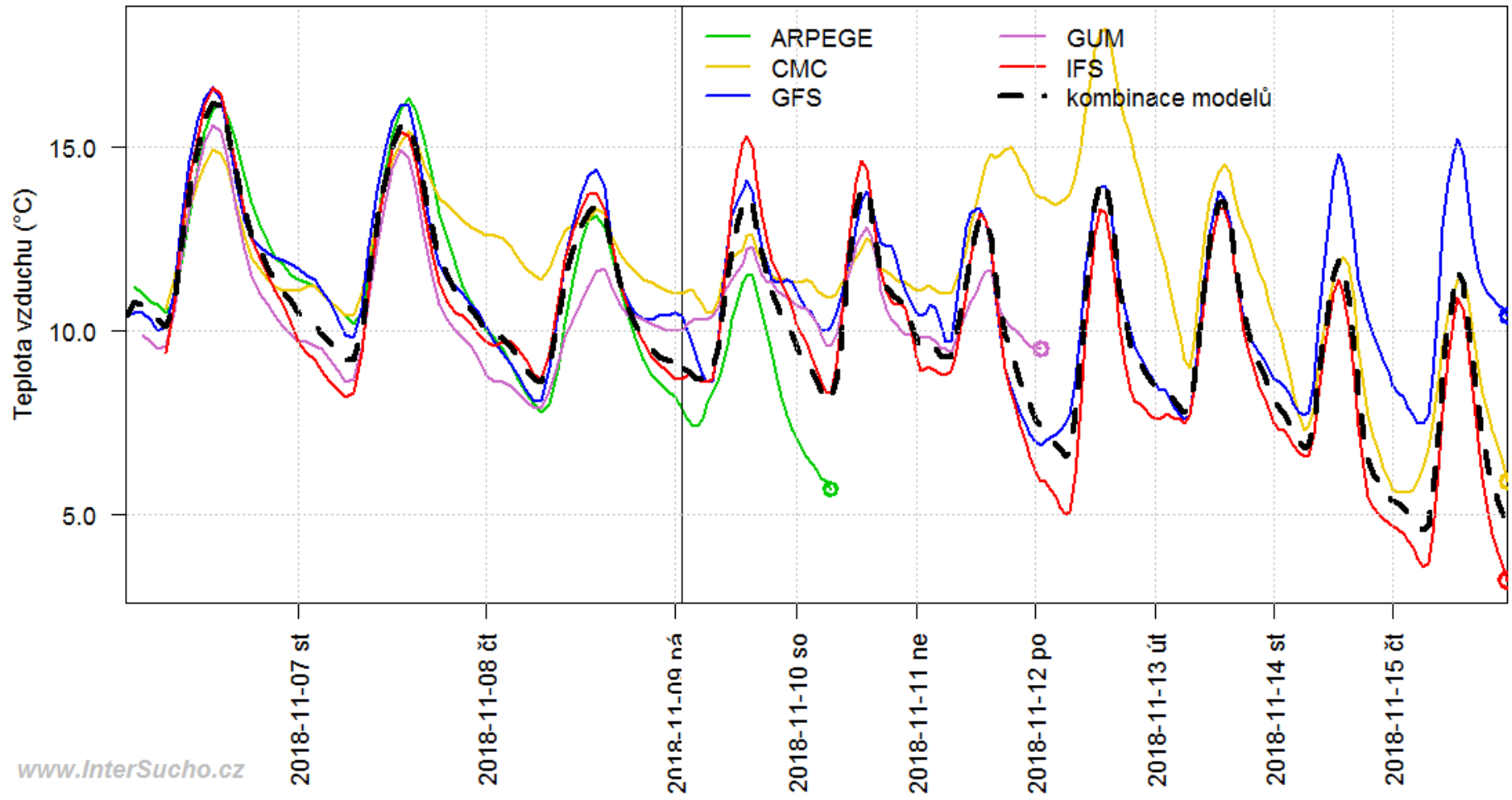
We try to extend it...and localize it

Polkovice - srážky, předpověď od 06.11.2018



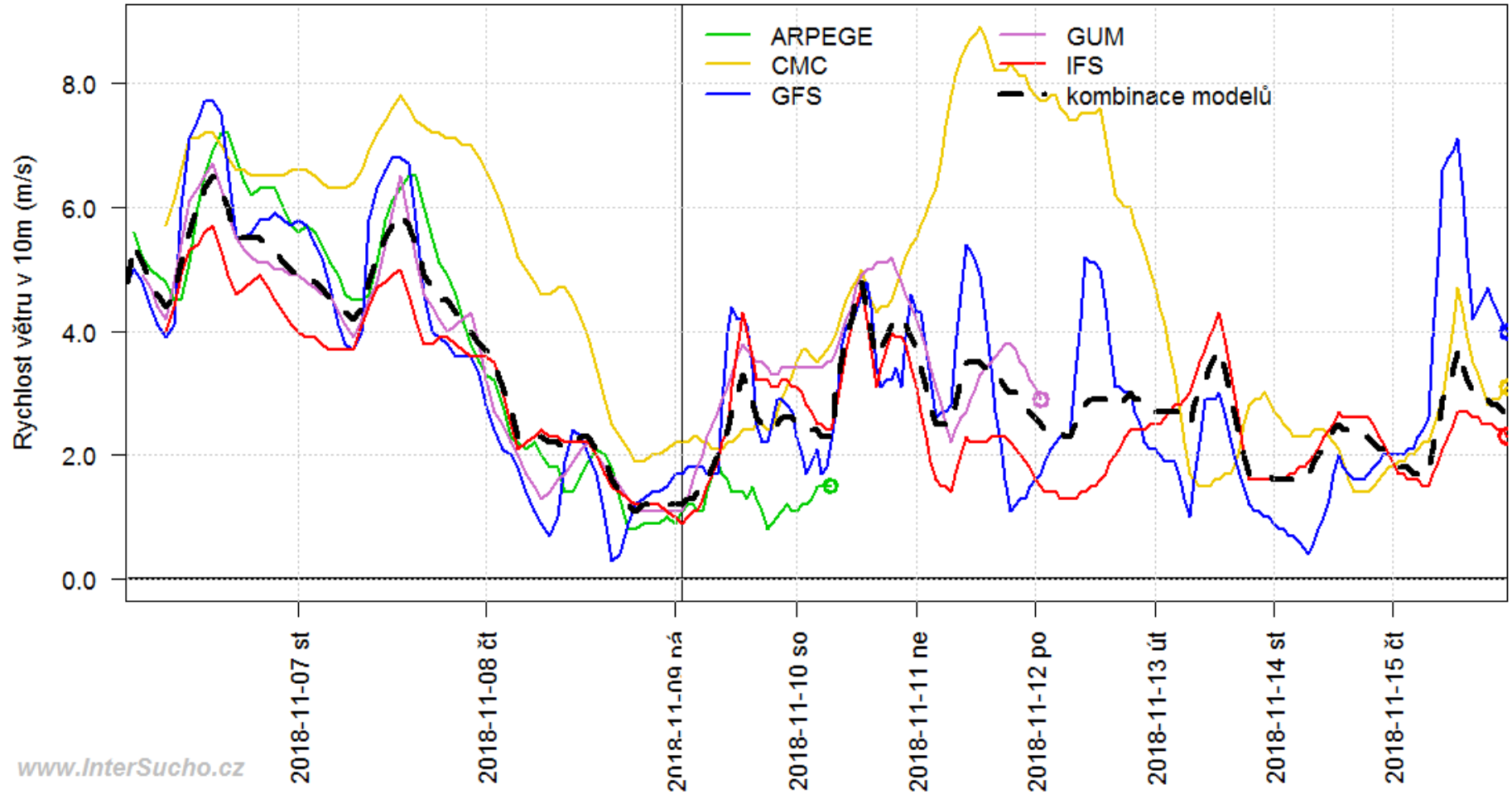
We try to extend it...and localize it

Polkovice - teplota vzduchu, předpověď od 06.11.2018



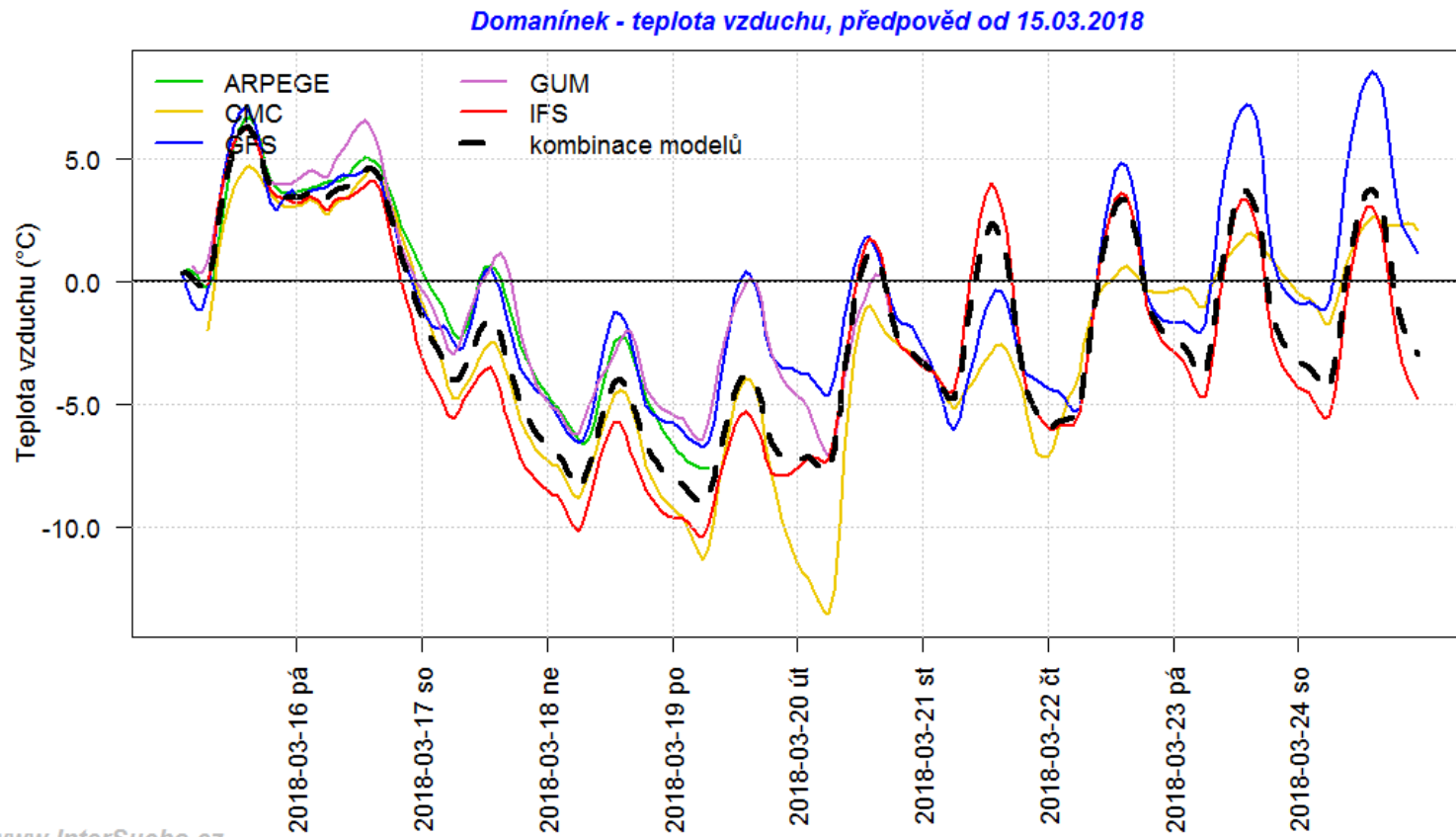
We try to extend it...and localize it

Polkovice - rychlost větru, předpověď od 06.11.2018



.....and motivate farmers to report

This operational forecast can help to prevent losses



We forecast drought & Wild Fire Risk

To increase usefulness the forecast of soil moisture is issued daily....5 forecast models (IFS, GFS, GEM, GLOBAL UM, ARPEGE) RUN AS ENSEMBLE

PŘEDPOVĚĎ NA 9 DNÍ - přehled 5 předpovědních modelů

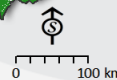
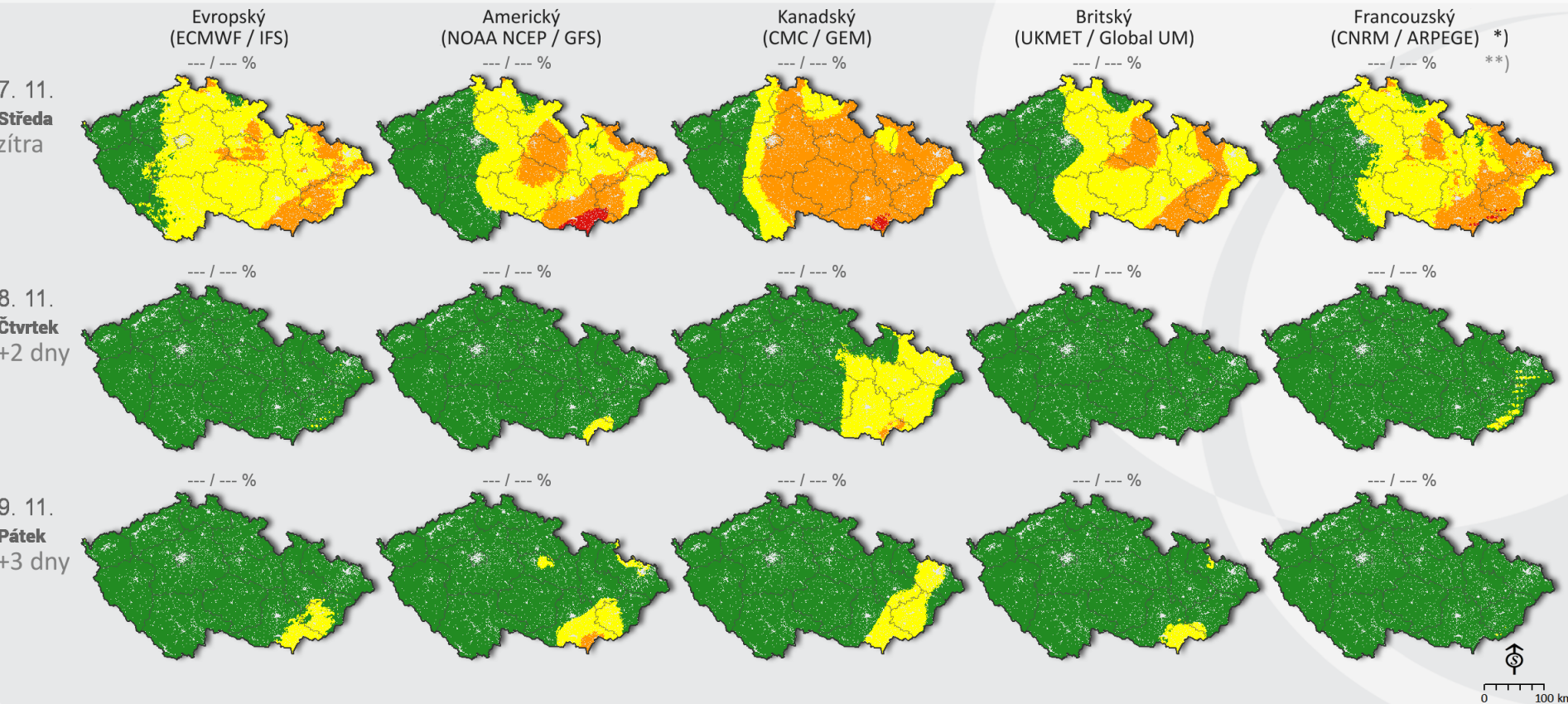
Vydáno: 6. 11. 2018 část: 1



Nebezpečí požárů - riziko vzrůstá s rostoucím indexem



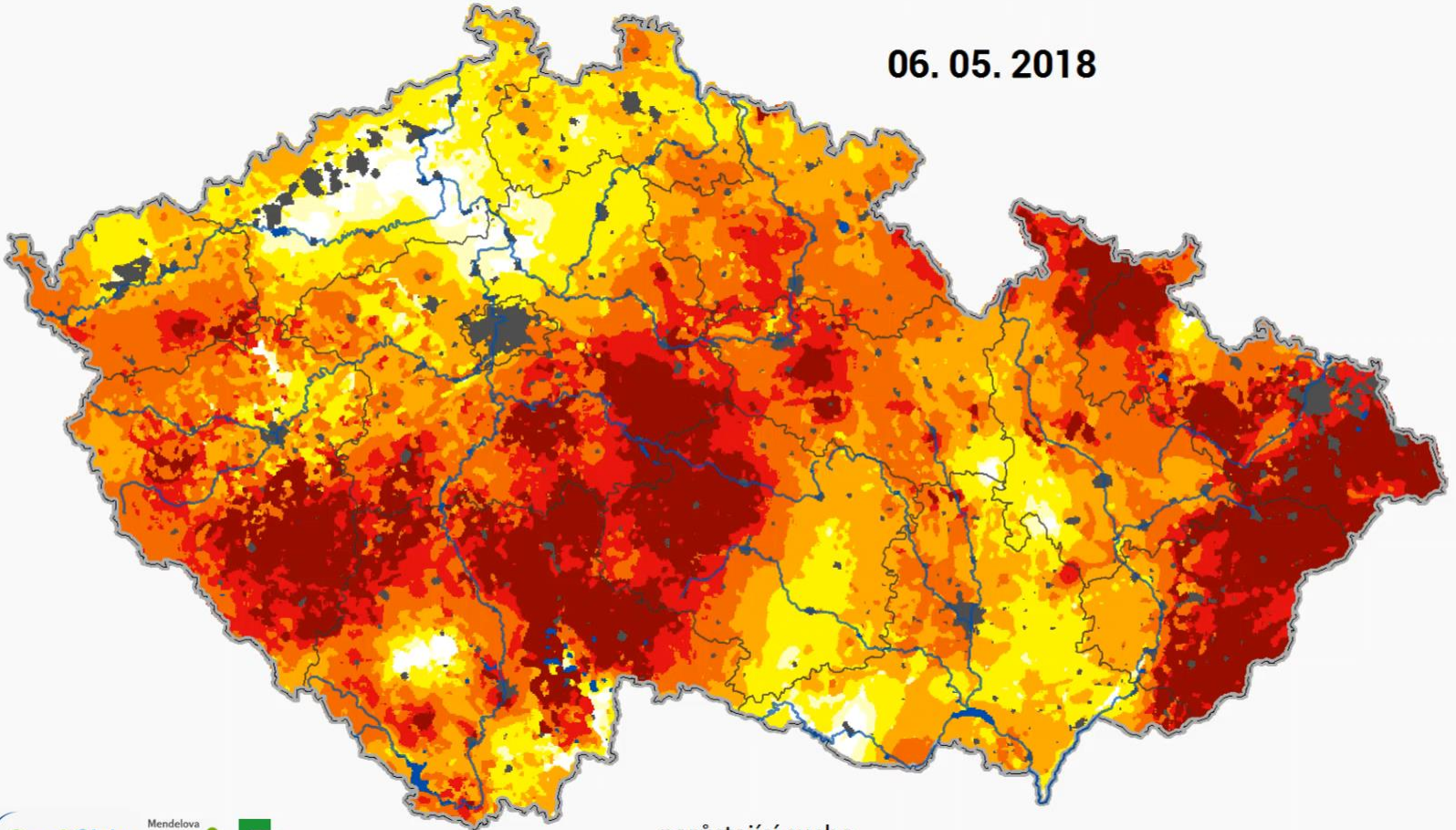
*) Použitý PŘEDPOVĚDNÍ MODEL pro datový podklad (zdroj / zkratka)
 **) ÚSPĚŠNOST PŘEDPOVĚDI: za poslední 3 týdny / 1 týden
 tj. jak velkou chybu v předpovědi lze očekávat v průměru



We evaluate impacts in near real time

INTENZITA SUCHA V PŮDNÍM PROFILU 0 - 100 cm

06. 05. 2018



narůstající sucho →

bez rizika sucha S0 S1 S2 S3 S4 S5 extrémní sucho



CzechGlobe Mendelova univerzita v Brně
úřad veřejné správy a informační služby AV ČR, s. r. o.

STÁTNÍ POZEMKOVÝ ÚŘAD

Meteorologická data poskytuje: CHMÚ
www.INTERSUCHO.cz

We evaluate impacts in near real time

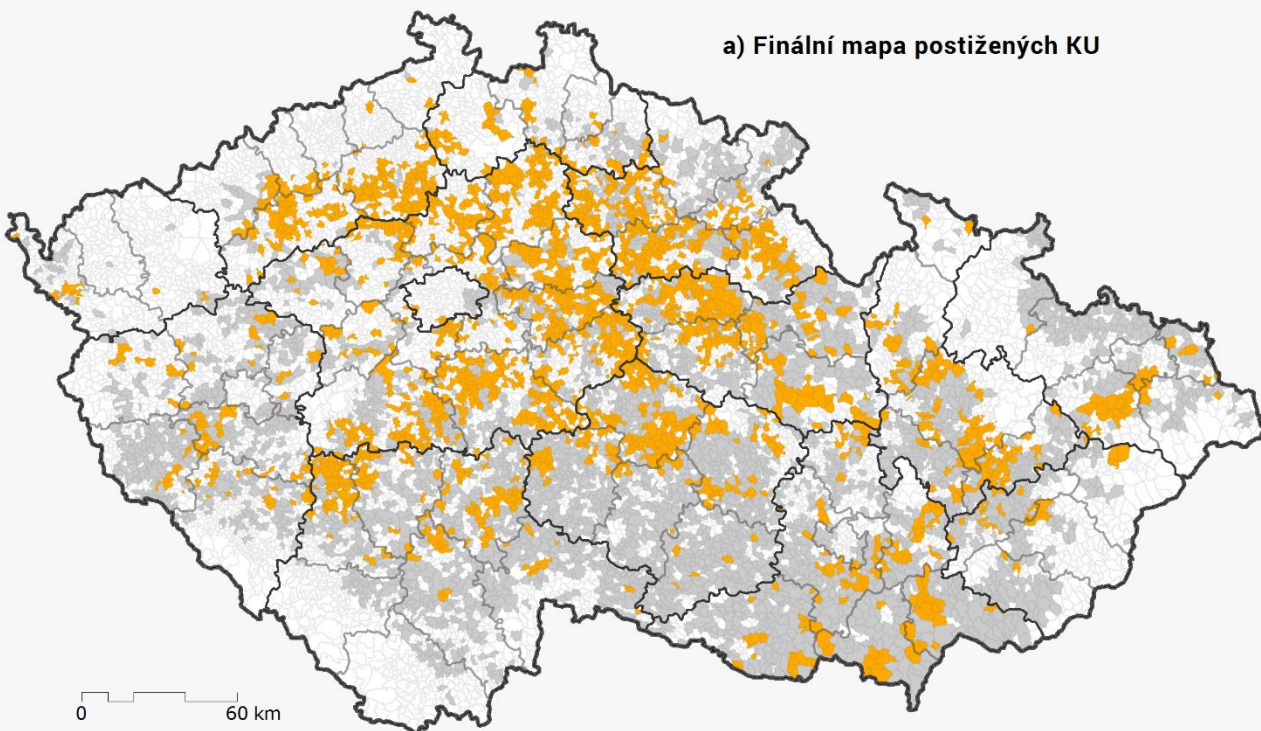
2018 – assessment of drought impact

- On cadastre level (13 000+ cadastrals)
- For all crops including special cultures

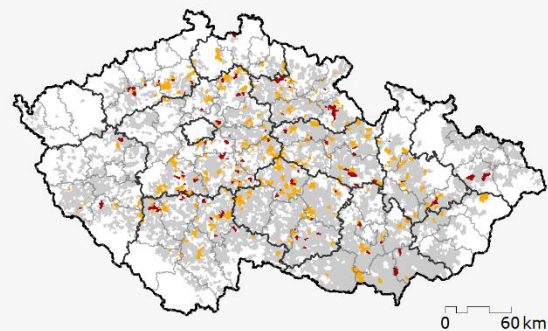
ODCHYLKA VÝNOSU SILÁŽNÍ KUKUŘICE

Pro katastrální území, kde bylo v roce 2018 podle databáze LPIS/SZIF pěstování plodiny evidováno

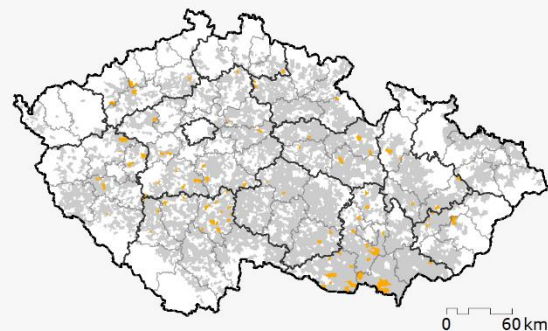
a) Finální mapa postižených KU



b) Šetření ZSČR



c) Hlášení zpravodajů Intersucha



Katastrální území s poklesem výnosu

- o 30 - 50 %
- o 50 % a více

Podíl z celkové výměry plodiny

- 33.4 %
- 0 %

Ostatní katastrální území, kde se podle evidence využití půdy

- plodina pěstována
- plodina nepěstována

Poskytovatel dat:



INTERSUCHO

Zpracoval:



Ústav výzkumu globální změny AMU ČR, s. r. o.

Can we transfer the knowledge?





DriDanube - Drought Risk In The Danube Region

The main objective of [DriDanube project](#) is to increase the capacity of the Danube region to manage drought related risks. Your contribution to the project bring the information about drought impacts currently in real time from your locality. Thank you for your cooperation.

How it works

1

Register

The automatic registration will be created with the first filling in a questionnaire. Please, use your email address to login to the system thereafter.

2

Fill in questionnaire

Please, make sure you complete your questionnaire carefully according to field of your activity at the location of your business conducting. Instructions for questionnaire completing are attached [HERE](#).

3

Continue in work

Please, keep reporting every week. Reporting continuity is core for entire cooperation. If you need an assistance, do not hesitate to contact us.

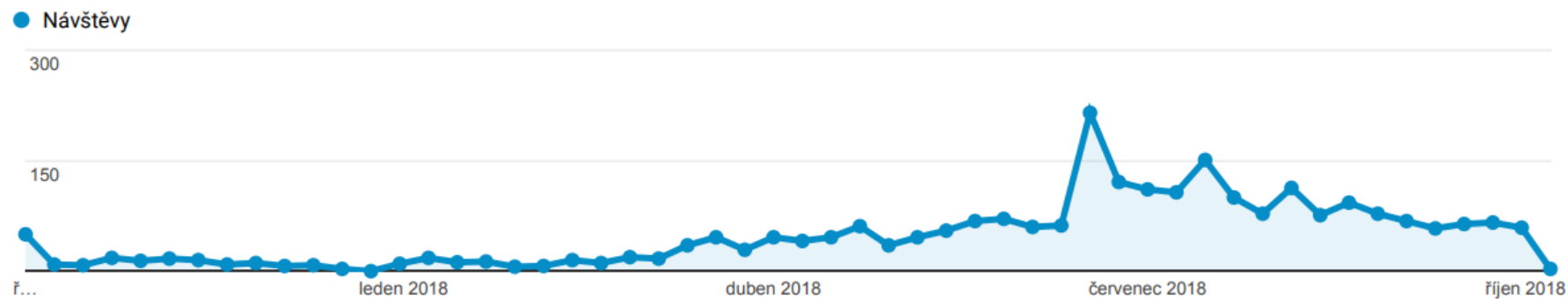
Questionnaire page now running for all involved countries, all translations are finished – **thanks for your excellent cooperation!**

Number of visitors of <http://questionnaire.intersucho.cz> by weeks (X 2017 – X 2018)

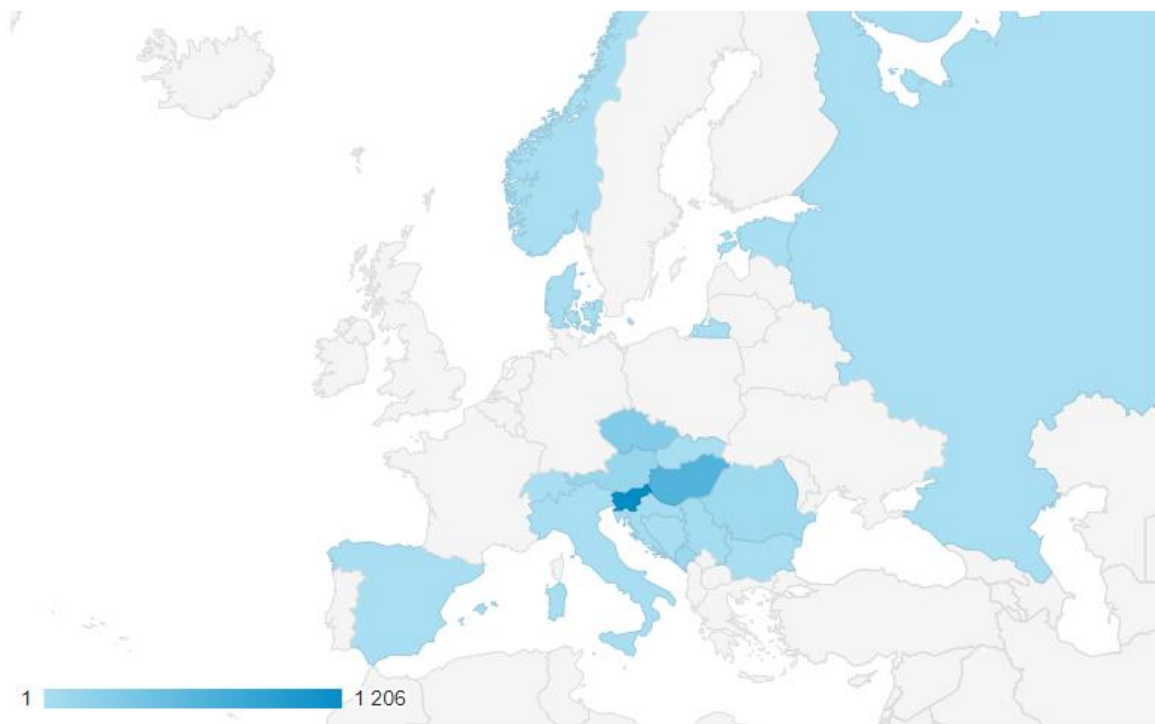
Všichni uživatelé
100,00 % Návštěvy






1. 10. 2017 - 7. 10. 2018

Přehled



Visits of <http://questionnaire.intersucho.cz> by countries (X 2017 – X 2018)



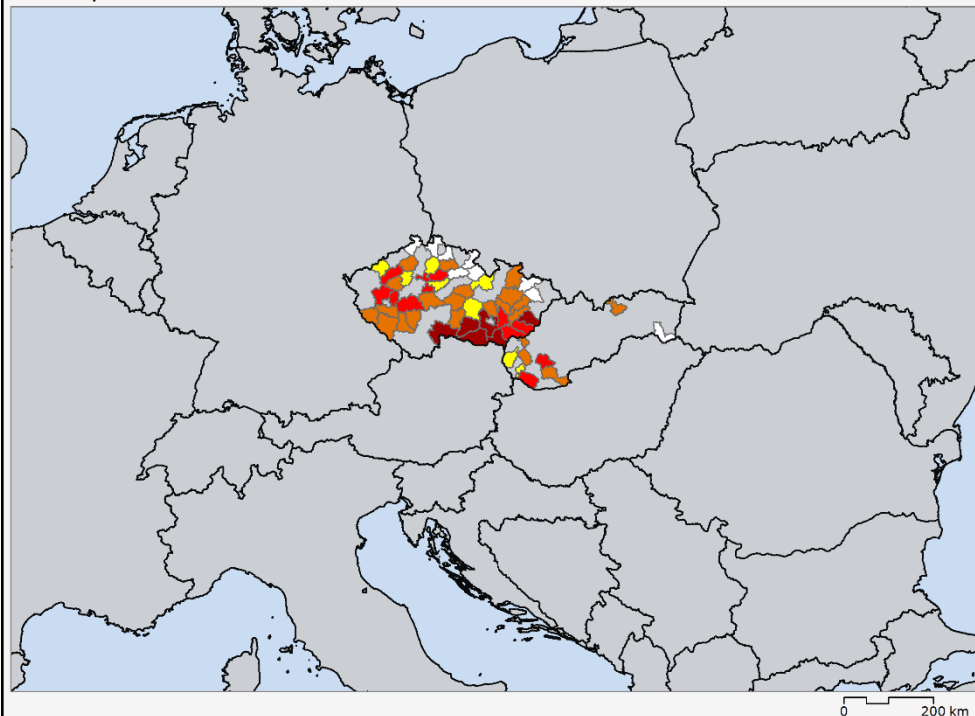
1.		Slovenia
2.		Hungary
3.		Czechia
4.		Austria
5.		Montenegro
6.		Romania
7.		Serbia
8.		Croatia
9.		Slovakia
10.		Bosnia & Herzegovina
11.		Bulgaria

Drought impacts assessment - maps

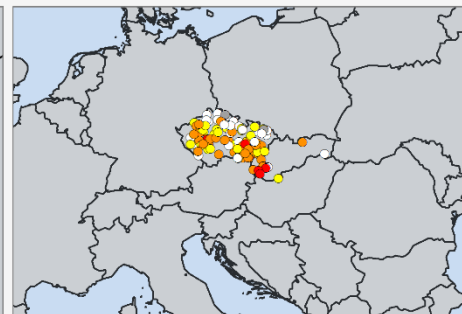
- Weekly getting data for maps from 4 (5) countries (+ Czech and Slovak republic)
 - Croatia: 40 reporters,
 - Hungary: 30
 - Slovenia: 25
 - Romania: 10

1. ESTIMATED DROUGHT IMPACT ON MAIN CROP YIELD

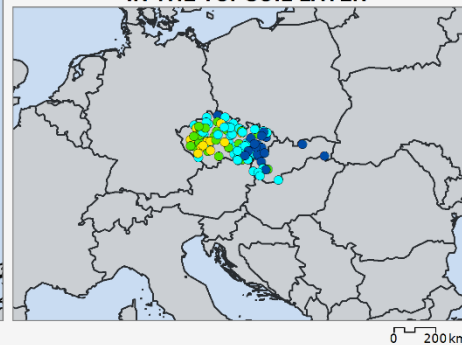
28. September 2017



2. WATER BALANCE FOR THE LAST THREE MONTHS



3. CURRENT SOIL MOISTURE IN THE TOPSOIL LAYER



Map of drought impacts – October 2017

Just an „idea“ how it may look Functional examples in the Czech and Slovak republic

- 1.**
- no drought impact
 - drought occurrence w/o impact on crop yield
 - drought occurrence is likely to reduce crop yield
 - drought occurrence significantly reduces crop yield
 - drought occurrence substantially reduces crop yield

- no drought impact
- drought w/o impact on crop yield
- drought reduces crop yield
- drought substantially reduces crop yield
- barley + wheat + rape
- sugar beet + potatoes
- corn
- forests
- fruit trees
- grapevine

- 2.**
- extre drought - precip. deficit/intense drought with significant impact
 - severe drought - precip.deficit with noticeable negative impact
 - rather dry period without noticeable impact
 - normal state / moderate humid period without negative impact
 - very humid - with noticeable negative impact
 - extremely humid - precipitation excess with negetive impact

- 3.**
- dry to touch and non-moldable
 - soil rather dry to touch with loose consistence
 - soil slightly moist, moldable with low cohesion
 - soil moist, well moldable
 - very wet soil, sticks to fingers
 - out of classification scale

Issued: Sep 28, 2017

Data provider:

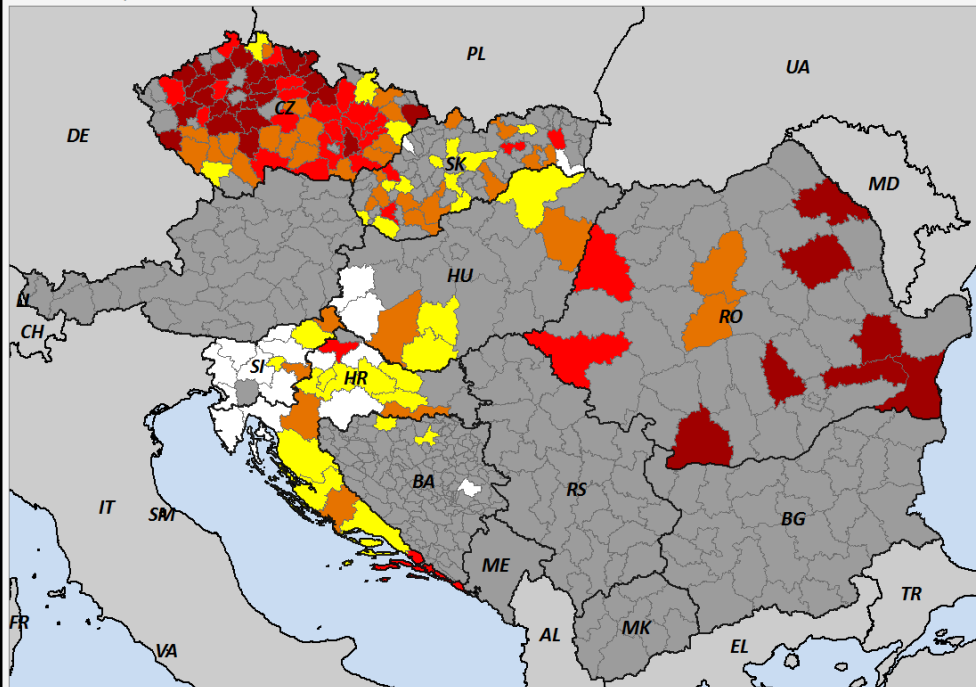


Data processed by:

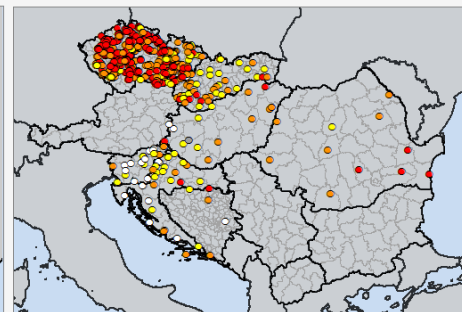


1. ESTIMATED DROUGHT IMPACT ON MAIN CROP YIELD

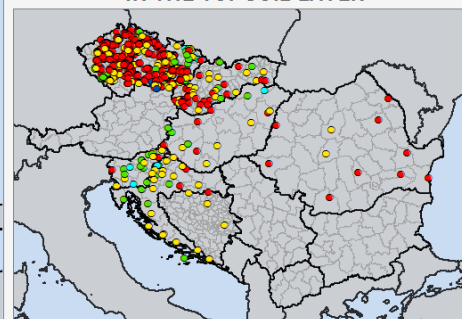
WEEK 43, 2018



2. WATER BALANCE FOR THE LAST THREE MONTHS



3. CURRENT SOIL MOISTURE IN THE TOPSOIL LAYER



Map of drought impacts – **October 2018**

- 1.**
- no drought impact
 - no report
 - drought occurrence w/o impact on crop yield
 - drought occurrence is likely to reduce crop yield
 - drought occurrence significantly reduces crop yield
 - drought occurrence substantially reduces crop yield

- 2.**
- extreme drought - precip.deficit/intense drought with significant impact
 - severe drought - precipitation deficit with noticeable negative impact
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 - soil rather dry to touch with loose consistence
 - soil slightly moist, moldable with low cohesion
 - soil moist, well moldable
 - very wet soil, sticks to fingers
 - out of classification scale

Data provider:



Data processed by:



Issued: Oct 25, 2018

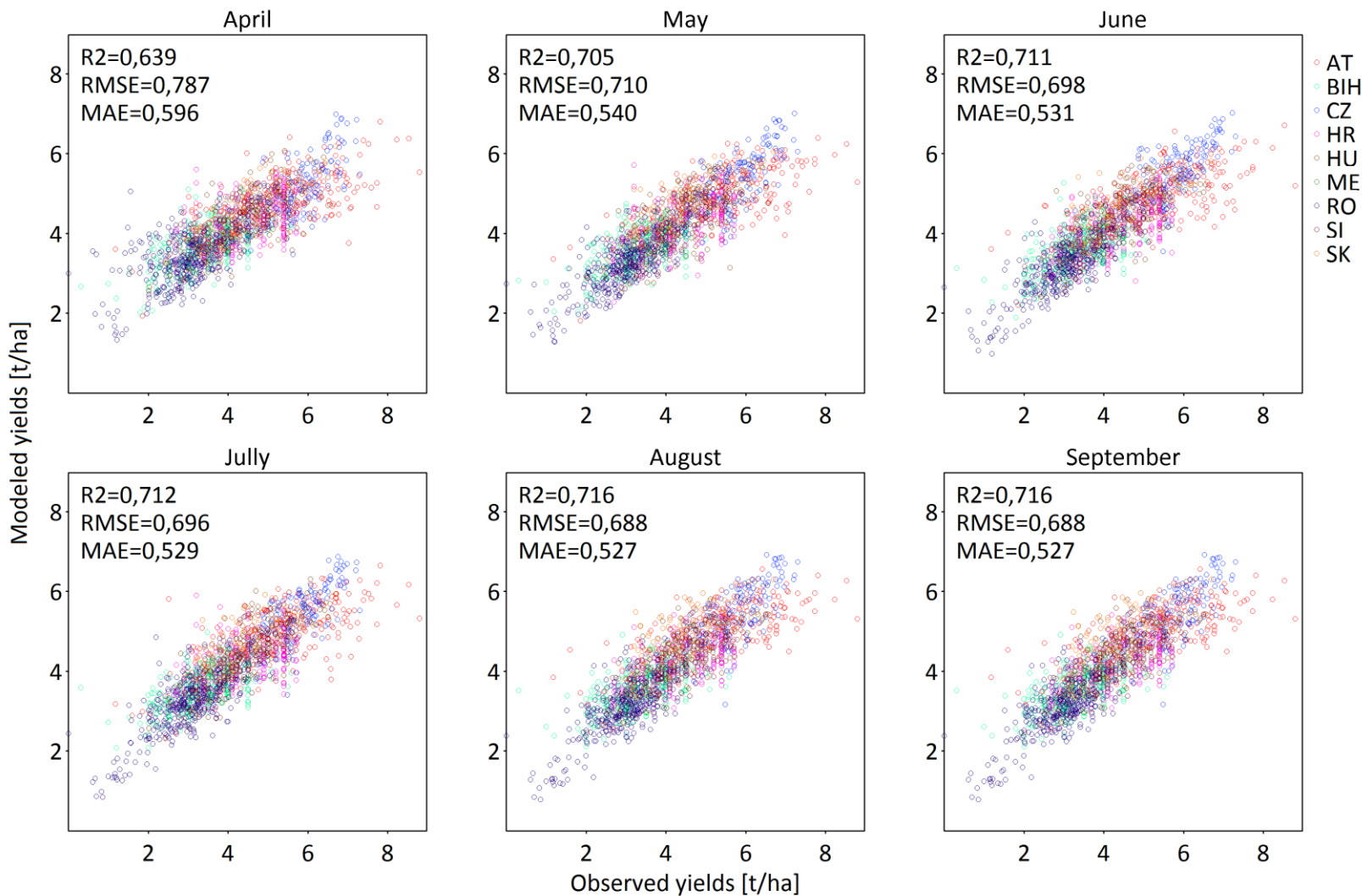
Project co-funded by European Union funds (ERDF, IPA, ENI)

Yield prediction

- Based on yield database collected by you on your national levels
- Now operational
- First maps for the most common crops (published in DriDanube bulletin No. 7)

Yield prediction - training

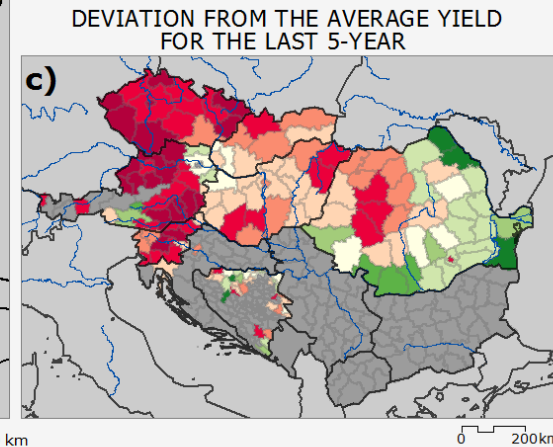
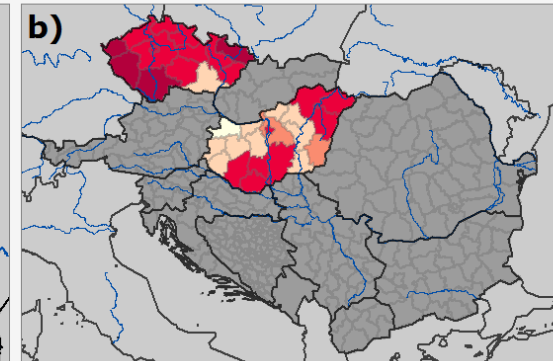
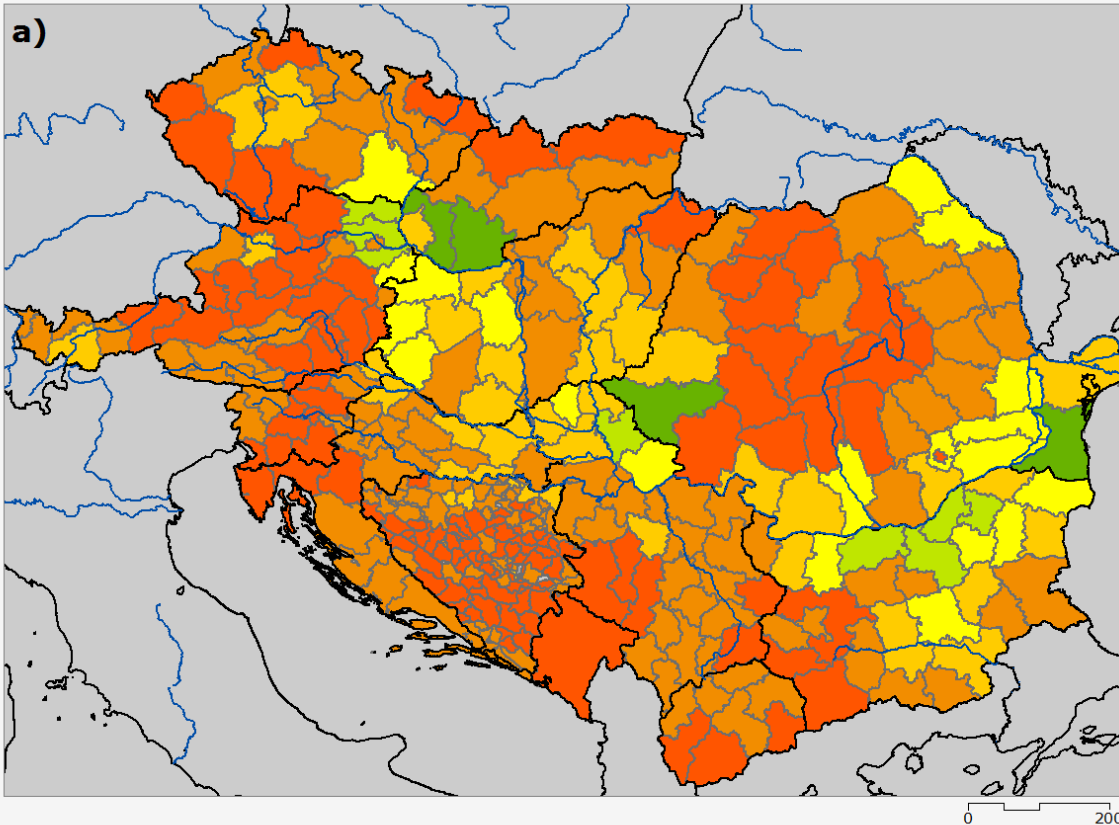
NUTS3



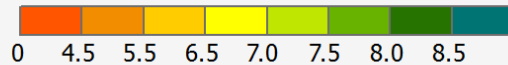
Yield prediction **now operational** for 5 most common crops – Barley, Maize, Potato, Sugar Beet, Wheat

PREDICTION OF WHEAT YIELDS

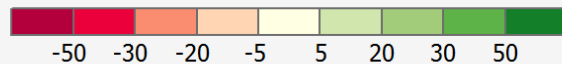
based on vegetation condition monitoring using remotely sensed surface spectral reflectance





a) Average Yield [t/ha]



b, c) Relative Change [%]

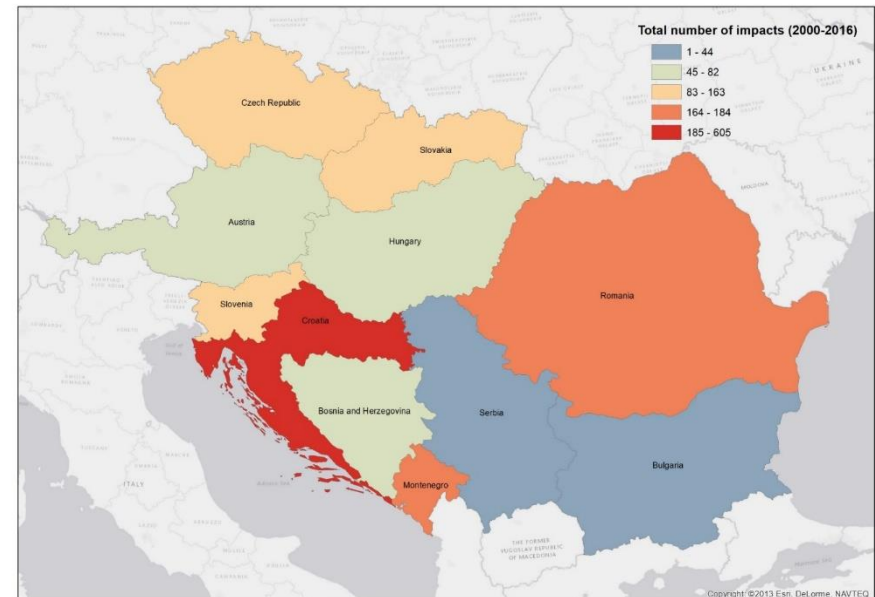


 NUTS3 regions
 Observed yield data no available

Issued: 04.09.2018

Impact database + prediction

- Data collected from Interreg partners processed into model
- Estimating the drought impact gravity early in the season

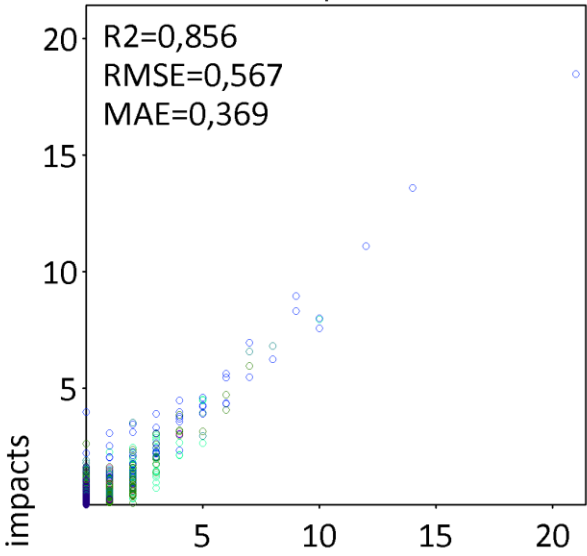


Impact database + prediction

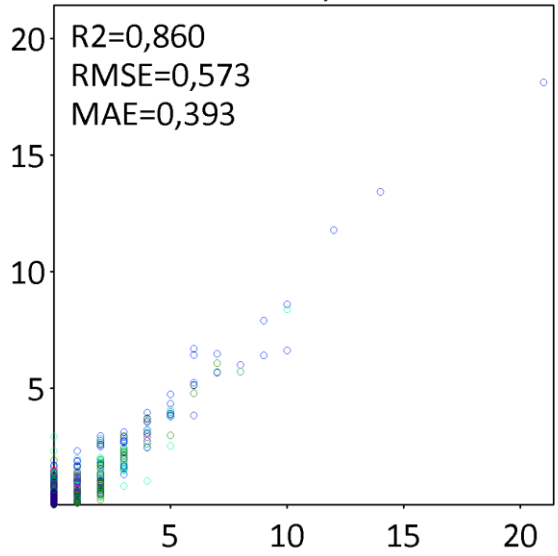


NUTS3 - All

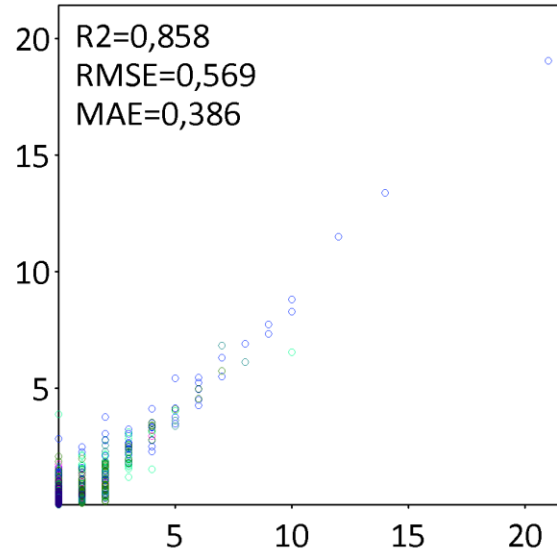
April



May

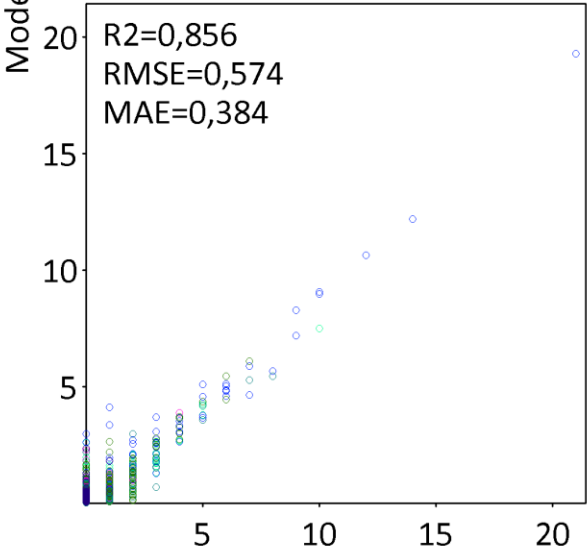


June

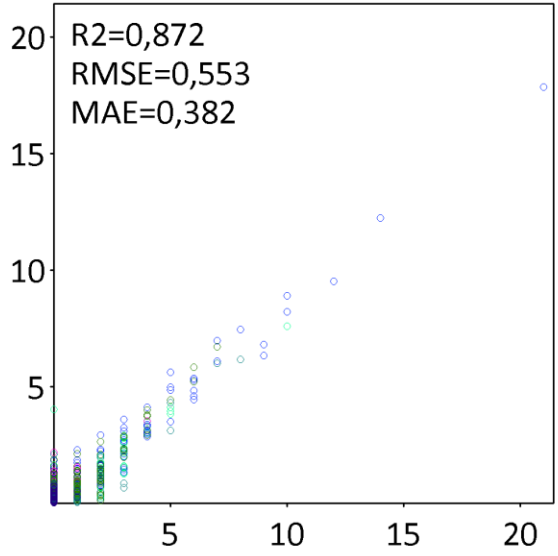


- CZ
- HR
- HU
- RO
- SI
- SK

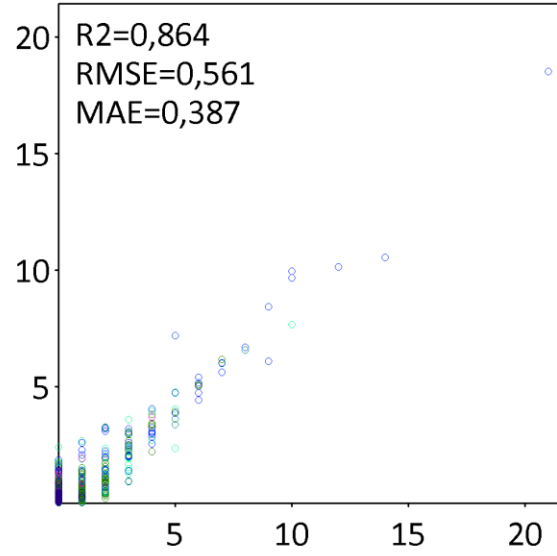
July



August

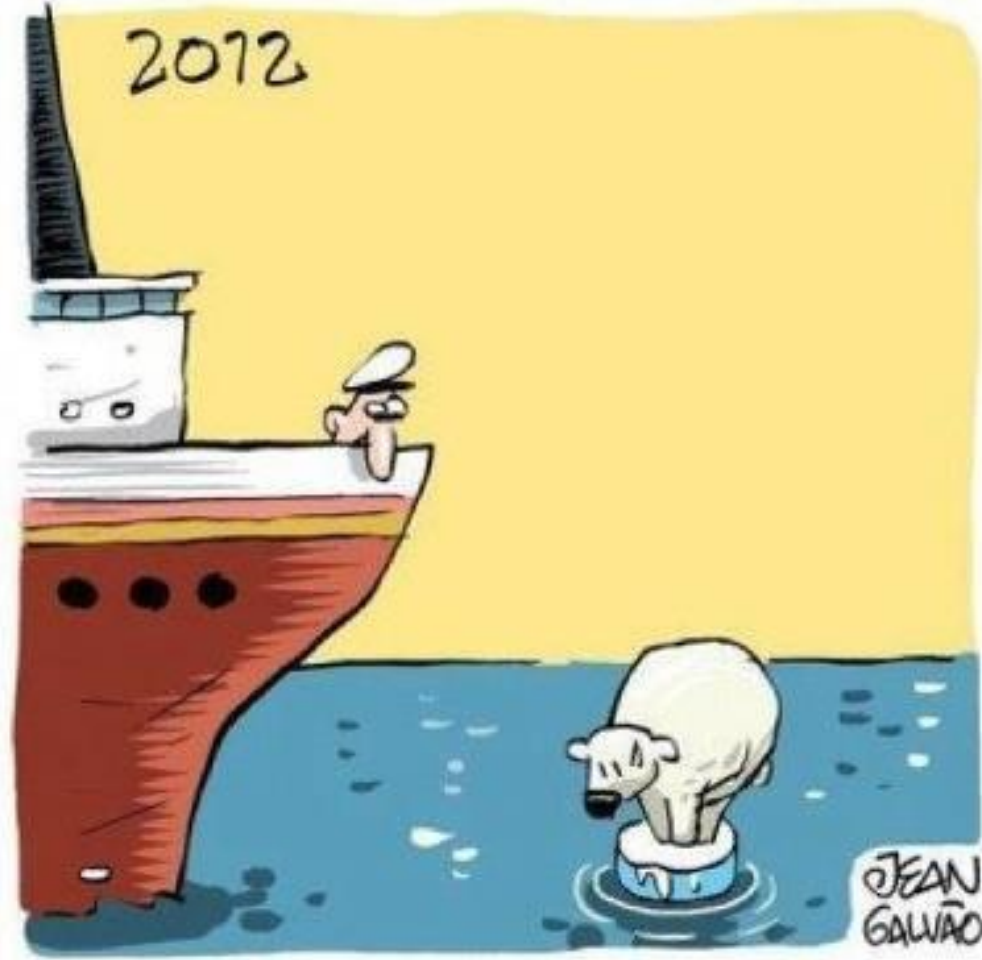


September



Observed impacts

Thank You for Your attention...



**Questions...if not answered at the spot to
mirek_trnka@yahoo.com**