Climate impacts and adaptation challenges in hilly regions of NE-Hungary

MIKA, JÁNOS – LAKATOS, LÁSZLÓ – RÁZSI ANDRÁS, – UTASI Z
EKC(U) EGER

OUTLINE

Changes in renewable energy potential

Grapevine sensitivity to climate anomalies

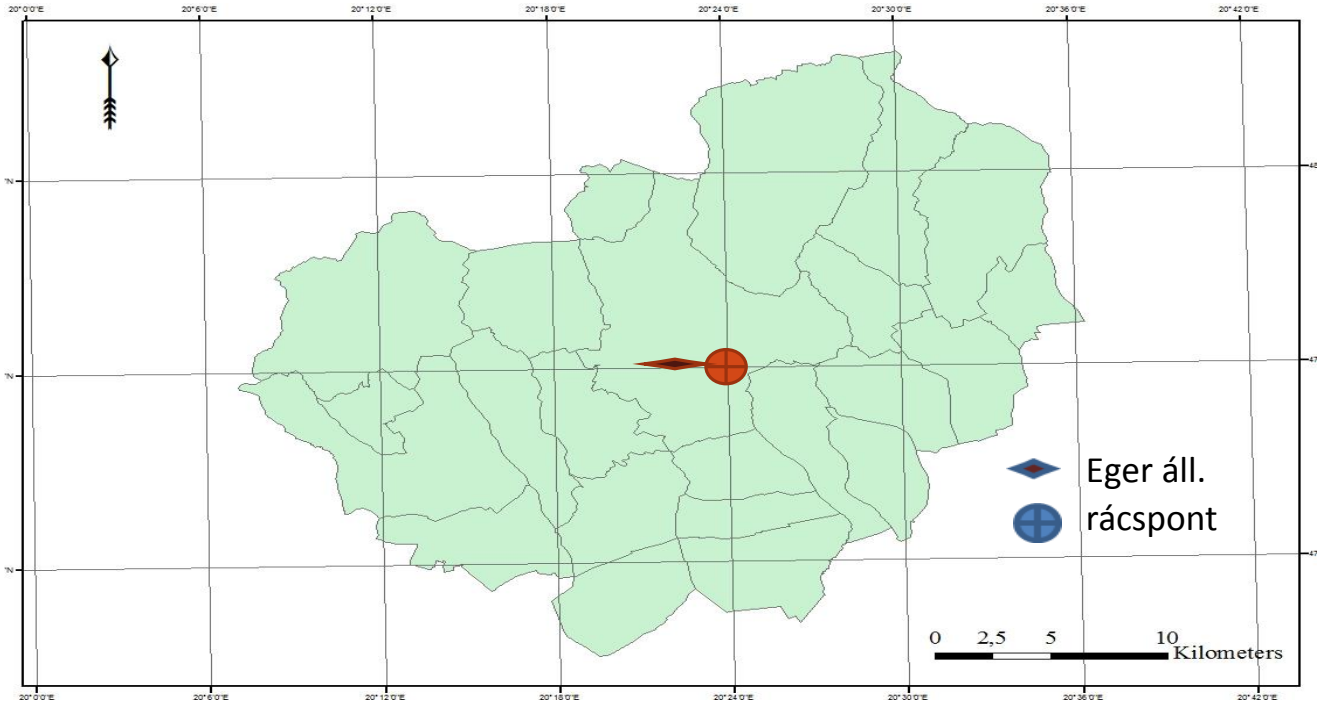
Synthetic judgements I.: Extreme weather impacts

Synthetic judgements II.: Climate change

Conclusion

Solar and wind energy
Data (Carpatclim, NE HU ca. 50x60 km)

Homogenized, interpolated data
0,1 x 0,1 deg. network 1961-2010



Pointwise global radiation and wind speed data in Eger

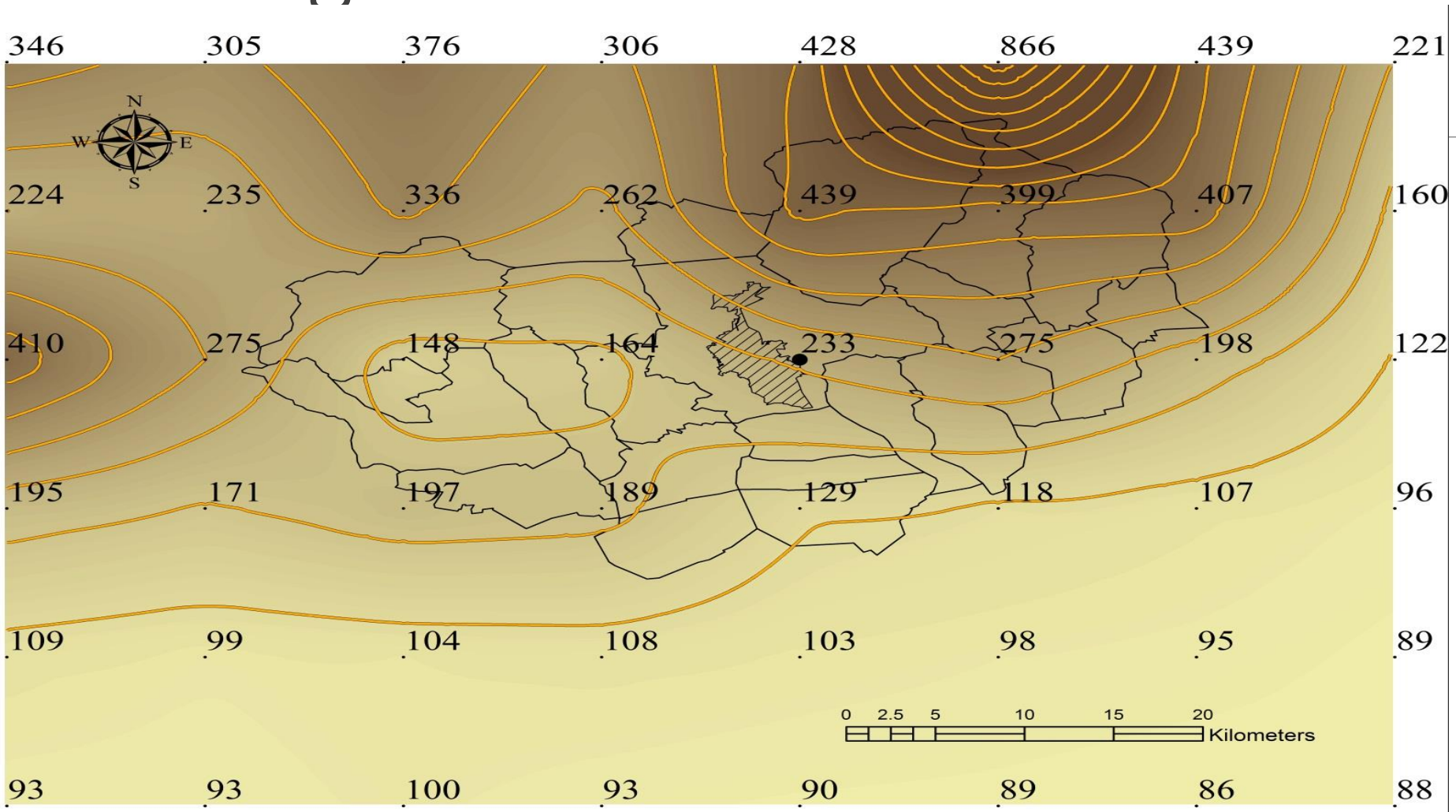
Wind speed (1996-2010): Vaisala sensors, 10 m height

Global radiation (2001-2010): Kipp&Zonnen CM11 pyrano-met. horizontal

Eger (47,9 N, 20, 39 E, 225 m)

Global radiation:
from sunshine duration + wind^3

CarpatClim grid: relief



Regression methods (*local clouds vs. global T*)

Y: clouds

X: NH-Temp

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$$\mathbf{Y(X) = Yo + b \bullet X + \varepsilon}$$

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II. Method of instrumental variables *(MIV)*

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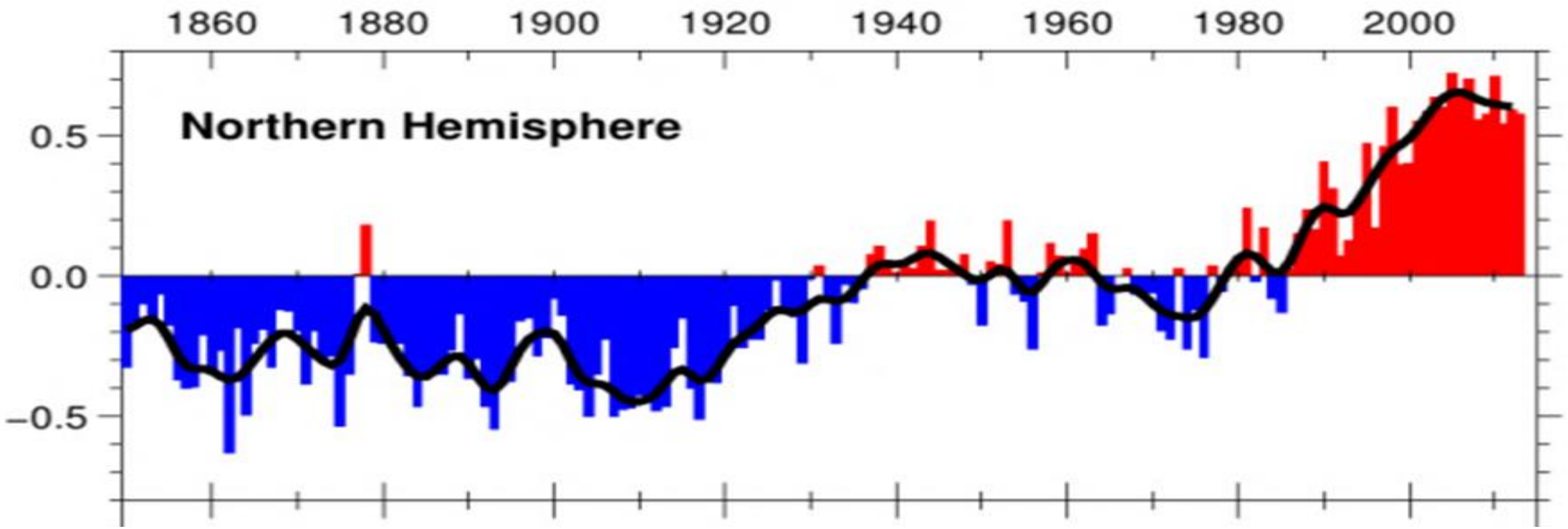
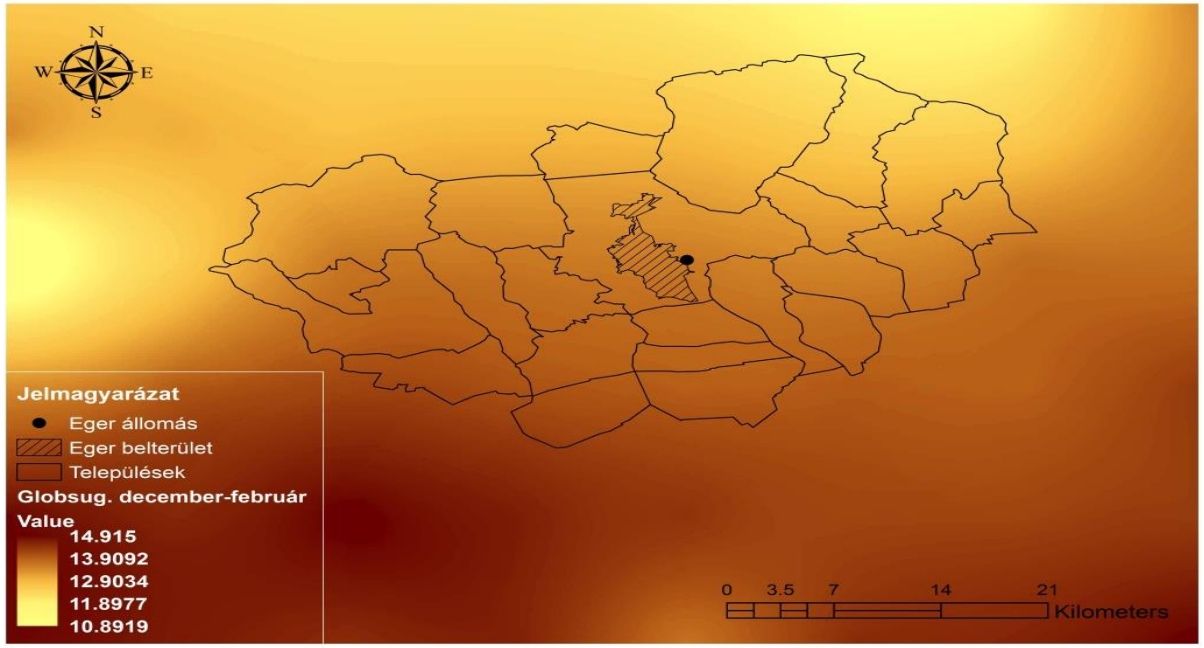
Hemispherical warming: R = 0.695, trend= + 0.017 K/ yr

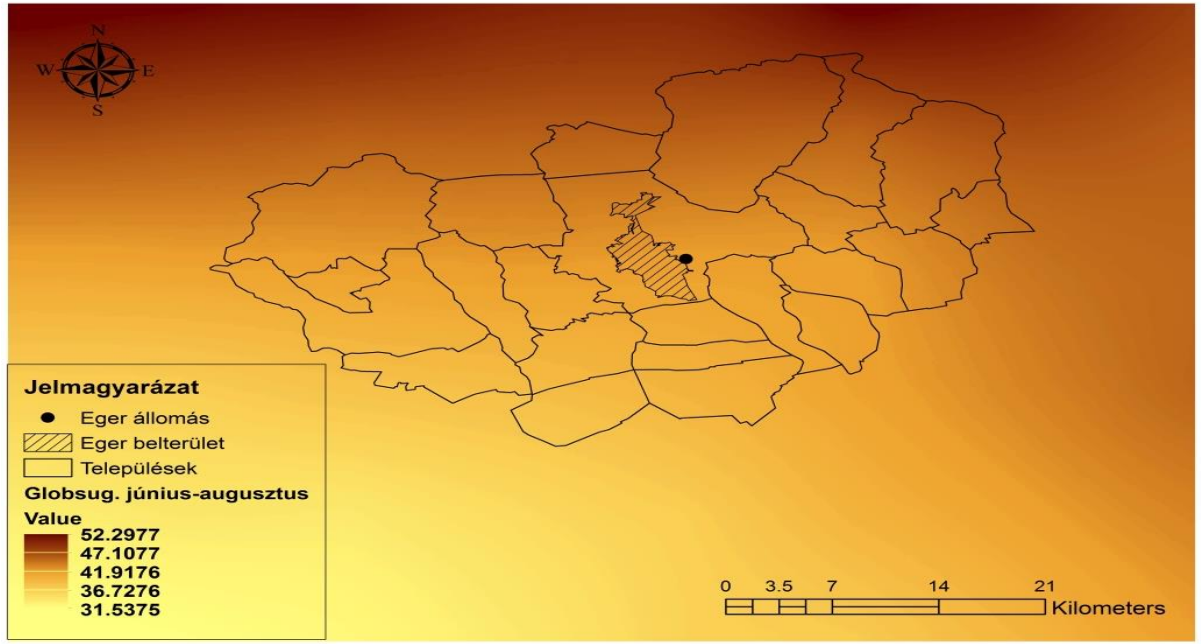
Annual mean temperature



(http://www.cru.uea.ac.uk/cru/data/temperature/#sciref).

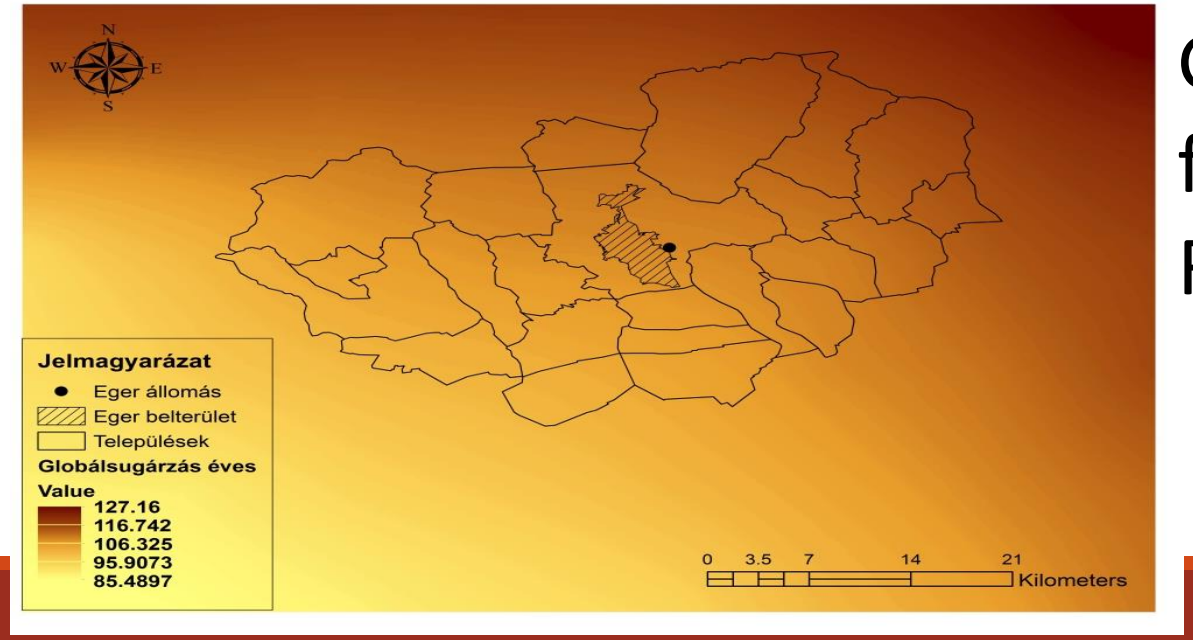


December



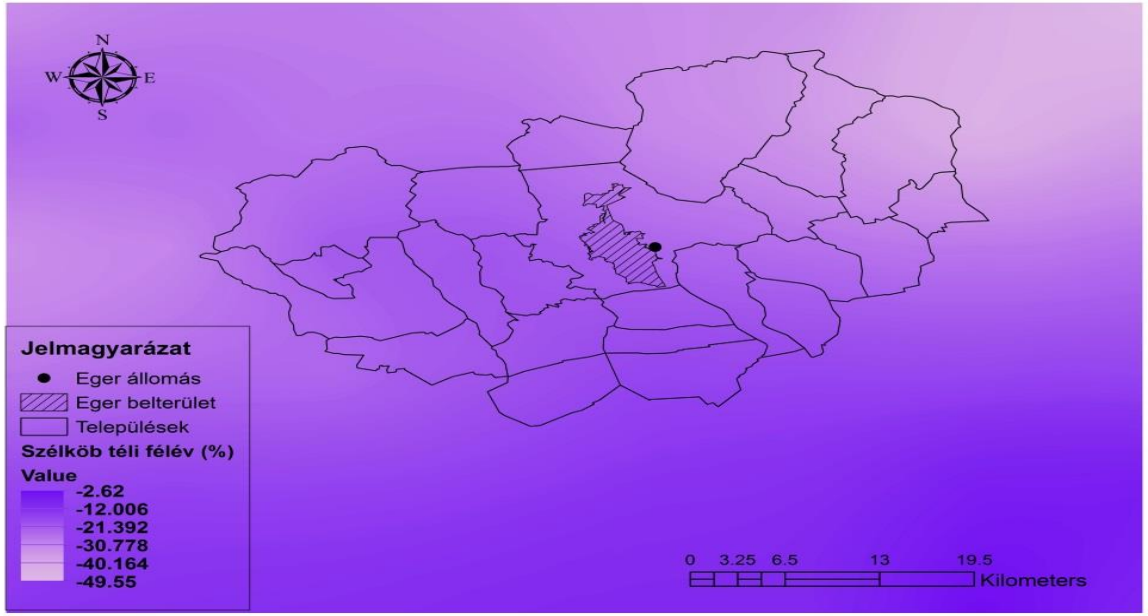
June

Global radiation changes from 1976-2005 normalized For 0.5 K global warming

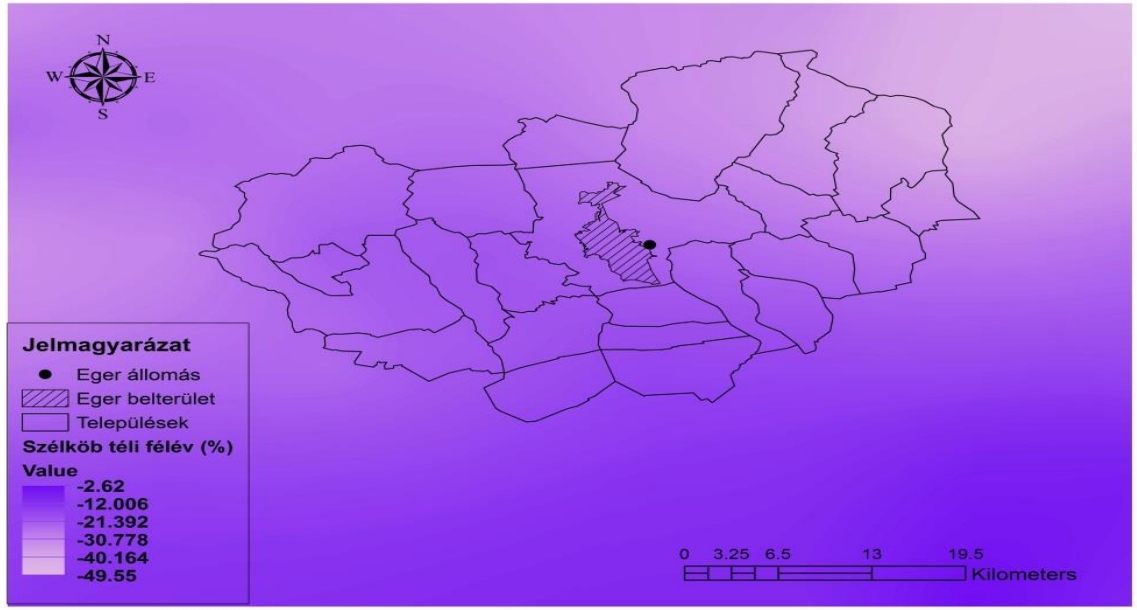


Year

Wind-cube decrease (at 10 m a.s.l.)

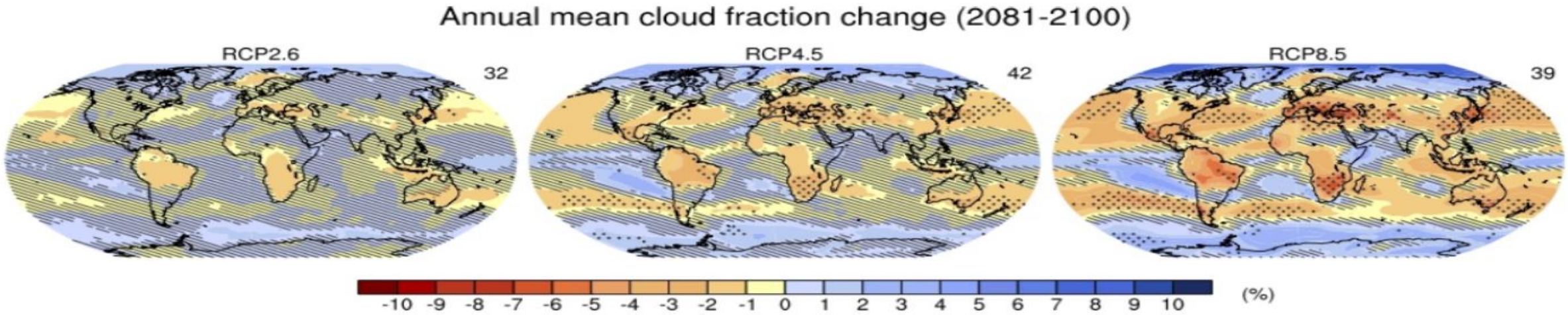


Winter

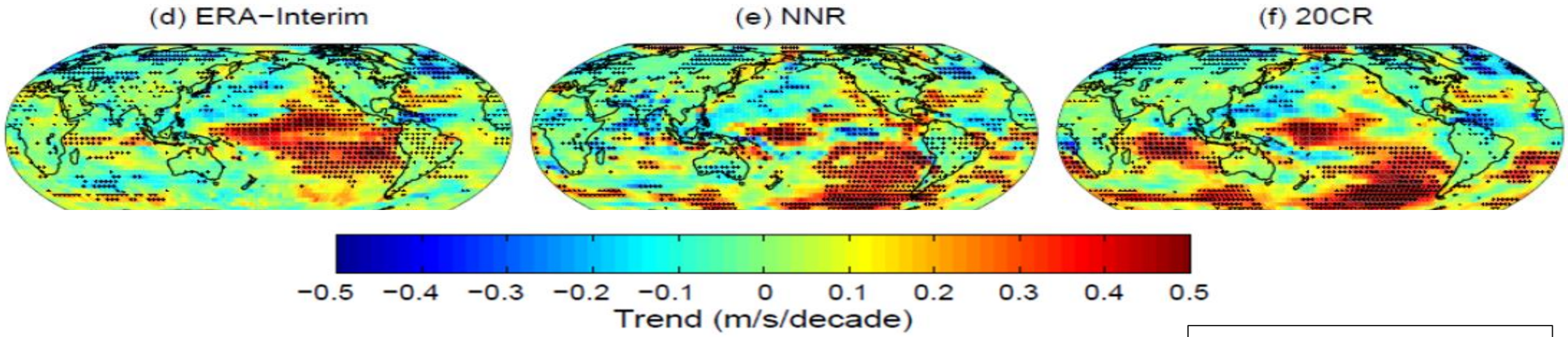


Summer

Data: CarpatClim Project (http://www.carpatclim-eu.org/pages/home/).



Wind-speed reanalyses: trends



Both: IPCC AR5 WGI (2016)

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Two further results (run-off and maize yield)

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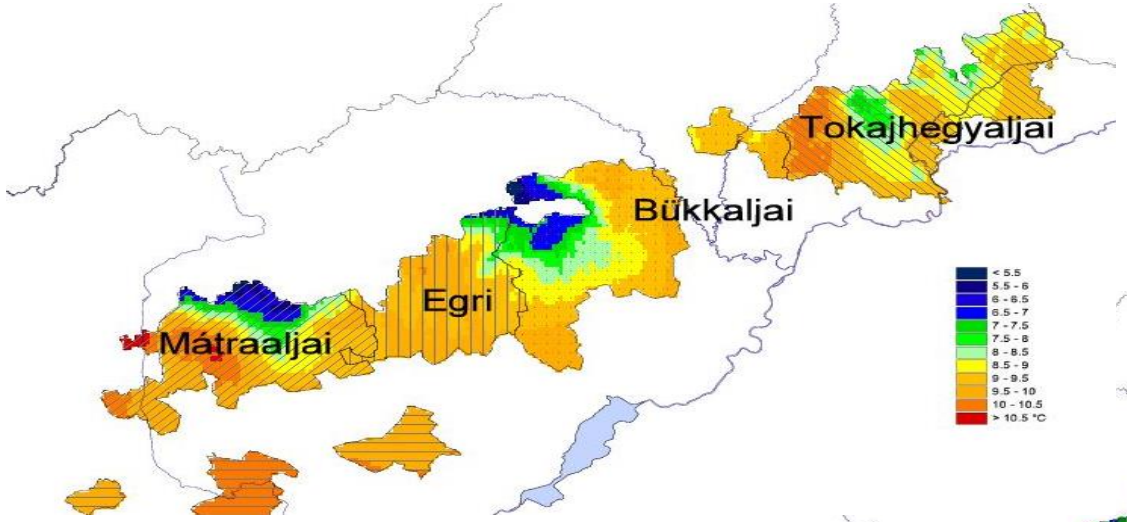
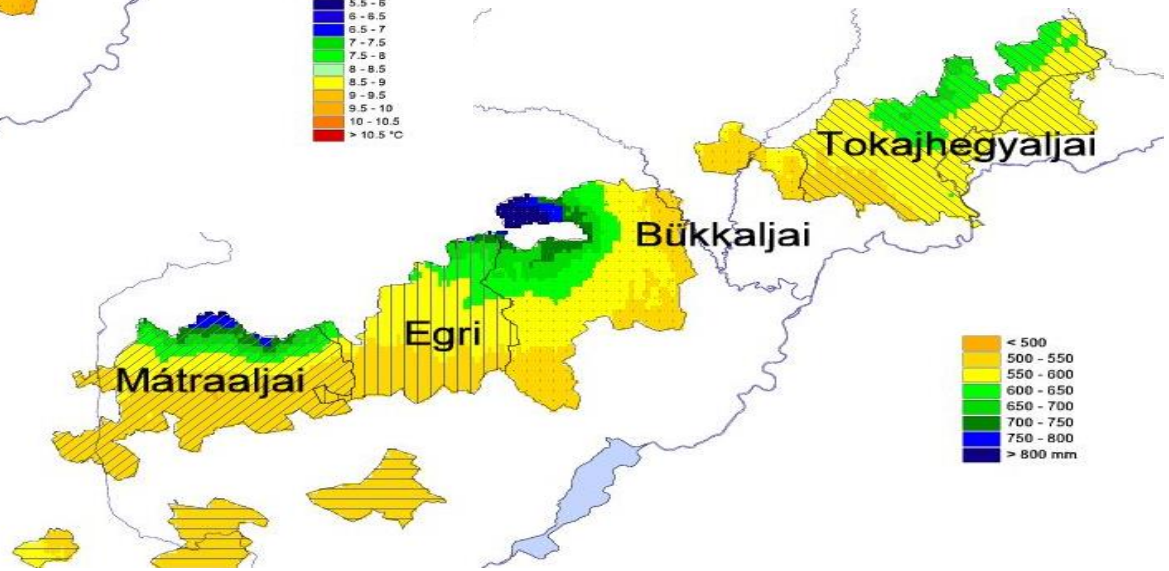
Grapevine quality and quantity (4 regions in NE-HU)

Bihari et al. (2009)



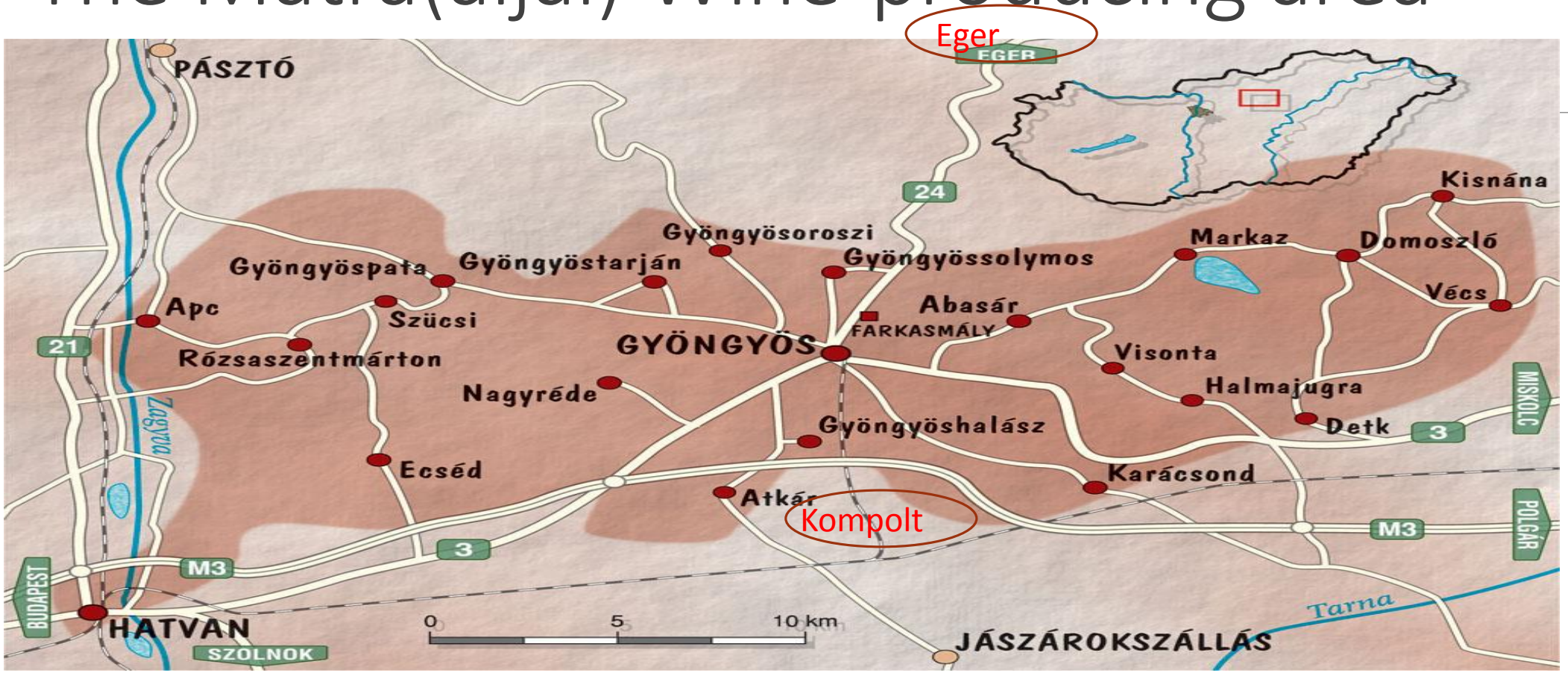
Annual mean temperature
(1961-1990)
57 stations



Annual mean precip.
(1961-1990)
162 stations

Credit to:
OTKA K-113209 support
(2015-2017)

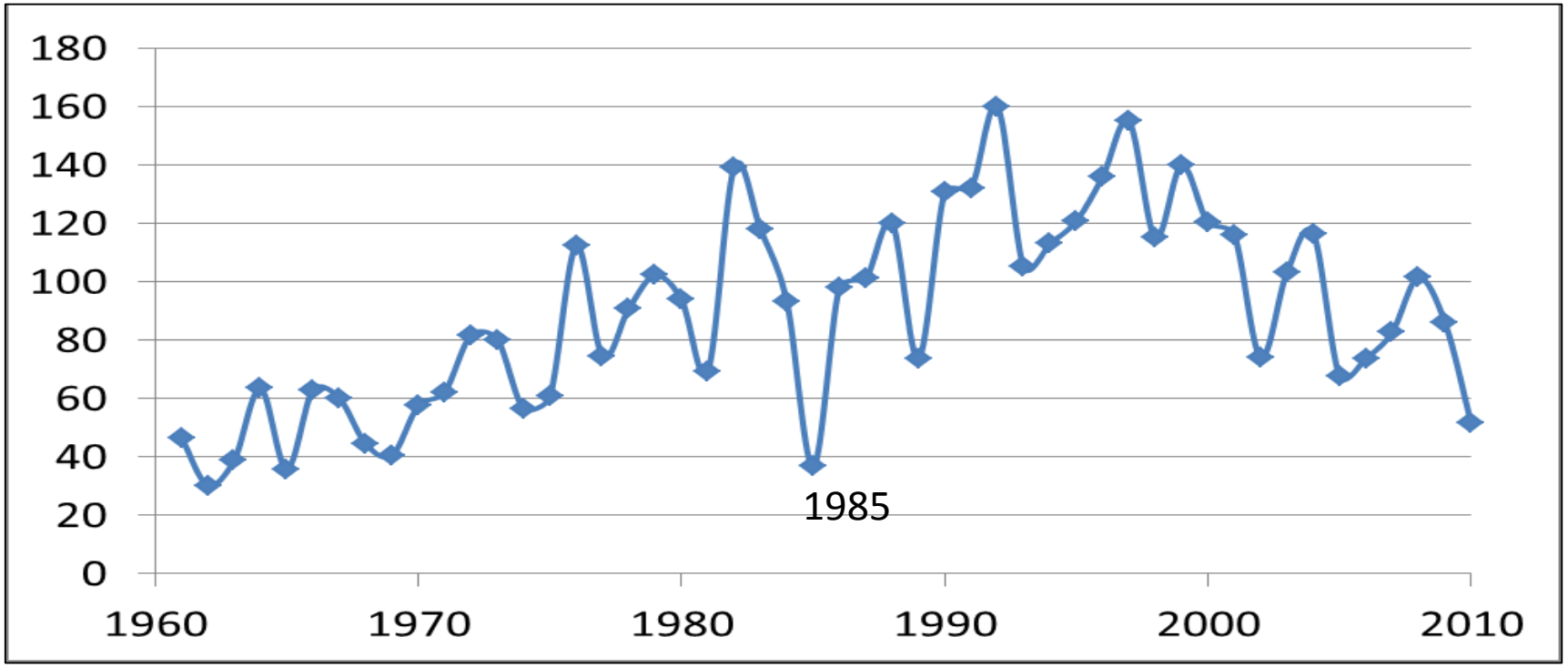
The Mátra(aljai) Wine-producing area



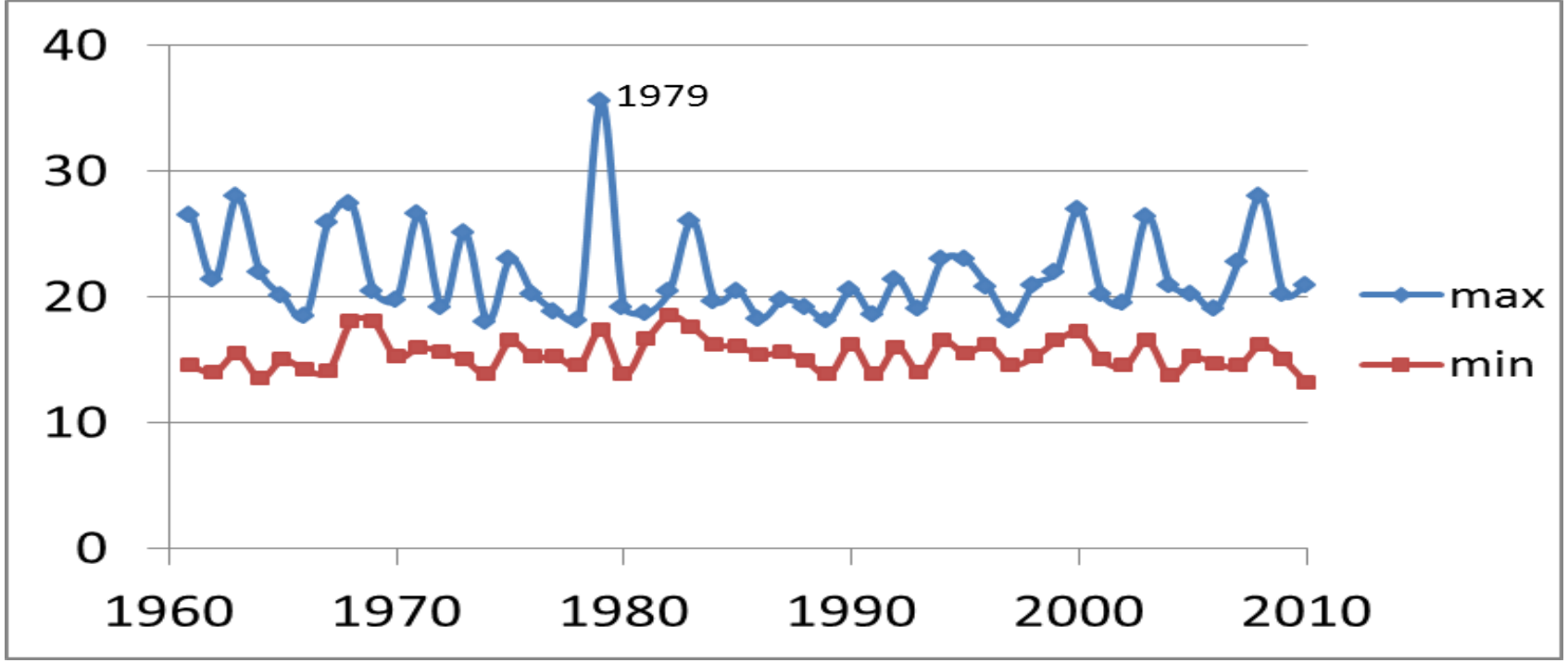
http://aborfesztival.hu

Area 33000 ha, 6000 ha of which is grapevine

Hrapevine yield (quantity)



Mika et al, 2014

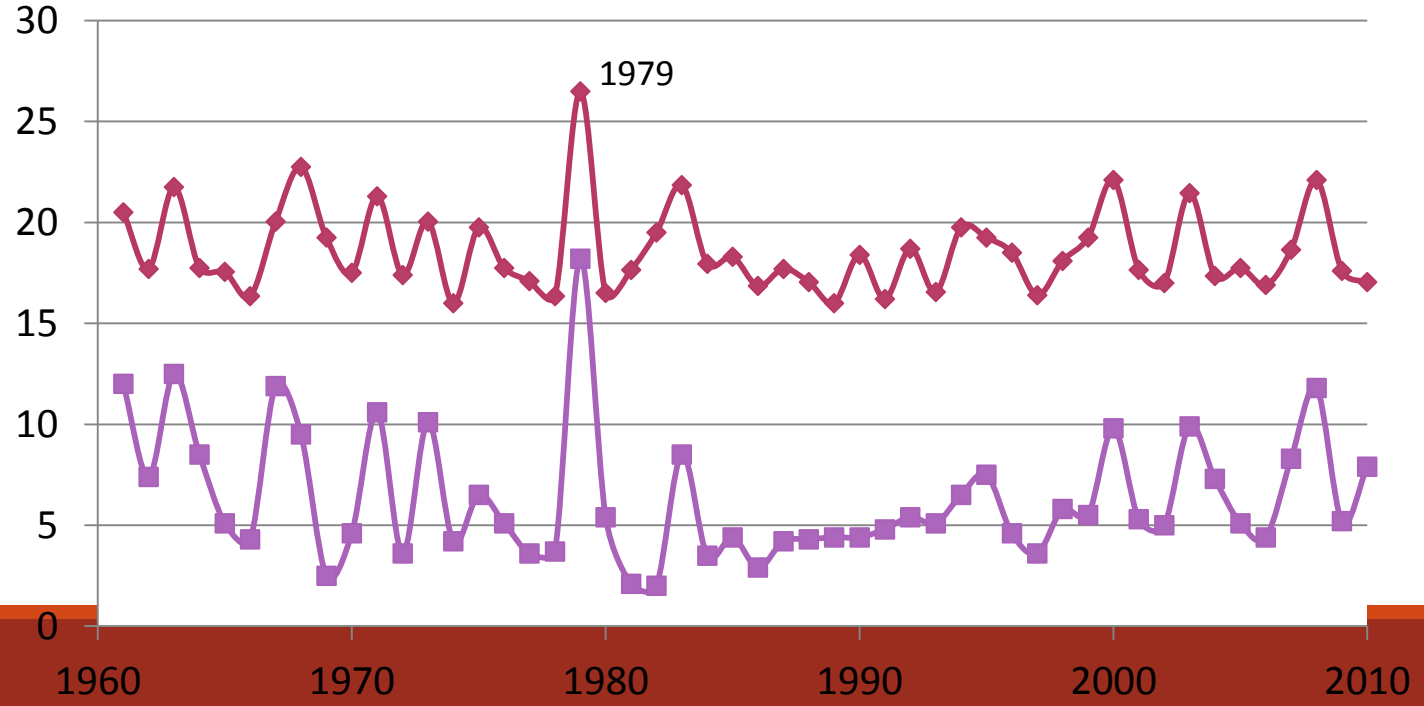


Must sugar content

No reason to divide
the period in this respect!

Mean

Max-min



Potencially 126 variables (50 years) *KOMPOLT station*

X-IX precip, (1, 2, …, 12 monthly)
XI- temp. sum (1, …, 11 monthly)
XI- sunshine duration (1, …, 11 monthly)

Yield quantity (50 év): not to be accepted (managed)
Negative correlation with March-June precip and March April sunshine duration!

126 potential variables stepwise regression.

Must sugar (50 years): significant regression with 2 variables:

JUNE (!) temperature sum és May-Oct sunshine dur.

Correlation coeff: 0.54 with 1 var, 0.62 with thw above two.

Regressions: T_{VI}: **2,9 must deg /100 °C** (mean: 571 °C)

SD_{V-X}: 0,7 must deg/100 hour (mean: 1340 h)

More variables: no significantly improvement (F-test),

but other pairs of variables may also be significant!

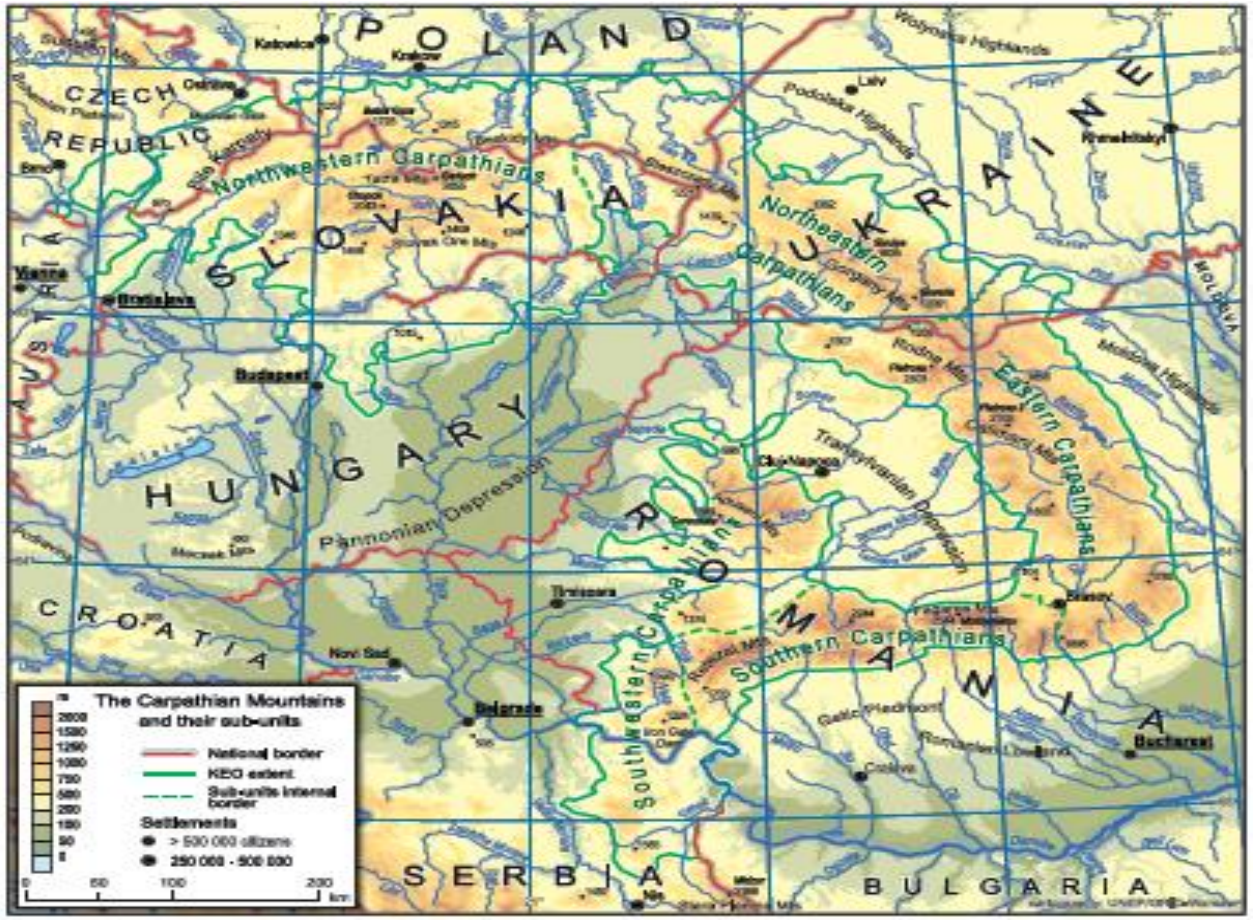
CARPATCLIM DATA

5 Days Temperature and precip data (PILOT STUDY)

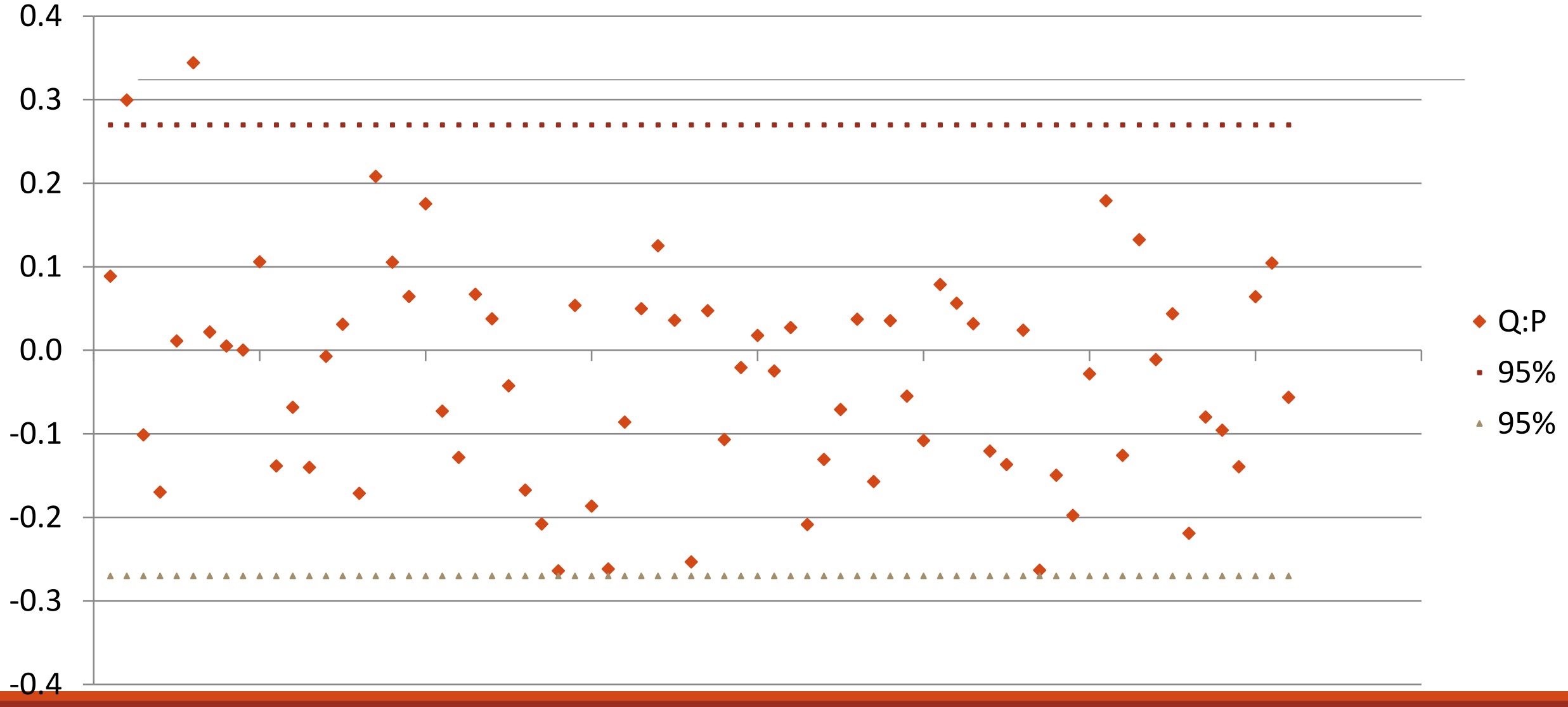
47,7 – 47,8 N 19,7 – 20,1 E

7x11 km

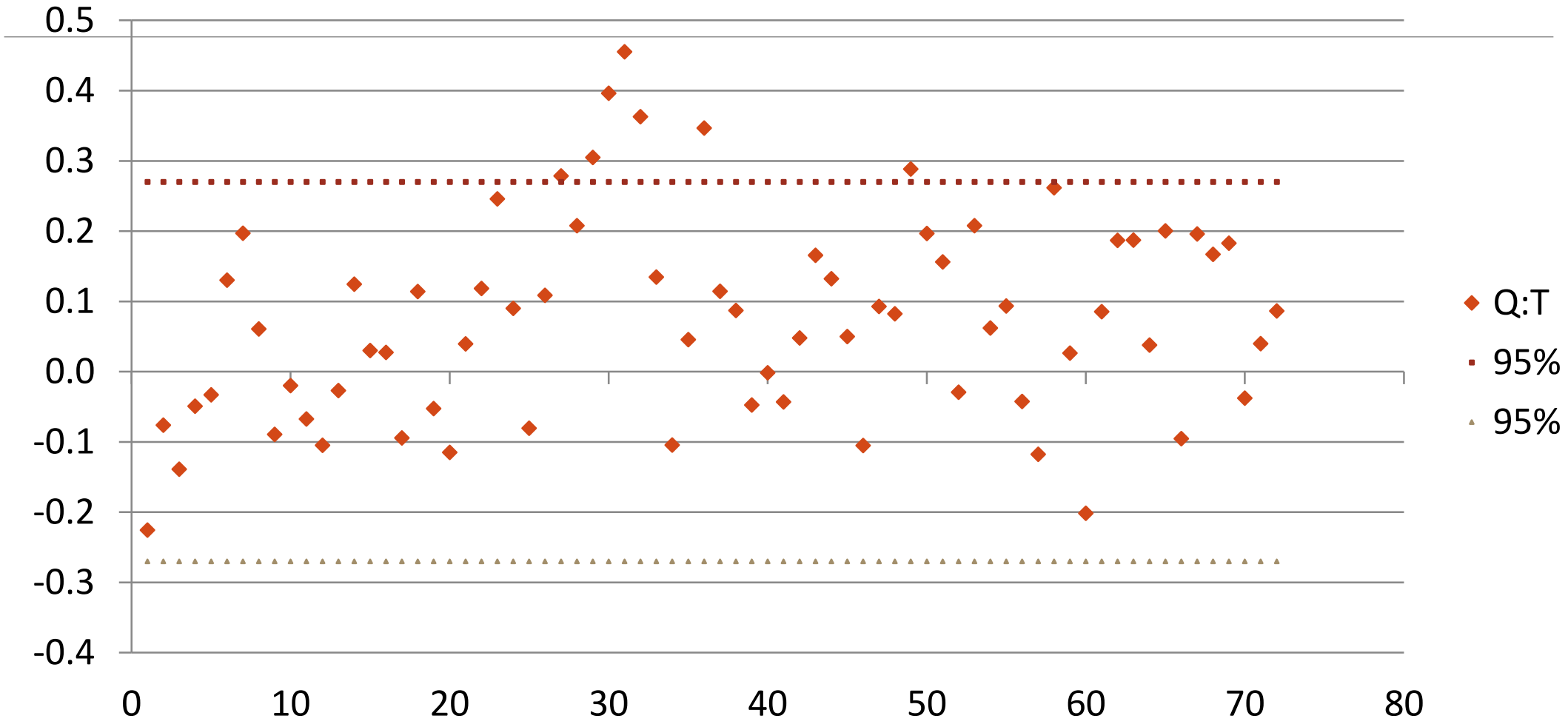
means of 2x5 = 10 gridpoint data covering the Matra region



SUGAR CONTENT of WINE vs. PRECIPITATION



SUGAR CONTENT of WINE vs. TEMPERATURE



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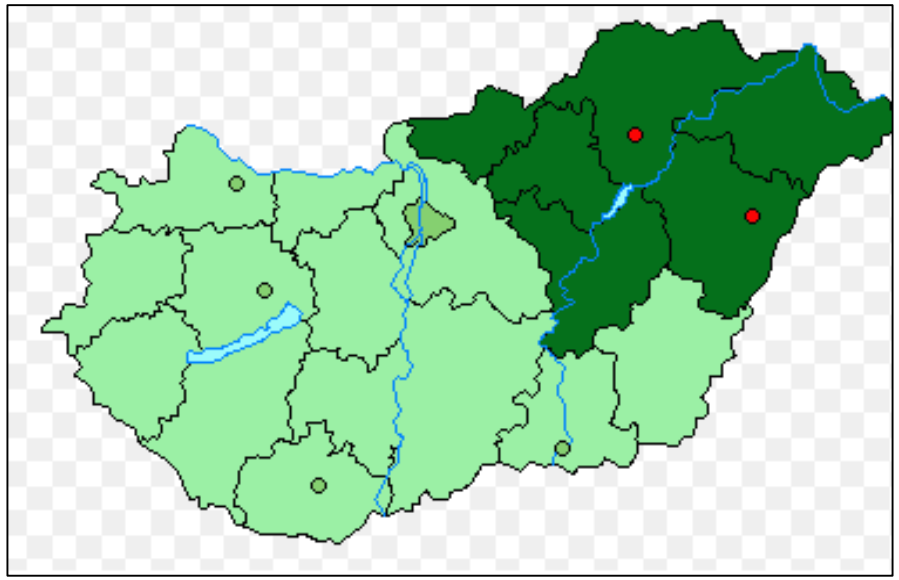
LOCCLIMACT: Northern-Hungary regions



Northern Hungary

Miskolc micro-region

Impacts of weather extremes I.

Table 1. Impacts of climate change on various human activities.
Bold italic: important in Miskolc sub-region,
italic: important in N-E Hungary,
normal set: country-wide.
Proportion of the three sets is equal in the columns and rows for the full matrix joined with Tab. 2, too.

Priority effects	Sectors / Areas relevant to the target region		
	Hydrology, water management	**Natural ecosystems**	**Agriculture, food supply**
Extreme cold day and night	unexpected freezing of lakes	*likely damages (animals)*	damages possible (e.g. winter wheat)
Extreme hot day and night	*increased peak water demand*	damages possible	*risk of damage, overheat of plant*
Long heat wave	*water quality degradation*	*damages possible*	***crop reduction, food safety risks***
Severe drought	***less sources, more demand, water quality***	*green-mass reduction*	***strong crop reduction***
Heavy rainfall, long rain period	***flash flood, water surplus, inundation***	***soil degradation, mudslide, pests***	*soil degradation, crop quality risks*
Heavy snowfall, accumulation	*flood risk possible after melting*	inundation risk, after melting	***inundation risk, after melting***
Evenly bright day	strong evaporation, water quality risk	some plants sensitive to UV	*some plants sensitive to UV*
Thunderstorm, lightning, hail	***danger for devices and workers***	*lightning and hail damage on plants*	***lightning, hail damage: fruit, grape***
Stormy wind, inc. tornado	***tilted slope of lakes, danger for devices***	***wind break of trees possible***	*wind damage possible*
Long lasting lack of wind	water quality problems possible	***enhanced ozone near the roads***	enhanced ozone near the roads
Haze, fog	*lake and river shipping limited*	more plant diseases possible	more plant diseases possible
Freezing rain surface icing	mechanical load on devices	***mechanical damages***	mechanical damages

Impacts of weather extremes II.

Table 2. Impacts of weather extremes on various human activities. ***Bold italic***: important in Miskolc sub-region, *italic*: important in N-E Hungary, normal set: country-wide. Proportion of the three sets is equal in the columns and rows for the full matrix, joined with Tab 1, too

Priority effects	Sectors / Areas relevant to the target region		
	Urban settlements	**Energy and transportation**	**Human health**
Extreme cold day and night	*unexpected energy request*	***enhanced heating, technical problems***	***lives in danger***
Extreme hot day and night	heat alarm, water supply problems	***enhanced cooling, melted roads, traces***	***lives in danger***
Long heat wave	***heat alarm, water supply problems***	enhanced cooling, workers in danger	lives in danger
Severe drought	water supply problems possible	water energy, water traffic limitations	*drinking water*
Heavy rainfall, long rain period	canalisation problems	*low class road damages possible*	rheuma, open air activity risk
Heavy snowfall, accumulation	*too heavy load possible*	***road and train transport in danger***	risk of food availability
Evenly bright day	***photochemical smog possible***	*unexpected melting, car limitation possible*	***more UV- and ozone***
Thunderstorm, lightning, hail	mechanical and lightning damage	mechanical and lightning damage	*lightning, heart risks*
Stormy wind, inc. tornado	*mechanical damage possible*	mechanical damage possible	mechanical danger
Long lasting lack of wind	***increased air pollution possible***	*engine use reduction possible*	*risk of air pollution*
Haze, fog	***London-type smog possible***	*reduced speed, engine-use limitation*	***risk of air pollution***
Freezing rain surface icing	*bus and car transport at risk*	***electric wires at risk, road transport at risk***	*leg and arm breaks risk*

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Climate change impacts I.

Table 4. Impacts of climate change on various human activities. ***Bold italic***: important in Miskolc sub-region, *italic*: important in N-E Hungary, normal set: country-wide. Proportion of the three sets is equal in the columns and rows for the full matrix joined with Tab. 5, too.

Priority effects	**Sectors / Areas relevant to the target region**		
	Hydrology, water management	**Natural ecosystems**	**Agriculture, food supply**
Increased temperature in all seasons	worse water balance, intensified chemical, biological processes	***phenologic shifts more yield and invasive species***	*phenologic shifts more yield, where enough rainfall*
Less extreme cold days and nights	less unexpected freezing of lakes,	*more productive yield, where enough rainfall*	***better and more evenly crop yield and quality***
More extreme warm days and nights	*more water quality and peak water supply problems*	***reduced biomass possible, some plants in stress***	reduced crop yield, problems in food treatment
Longer heat waves in summer	*stronger water quality and supply problems,*	more tourist load, reduced biomass possible	***reduction in crop yield, problems in food treatment***
Less rainfall in the warm half of the year	***more low level cases in rivers, less water energy and supply***	*phenological shifts, loss of yield and biomass possible*	***reduction in crop yield, but better quality of e.g. wine***
Longer dry periods, more drought	***stronger water quality and supply problems, enhanced demand***	loss of biomass production and carbon store	*reduction in crop yield and livestock*
More heavy, even torrential rain	***wider spread of water level in rivers, lakes, more flash floods***	*faster soil erosion and more lightning may cause losses*	the faster soil degradation may lead to crop loss
Less snowy days, shorter snow cover	*possibly less frequent spring flooding in average*	***longer vegetation period, less soil moisture in spring***	longer vegetation period, less soil moisture in spring
More sunshine (less clouds) in summer	enhanced areal, lake evapotranspiration and water chemistry	more productive yield, where enough rainfall	*better fruit, grape quality, enhanced photosynthesis*

Climate change impacts II.

Table 5. Impacts of climate change on various human activities.
Bold italic: important in Miskolc sub-region,
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Proportion of the three sets is equal in the columns and rows for the full matrix joined with Tab. 4, too.

Priority effects	Sectors / Areas relevant to the target region		
	Urban settlements	**Energy and transportation**	**Human health**
Increased temperature in all seasons	heat island surplus starts from higher temperature	***less energy needs for heating, but more for cooling***	*new pests, vector-born diseases*
Less extreme cold days and nights	less insulation is enough in walls and windows	*less energy supply and transport challenges*	***good for ill people, more pests survive***
More extreme warm days and nights	***more heat alarms, water supply and quality problems***	*more energy for cooling, pavement and trace melting*	risks for ill people and for healthy ones
Longer heat waves in summer	*stronger insulation is needed, water supply at risk*	overheated energy and transport infrastructure risk	***risks for ill people, shift in pollen peak***
Less rainfall in the warm half of the year	less water supply and wet deposition, high concentration	less water energy available, more dry days on roads	*shift in pollen peak, less epidemics*
Longer dry periods, more drought	*water supply and quality problems, more air pollution*	less water energy and shipping is possible	***air- and water quality risks***
More heavy, even torrential rain	***canalisation needs and lightning safety requests increase***	*more temporal and persistent road traffic problems*	cardiovascular ill people at risk in electric field
Less snowy days, shorter snow cover	*advantage for urban transport and hygiene*	***good for road traffic, more heating due to less roof insulation***	less polluted, black snow
More sunshine (less clouds) in summer	***more summer smog and solar energy***	***more solar energy, but more pavement and trace melting***	*UV radiation risk increase, additional heat*

Conclusion:

- Emprical regressions: less wind but more solar energy in an N-Hu region parallel with the recent global wearming. These signs and magnitudes are in coincidence with GCMs and re-analyses.
- Unequivocal impact on wine (must) quality, but not for grapevine yield due to intervention to yield amount. For must sugar content the highest significance is provided by June temperature sum and May-October sunshine duration. Other combinations are also useful for combination with RCM projections.
- Synthetic judgement table is collected for 12 weather extremes in 6 impact sectors. A separation from country-wide to micro-region relevance is also given
- The same 6 sectors are qualitatively assessed as affected by 9 features of projected climate change.
- Combination of each above problems and empirical/expert trials with ensembles of RCM based projections would increase their scientific value

Thank you for your attention!

mikaj@ektf.hu