The Soil resources in the Danube Region:

Opportunities and constraints for Agricultural Production

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My presentation today

- **Introduction**

- **Objectives & Research questions**

- **Results & Methodology**

- **Synthesis and conclusions**

Fig.1.: Wilder Kaiser (AT/DE)

Fig.2.: Marchfeld (AT)

Fig.3.: Great Hungarian Plain (HU)

Fig.4.: Vojvodina (SRB)

Fig.5.: Danubian Plain (BG)

LEGEND

☐ Danube River Basin District (DRBD)
— Danube River
— Tributaries (with catchment area > 4,000 km²)
☐ Lake water bodies (with surface area > 100 km²)
■ Transitional water bodies
■ Coastal water bodies
— Canals

Cities:
● 100,000 - 250,000 inhabitants
■ 250,000 - 1,000,000 inhabitants
⬮ > 1,000,000 inhabitants

0   50   100   200 Kilo

SWITZERLAND

ITA

SLOVENIA

Adriatic
Sea

Kolpa

Wheat yields in the Danube region:

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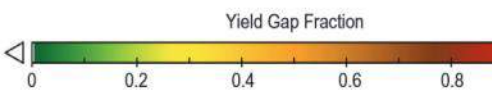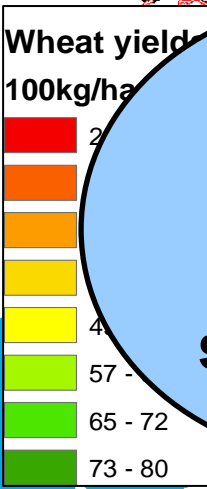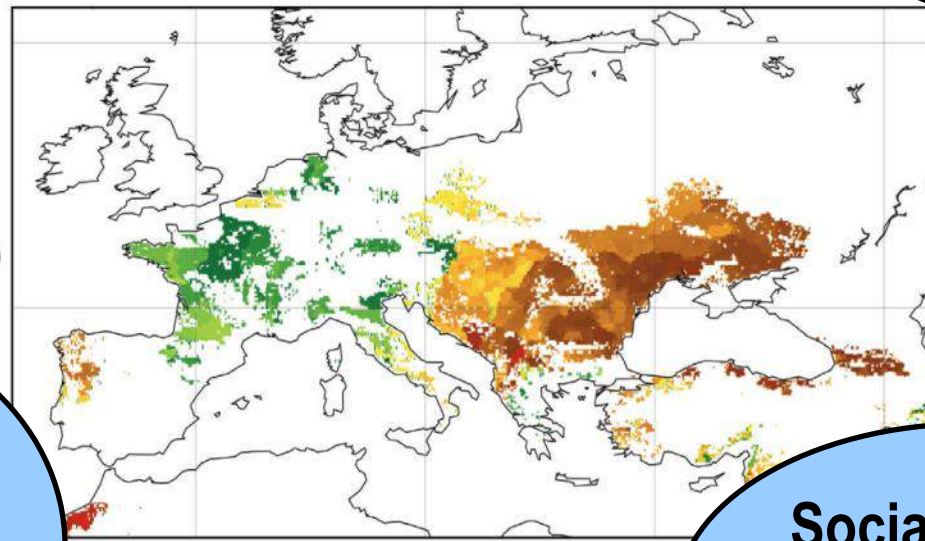Department of Forest and Soil Sciences

Seed quality

Fertilization

Machinery

Wheat yield gaps (Licker et al., 2010)

Institutional aspects: Legislation, subsidies,…

Social aspects like skills and knowledge

Wheat yields
100kg/ha

57 -
65 - 72
73 - 80

Yield Gap Fraction
0   0.2   0.4   0.6   0.8

s (00'-09') at NUTS 2 level
e land (CORINE, 2006)   Source: eurostat.org

Objectives and research questions

Objective:

Analysis of the agricultural production capacity of the Danube region(*) in regard to the consequences of a sustainable intensification for the soil resources.

*DE, AT, SK, SI, CZ, HU, HR, BIH, SR, RO, BG

Research questions:

1.) Are there yield gaps for wheat in the Danube region(*)?

2.) How can nitrogen fertilisation contribute in a sustainable manner to close the yield gaps of wheat in the Danube region(*)?

3.) Which agricultural areas could be identified as sensitive to a higher nitrogen input in the Danube region(*)?

4.) How big would be the contribution of a replacement of fodder crops by direct food production in the Danube region(*) ?

Preliminary Results & Methodology I

Wheat yield gaps & Nitrogen gaps in the Danube region
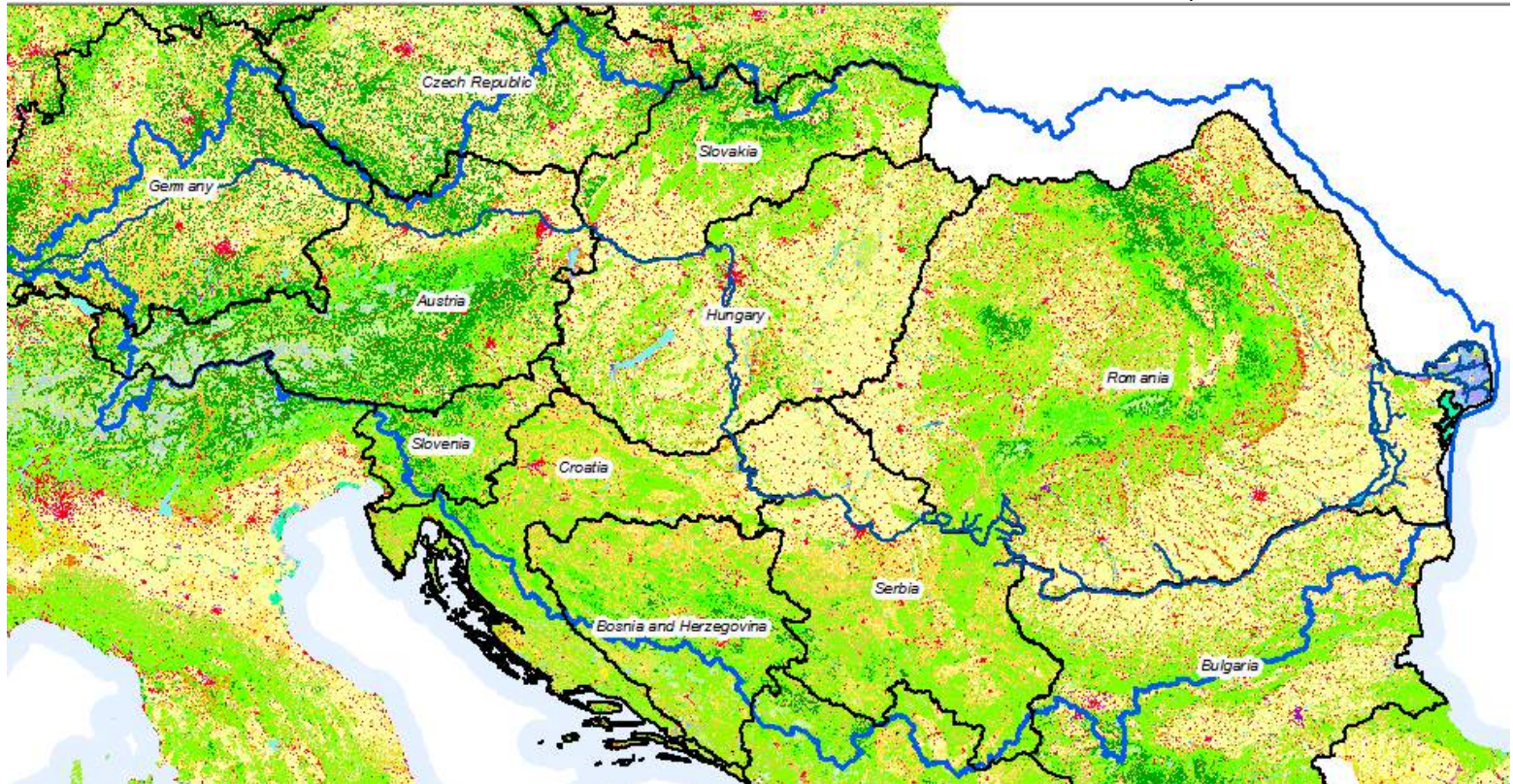

Fig. 6: N- deficiency of Winter wheat
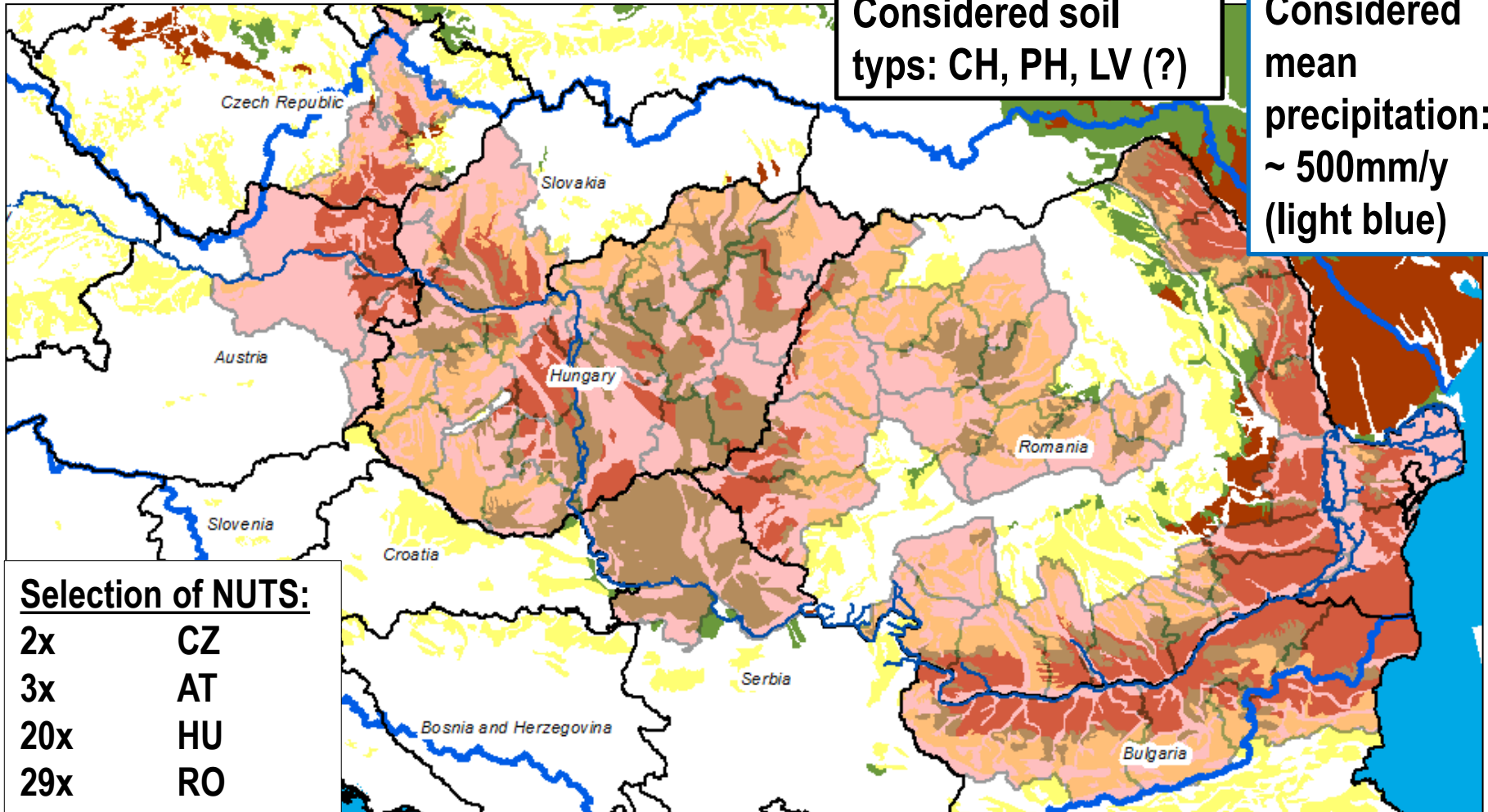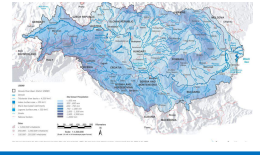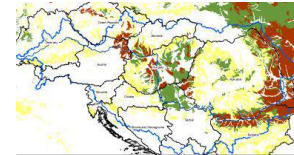
Selection procedure I – country level

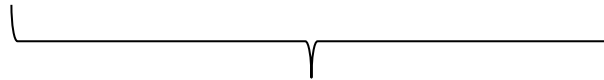**Considered countries:**
DE, AT, SK, SI, CZ, HU, HR, BIH, SR, RO, BG

Selection procedure IV – synthesis and selection of NUTS regions

Considered soil typs: CH, PH, LV (?)

Considered mean precipitation: ~ 500mm/y (light blue)

Selection of NUTS:

2x	CZ
3x	AT
20x	HU
29x	RO

Methodology – Assessing a Nitrogen gap
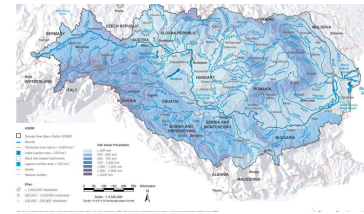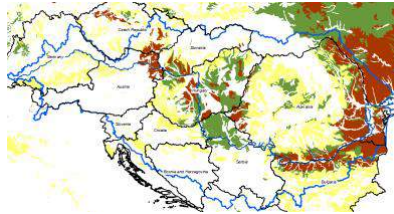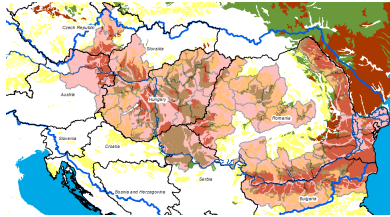
| Selection of climate – soil regions	
Compilation of nitrigenous fertilizer use (national sources & UNFCC)	
Divided per hectar arable land	Averaged for 2000 – 2012 for 54 NUTS
Subnational yield statistics for wheat	
90th percentile of recorded mean yields = „attainable yield"	
Simple regression to estimate the N-Fertilizer gap	

„Nitrogen gap"

Average Wheat yields and Nitrogen application rates (00'-12')

- HU
- RO
- CZ
- AT

Wheat yield (kg/ha)

kg Nitrogen/hectar

$R^2=0.75$
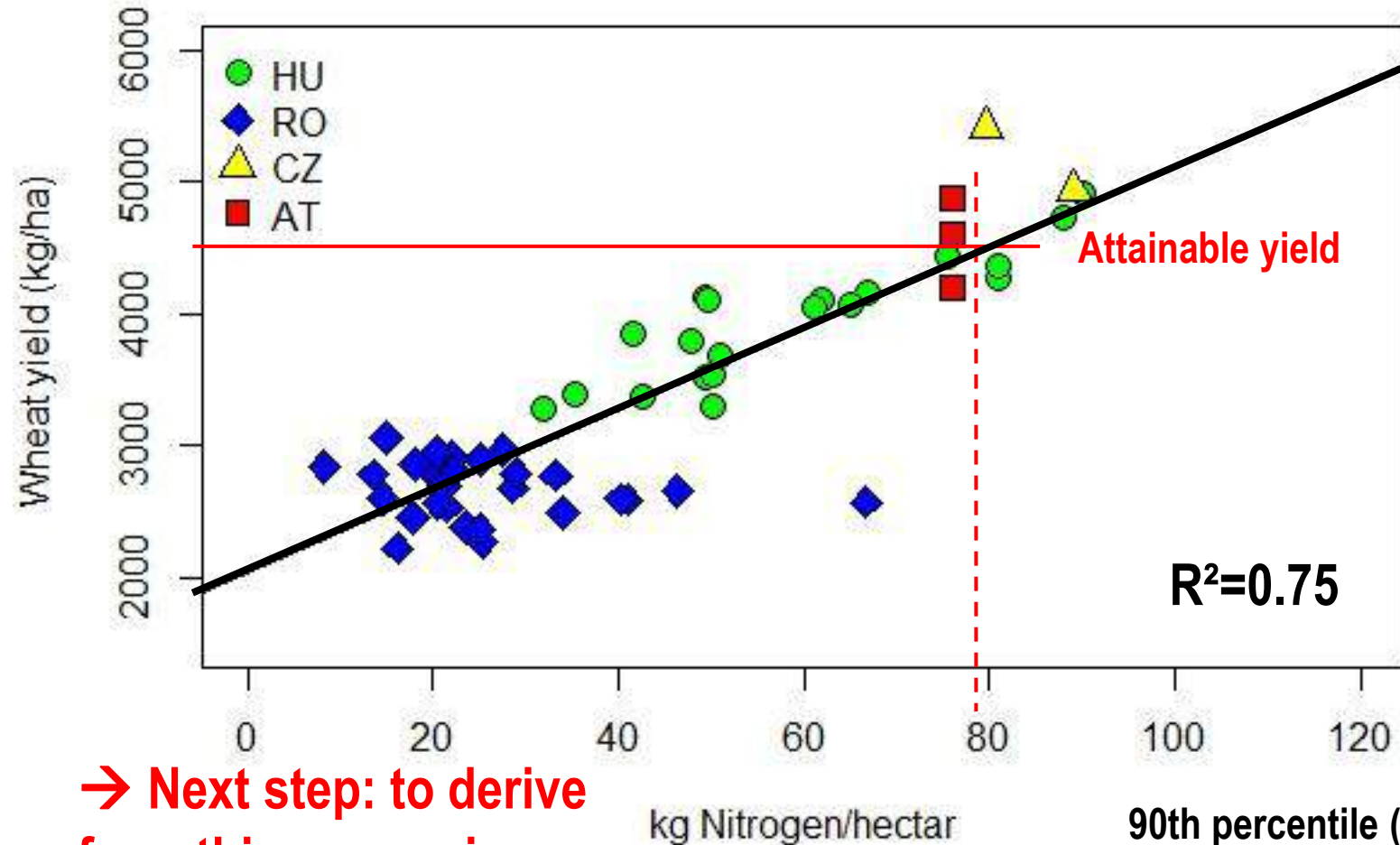
Attainable yield

➔ **Next step: to derive from this regression a nitrogen gap**

90th percentile (yield): 4550kg/ha

Yield gaps [kg/ha]

Yield gap = Attainable yield – actual yield

Attainable yield: 4550 kg/ha
Negative values indicate an
exceedance of the attainable yield.
Positive represent the yield gap
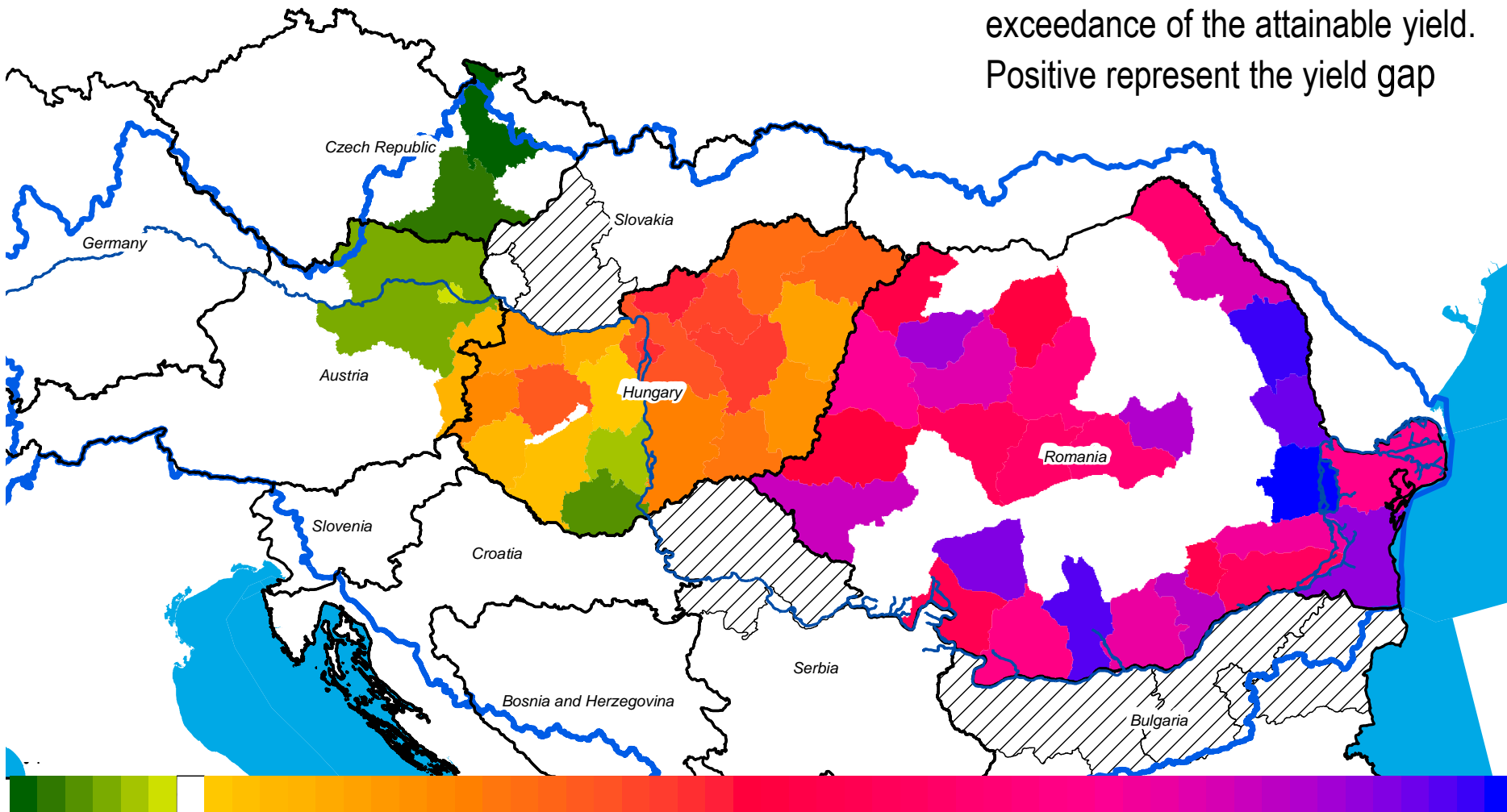
-1000   0*   200   600   1000   1200   1400   1600   1800   >2000

*(no data yet)

[kg/ha]

Results & Methodology II
Potentials of a diet transition

Methodology – „diet gap"

Fooder crops cultivated per NUTS region

Feeding of Livestock

Feed conversion into kcal (vector: edible kg)

Export to EU & Feed in EU

Chicken

Milk

Pork

Eggs

Beef

[tonnes]

Status quo:

Produced and feed nationally

Chicken

Milk

Pork

Eggs

Beef

Animal kcal/region

EUROSTAT & national statistics

Food balance sheets (FAO)

Smil, Nitrogen and food production: proteins for human diets(2002)

Institute of Soil Research I www.boku.ac.at I L. Rittler & W.W. Wenzel

Methodology – „diet gap"

Fooder crops cultivated per NUTS region

Feeding of Livestock

Conversion into vegetarian kcal (vector: kg flour)

Export to EU & Feed in EU

Total diet transition:

[tonnes]

Produced and feed nationally
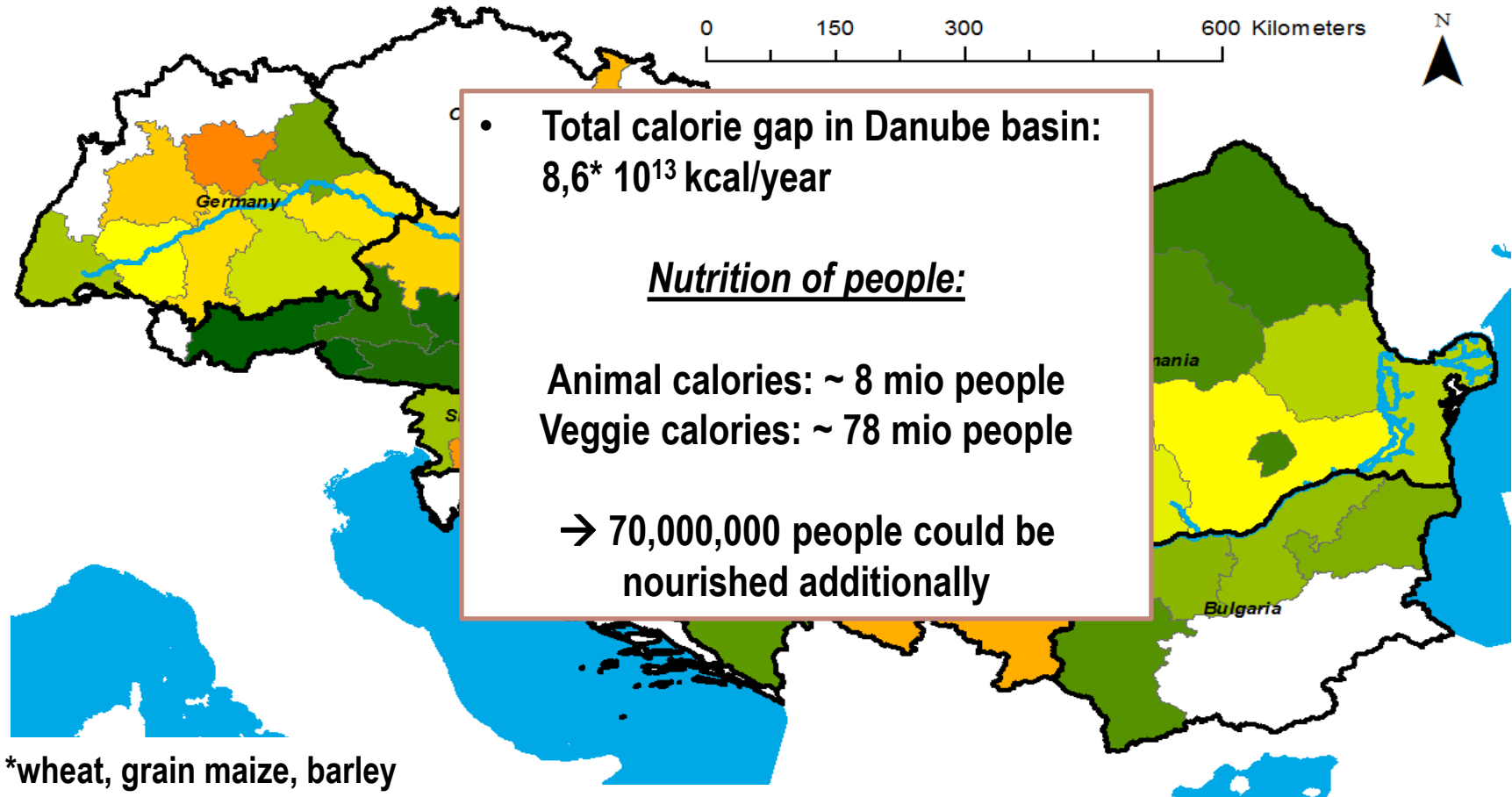
Vegetarian kcal/region

EUROSTAT & national statistics   Food balance sheets (FAO)   Food composition fact sheet (FAO)

Calorie gap of fodder crops in the Danube region

Calorie gap [10^6 kcal] = Animal calories from fodder crops (*) – alternative veggie calorie from fodder

- Total calorie gap in Danube basin: 8,6* 10^{13} kcal/year

Nutrition of people:

Animal calories: ~ 8 mio people
Veggie calories: ~ 78 mio people

→ 70,000,000 people could be nourished additionally

*wheat, grain maize, barley

Calorie gap [10^6 kcal]/1000 ha arable land

| 7000 | 4000 | 3000 | 2000 | >1000 |

29/05/2015

Discussion of the results

→ Wide yield gap for wheat within the study area

— Uncertainties:

- Nitrogen efficiencies of production systems
- Unconsidered nitrogen inputs (legumes etc.)
- Selection of NUTS (climate, soils)
- Accurate & reliable statistical data for fertiziler use

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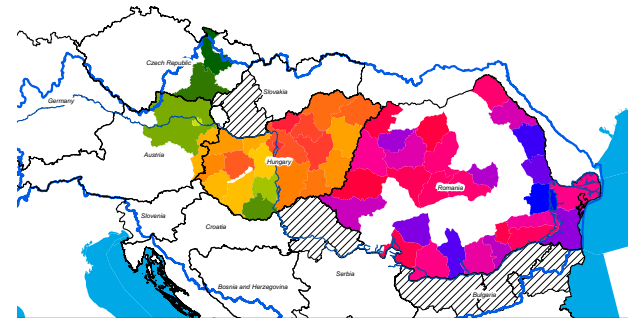
→ Great potential to feed more people

— Uncertainties:

- Conversion rates are just estimators
- Only few information about distribution pathways

Synthesis

➔ **Closing of yield gaps can offer a great potentials to feed more.**

➔ **A full closing of the diet gap is unrealistic but this modelling approach illustrates the „costly" animal production**

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References of the presentation

- CORINE. http://land.copernicus.eu/pan-european/corine-land-cover

- Eurostat: www.ec.europa.eu/eurostat

- Licker, R. et al. (2010): Mind the gap: how do climate and agricultural management explain the ''yield gap'' of croplands around the world? Glob. Ecol. Biogeogr. 19, 769–782.

- Mueller, N. et al. (2012):Closing yield gaps through nutrient and water management. Nature 490, 254 – 257.

- Smil, V. Nitrogen and food production: proteins for human diets. AMBIO: A Journal of the Human Environment 31, 126-131 (2002).

- JRC. European Commission- Joint Research Centre Institute of Environment and Sustainability, Ispra

- ICDPR. International Commission for the Protection of the Danube River, icdpr.org

- FAO. Food and Agriculture Organisation of the United Nations. www.fao.org

- Icons for Diet gap: https://cdn2.iconfinder.com/data/icons/bright-cafe/512/maize-512.png

- Fig.1.: Wilder Kaiser: http://www.hdpaperwall.com/bavarian-landscape/

- Fig.2.: Marchfeld: http://www.fotocommunity.de/pc/pc/display/13216374

- Fig.3.: Great Hungarian Plain: http://en.wikipedia.org/wiki/Great_Hungarian_Plain

- Fig.4: Vojvodina: http://onebigphoto.com/category/landscape-photography/page/10/

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References of the presentation

- Fig. 5: Danubian Plain in Bulgaria: http://en.wikipedia.org/wiki/Danubian_Plain_(Bulgaria)
- Fig. 6: Wheat field with N-defiency: www.nue.okstate.edu

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Thanks especially to...

Herbert Bauer
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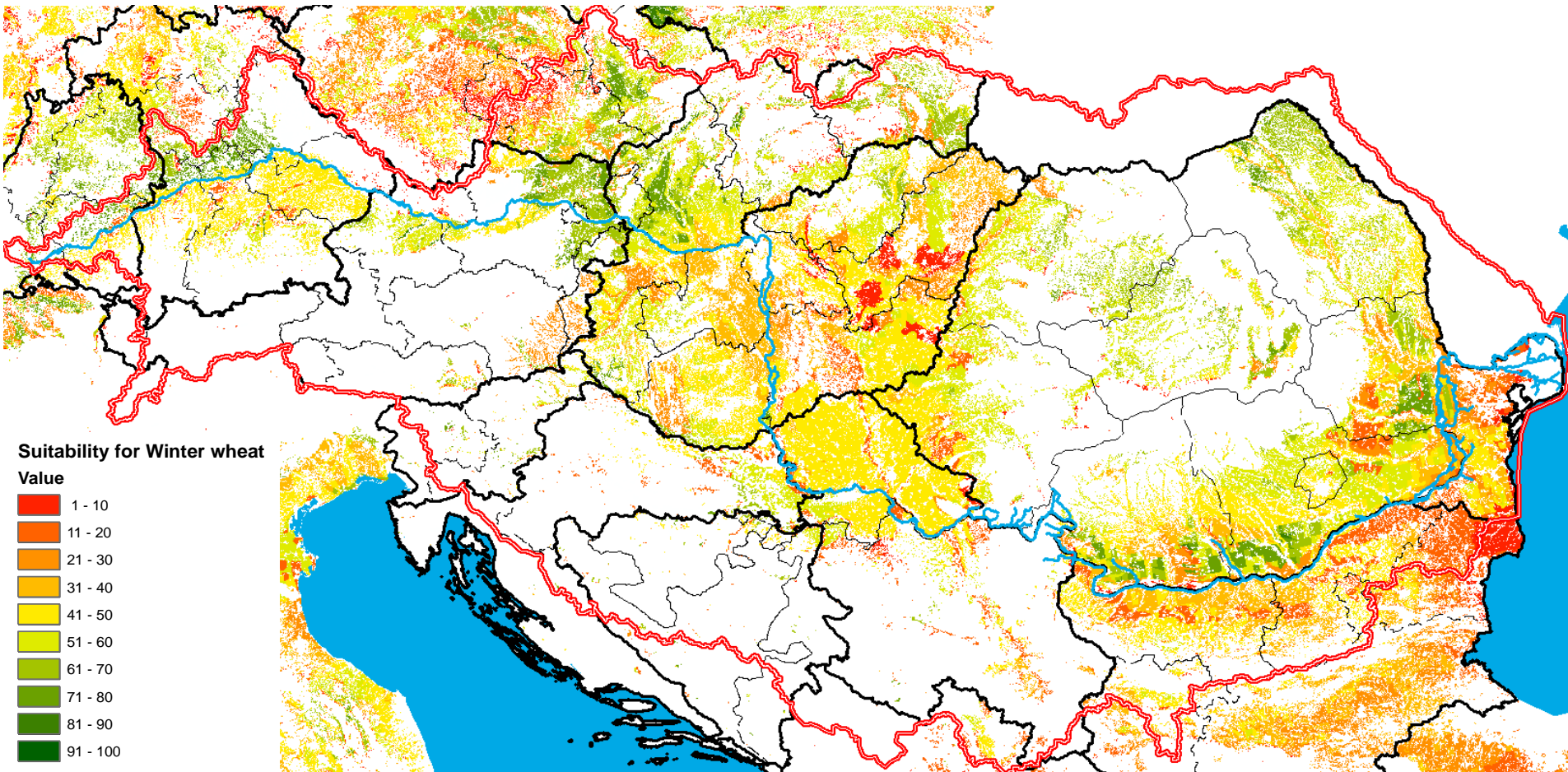Emoke Gyorfi

Thank you for your attention!

Yield gap assessment II

GLUES-project (BMBF): suitability evaluation for winter wheat considering soil, topography, climate, irrigation and crop requirements.

Source: http://geoportal.glues.geo.tu-dresden.de/

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Suitability for Winter wheat
Value

	1 - 10
	11 - 20
	21 - 30
	31 - 40
	41 - 50
	51 - 60
	61 - 70
	71 - 80
	81 - 90
	91 - 100

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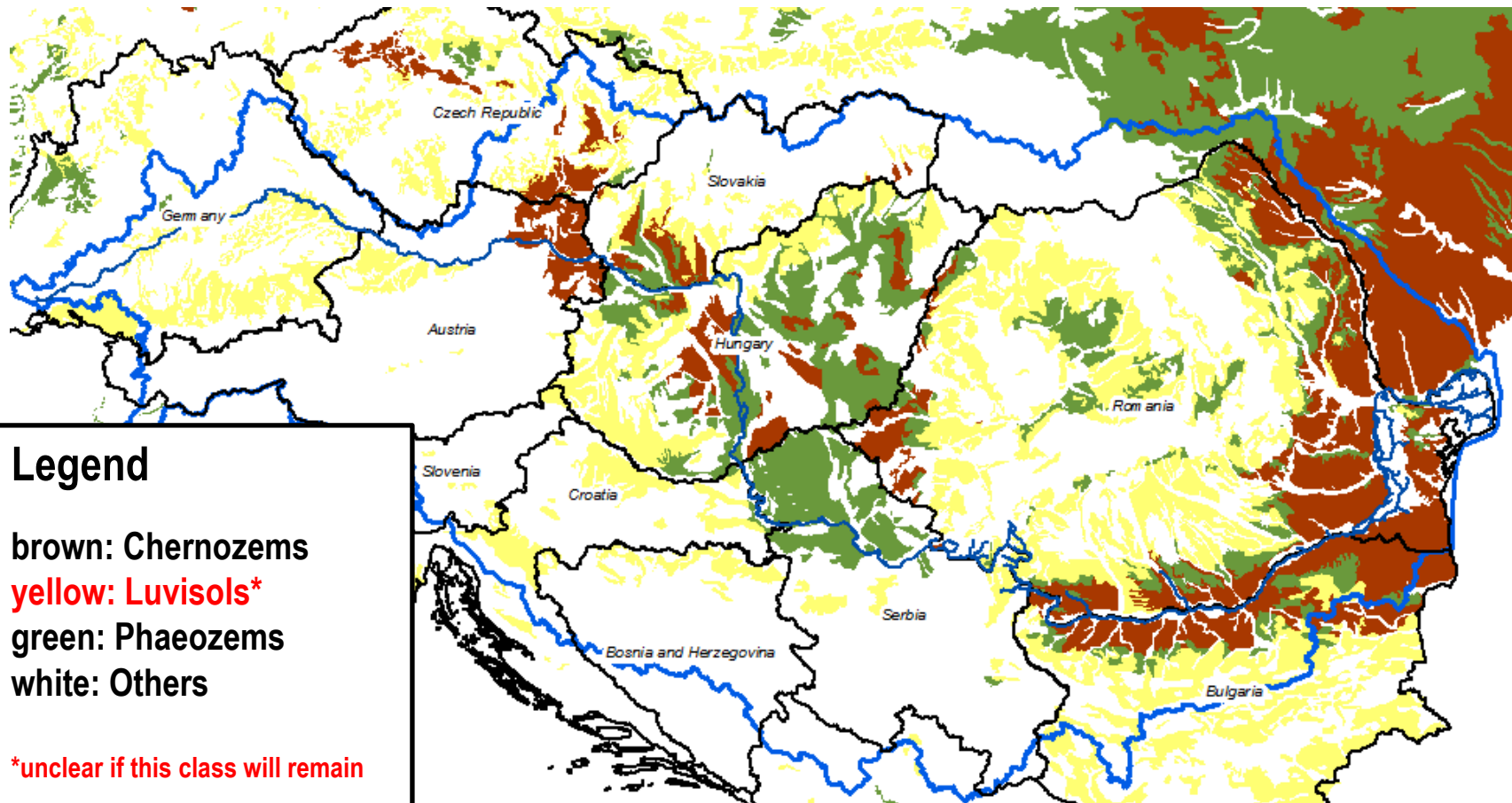and Life Sciences**
Department of Forest and Soil Sciences
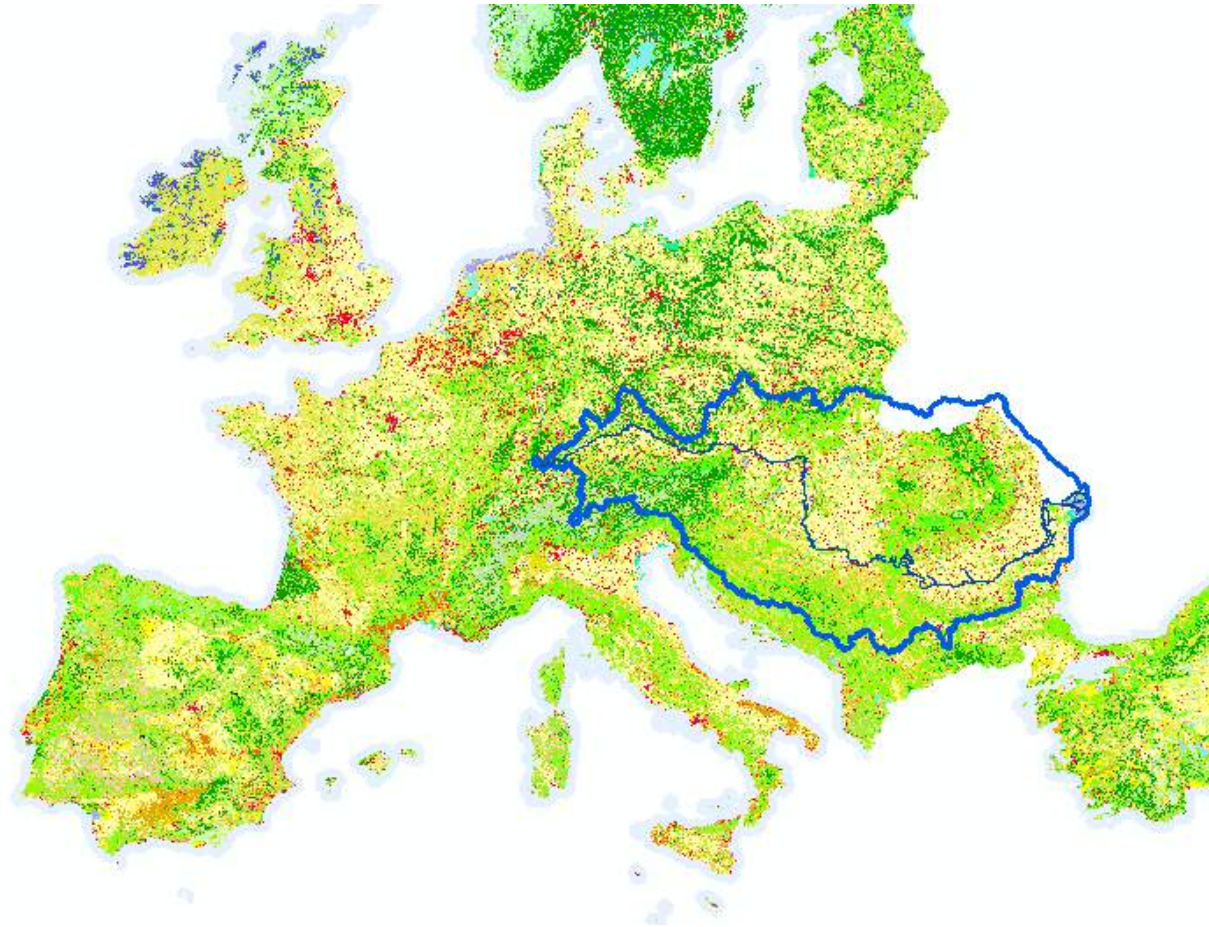
**CORINE (2006)
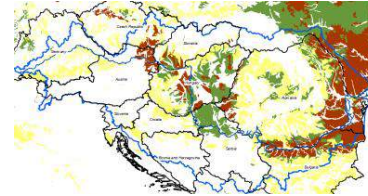land cover map
of Europe;
blue = danube
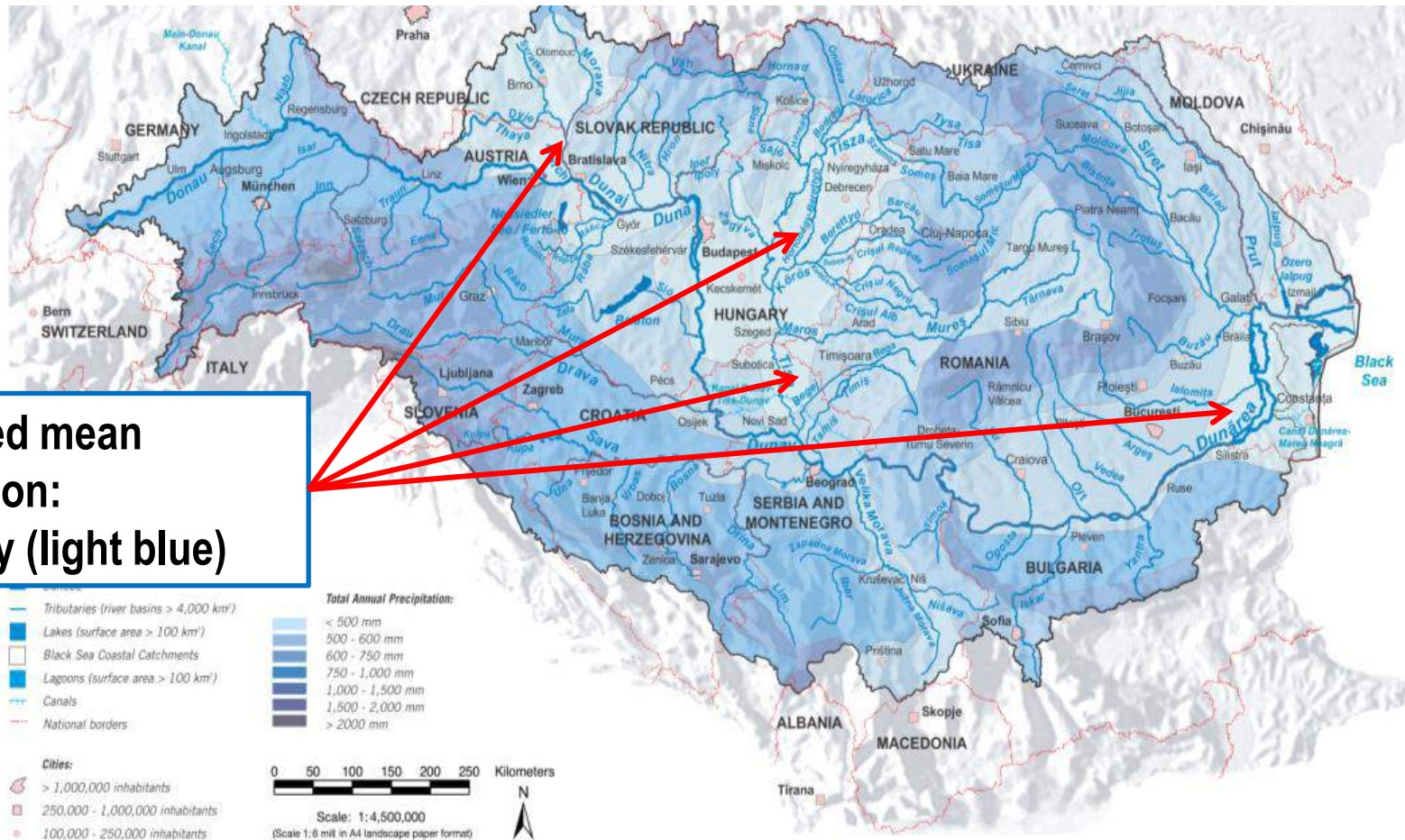basin**

Selection procedure II – Soil typs

Map of soil typs according to WRB (ESDB 2.0)

Legend

brown: Chernozems
yellow: Luvisols*
green: Phaeozems
white: Others

*unclear if this class will remain

Selection procedure III - precipitation

Average annual precipitation (ICPDR 2004)

**Considered mean precipitation:
~ 500mm/y (light blue)**

29/05/2015

Materials

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1. Institute for Environment and Sustainability, European Commission, ISPRA

- ESDB 2.0. (1km x1km; interpolated)

- Soil threats assessments (e.g.: PESERA)

2. CORINE land cover (100m x 100m)

3. ICPDR*

- Hydrological characteristics
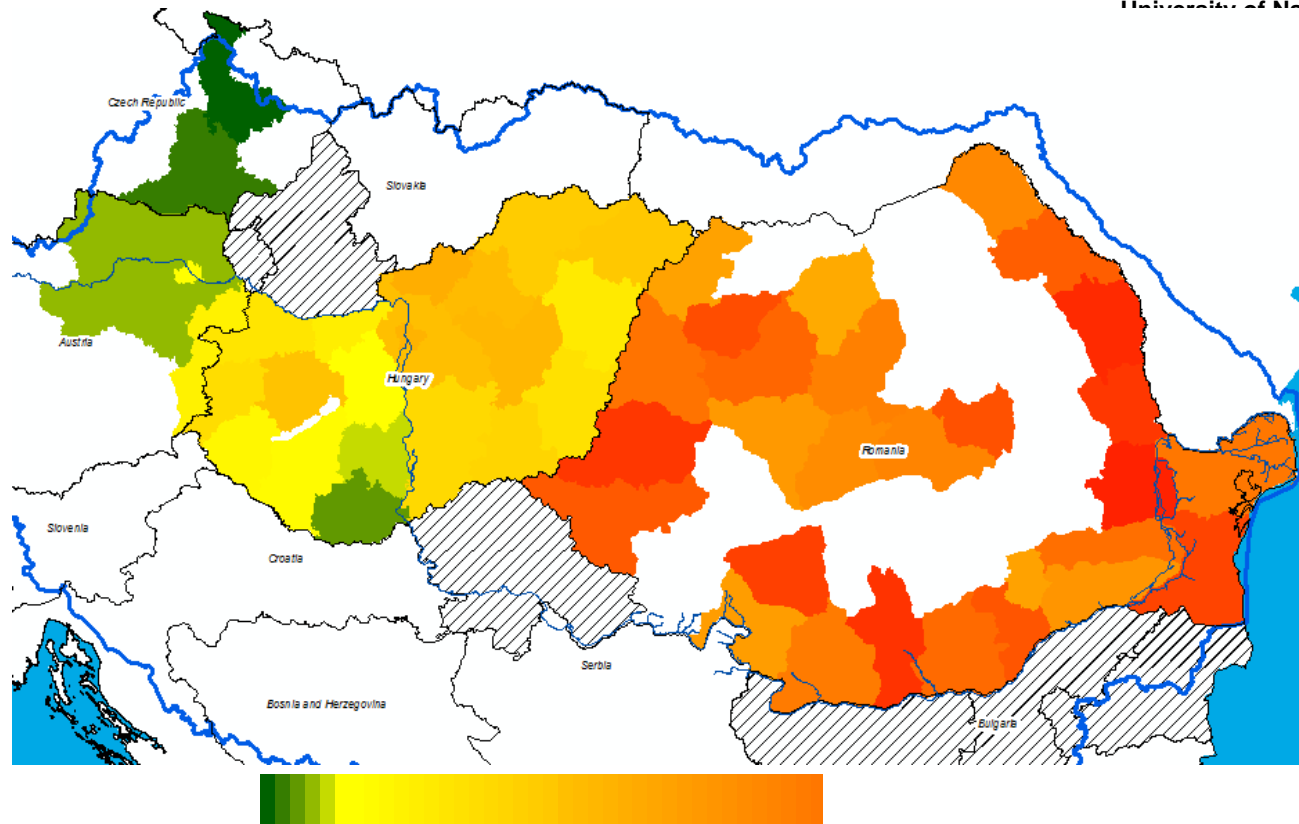
- Diffuse pollution by nutrients (→ Eutrophication)

4. EUROSTAT, FAOSTAT, IFA, national reports (yields, fertilization,…)

5. Yield gap models

- Closing yield gaps through nutrient and water management (Mueller et al. 2012)

- Solutions for a cultivated planet (Foley et al. 2011)

6. ArcGIS for producing maps

* International Commission for the Protection of the Danube River

Deficit of kg N/ha   -30   0   30   50   60   >70