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Long-term comparison of climatological variables used for agricultural land appraisement

Hana STŘEDOVÁ[1], Tomáš STŘEDA[2], Jaroslav ROŽNOVSKÝ[3]

[1] Department of Applied and Landscape Ecology, Mendel University in Brno
Zemědělská 1, 613 00 Brno, Czech Republic; e-mail: hana.stredova@mendelu.cz

[2] Department of Crop Science, Breeding and Plant Medicine, Mendel University in Brno
Zemědělská 1, 613 00 Brno, Czech Republic; e-mail: streda@mendelu.cz

[3] Czech Hydrometeorological Institute, Brno – Branch Office
Kroftova 43, 616 67 Brno, Czech Republic; e-mail: roznovsky@chmi.cz

Abstract: Official price of farmland in the Czech Republic is based on land value in different soil and climatic conditions. The paper compares relevant climatic and agroclimatic characteristics used for land appraisement. Characteristics defined in climatic region of estimated pedological ecological unit system for two fifty years period 1901–1950 and 1961–2010 were evaluated. Area of interest includes 53 points distributed within nine broad areas of the Czech Republic. It is evident that the development of climate has an enormous impact on soil fertility. Difference of station average values of air temperature of both fifty years vary from -0.5 to $1.1\,^{\circ}$C (mean difference is $0.3\,^{\circ}$C) in the case of vegetation period. The shift of precipitation is not so evident as in the case of temperature. The long term change in precipitation distribution within a year is documented by a different shift of annual, vegetation period and non-vegetation period values. Moisture certainty in vegetation period decreases in all cases of broad areas (except one region). All 50year averages of investigated parameters had been changed in 1961–2010 compared to the mean of 1901–1950. This should be taken into account when fixing the official price. Climatic region parameters should be replaced by a more complex "agroclimatological characteristic", which take into account also the basic pedological and plant characteristics, for example the available water holding capacity.

Key words: estimated pedological ecological unit, climatic region, moisture certainty, precipitation, air temperature

1. Introduction

Agricultural land is a differentiated good whose characteristics vary across parcels with land uses, building structures, soil and local climate (*Palmquist,*

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1989). Land prices differ along with these characteristics. Land valuation abroad has a large extent in each country apart. On the one hand, there are countries where pricing is regulated by law. Examples include Germany, where the code (alternatively adequate notice of valuation) defines the standard procedures (substantive, comparative yield method based on temporary annuity). The legislation provides only a framework (basic methods). On the other hand, in the United Kingdom the valuation is based not only on existing laws, but on particular precedents and technical standards. In the United States a hedonic analysis is used for land valuation. Hedonic analysis, a revealed preference valuation method, uses multiple regression to infer the economic value of changes in specific land characteristics from their effects on prices, in this case the price of agricultural land (*Ma and Swinton, 2011*). Other studies constructed variables from landscapes and natural resources to measure the amenity value from farmland. *Bastian et al. (2002)* used GIS data to measure recreational and scenic amenities associated with rural land in the USA. *Drescher et al. (2001)* created a county-level natural amenity index using climate, topography, and water conditions to capture farmland prices in Minnesota, USA.

Land market in the Czech Republic (CR) traditionally uses two kinds of prices. Market prices are formed by supply and demand and vary from 80 to 110 thousand CZK per hectare. An official price is used for tax purposes, for the sale and purchase of land owned by the state and in frame of the land adjustments etc. Actualization of the official prices is based mainly on qualitative changes in soil properties and subsequent changes of estimated pedological ecological unit (EPEU) system. EPEUs were determined by Complex pedological survey realized in the period of 1973–1980 (*Mašát et al., 1974*) for the whole area of former Czechoslovakia. EPEUs in CR are defined as a five position numeral code which expresses the main pedological and climatic conditions influencing production potential and economical evaluation of the soil. EPEU system is an integral part of the national legislation in the form of Regulation of Ministry of agriculture no 327/1998 Coll., Assessment of EPEU characteristics and method of their actualization.

Except for the land appraisement, the EPEU system is used for assessment of payment on land exemption from agricultural land fund, assessment of erosion intensity (in the case of water erosion for the factor of soil erodibility determination and in case of wind erosion for estimation of potential risk areas) and for suggestion of new plots in frame of land adjustment to judge a homogeneity of proposed plots.

The structure of EPEU code is as follows: 1st position means a climatic region CReg. (0–9), which is defined as an area with approximately same climatic conditions for crop growing and development; 2nd and 3rd positions the mean main pedological unit (01–78) i.e. special-purpose groups of soil types with common ecological properties; 4th position deals with slope and exposure and the 5th with soil profile depth and a skeleton content.

EPEU climatic zonation (i.e. CReg. definition) was carried out for the period of 1901–1950 and is based on long term climatic factors significant from agricultural point of view i.e. climatological variables (*Středová et al., 2011*). It represents the characteristics of vegetation period (VP) of agricultural crops and parameters influencing natural yields in long term perspective. The basic criteria for CReg. determination are as follows: temperature sum above 10 °C, mean annual temperature, mean annual precipitation total, probability of dry VP and moisture certainty in VP. So the determination of CReg. is based on both the temperature and precipitations as well as on their combination.

Many studies in various areas of science deal with the term (agro)climatological variables. *Perry and Hollis (2005)* used 36 climatic parameters to describe climatological variables over the United Kingdom. As well as the usual elements of temperature, rainfall, sunshine, cloud, wind speed, and pressure, derived temperature variables (such as growing-season length, heating degree days, and heat and cold wave durations) and further precipitation variables (such as rainfall intensity, maximum consecutive dry days, and days of snow, hail and thunder) they analyzed. On the basis of temperature and rainfall the meteorological drought can be estimated. Some of the commonly used drought definitions stated *Mishra and Singh (2010).*

2. Material and methods

This work is aimed at a long-term development of agroclimatological parameters used for land appraisement i.e. characteristics defining the CReg of EPEU system. Individual localities of interest represent different land price categories (Fig. 1) and different climatic conditions as well (Table 1).

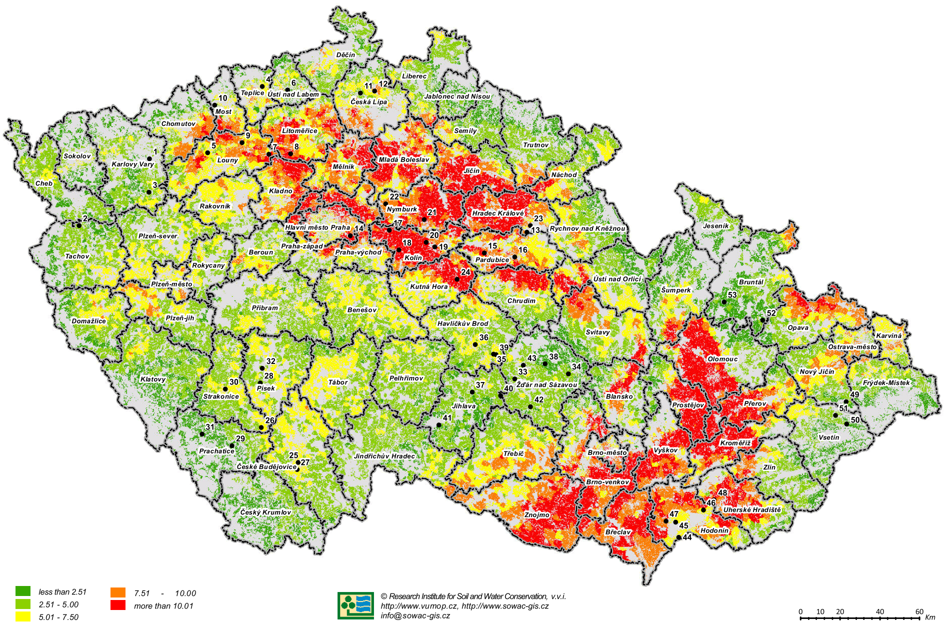

Fig. 1. Map of official land prices with localities of interest marked.

As has been already mentioned the CReg. determination is based on several parameters:

a) *Temperature sum above 10 °C* (i.e. the long-term mean annual sum of daily air temperature exceeding or equal to 10 °C).

b) *Mean annual temperature*

c) *Mean annual precipitation total*

d) *Moisture certainty in VP.*
The moisture certainty is generally given by a difference between an annual limit of drought and a long-term annual precipitation total divided by a long-term mean annual air temperature. The limit of drought is defined by a formula:

$$p_{\mathrm{a}} = 3 \times (t + 7),$$

where:
P_a – precipitation total characterized the limit of drought (cm),
t – long-term mean annual air temperature.

This formula is analogous to the Köppens characterization defining the borders between desert and steppe climate ($p_a = t + 7$) and between steppe and wood climate $p_a = 2 \times (t + 7)$. The above-mentioned formula $p_a = 3 \times (t + 7)$ defines the lower limit of so-called field crops climate. Moisture certainty is thus an amount of precipitation exceeding the limit of drought per every one centigrade of mean annual air temperature. To judge an agro-climatological suitability the characteristics of PV are more important. Assessment of moisture certainty in VP according to *Mašát et al. (1974)* methodology is based on the assumption of the ratio of long term mean annual precipitation total and annual limit of drought is equal to the ratio of long term mean precipitation total in VP and limit of drought in VP (VP means the months from April to September in this case).

$$P_a/p_a = P_{VP}/p_{VP}$$

and thus

$$p_{VP} = (P_{VP} \times p_a)/P_a,$$

where:
p_{VP} – limit of drought in VP,
P_{VP} – long-term mean precipitation total in VP,
p_a – long-term annual limit of drought,
P_a – long-term annual precipitation total.

e) *Probability of dry VP*
(i.e. the percentage of years when the precipitation total in VP was lower than the limit of drought in VP)

Comparison of historical and actual data was carried out. Historical data from the period 1901–1950 were digitalized from the "Podnebí Československé socialistické republiky: tabulky" – *The Climate of Czechoslovak Socialist Republic: Tables (1961).* Climatic tables contain the data of mean annual and mean monthly air temperatures and precipitation totals (as an average for fifty year period 1901–1950) for more than 200 stations.

Table 1. Detailed description of evaluated localities (stations and relevant grid points)

Broad area	Locality No.	Climatological station	Altitude	Latitude	Longitude	Creg.
KV	1	Doupov	580	50.2500	13.1333	7
KV	2	Chodová Planá	563	49.9000	12.7167	7
KV	3	Žlutice	504	50.1000	13.1667	5
ZAT	4	Teplice (Trnovany)	228	50.6500	13.8500	1
ZAT	5	Žatec	255	50.3167	13.5333	1
ZAT	6	Ústí n. L.	186	50.6500	14.0333	1
ZAT	7	Peruc	333	50.3500	13.9667	1
ZAT	8	Mšené-Lázně	220	50.3667	14.1167	1
ZAT	9	Lenešice	181	50.3833	13.7667	1
ZAT	10	Ervěnice	234	50.5333	13.5333	1
ČL	11	Česká Lípa	285	50.6833	14.5500	5
ČL	12	Zákupy	286	50.7000	14.6500	5
POL	13	Vysoká nad Labem	275	50.1500	15.8500	3
POL	14	Uhříněves	295	50.0333	14.6167	2
POL	15	Přelouč	218	50.0333	15.5667	3
POL	16	Pardubice	226	50.0333	15.7833	3
POL	17	Liblice	227	50.0833	14.8833	2
POL	18	Kouřim	270	50.0000	14.9667	3
POL	19	Kolín	203	50.0333	15.2167	2
POL	20	Nová Ves (Velim)	200	50.0500	15.1500	2
POL	21	Poděbrady	180	50.1500	15.1167	2
POL	22	Lysá n. Labem	192	50.2000	14.8333	2
POL	23	Hradec Králové	278	50.1833	15.8667	3
POL	24	Čáslav	249	49.9000	15.4000	3
SUM	25	České Budějovice	383	48.9833	14.4667	5
SUM	26	Libějovice	468	49.1167	14.1833	7
SUM	27	Litvínovice	391	48.9500	14.4667	5
SUM	28	Písek	373	49.3167	14.1333	5
SUM	29	Prachatice	600	49.0167	14.0000	8
SUM	30	Strakonice	400	49.2667	13.9000	5
SUM	31	Vimperk	686	49.0500	13.7833	9
SUM	32	Vráž	453	49.3833	14.1333	7
VYS	33	Bohdalov	575	49.4833	15.8833	7
VYS	34	Bystřice n. Perštejnem	554	49.5333	16.2500	7
VYS	35	Dobrá (Keřkov)	490	49.5833	15.7167	7
VYS	36	Havlíčkův Brod	455	49.6167	15.5833	7
VYS	37	Jihlava	526	49.4000	15.6000	7
VYS	38	Nové Město na Moravě	614	49.5667	16.0833	8
VYS	39	Přibyslav	483	49.5833	15.7333	7
VYS	40	Řehořov	567	49.4000	15.8000	7
VYS	41	Řídelov	636	49.2333	15.4000	8
VYS	42	Velké Meziříčí	440	49.3667	16.0167	7
VYS	43	Žďár nad Sázavou	580	49.5500	15.9333	8
JMO	44	Hodonín	169	48.8500	17.1333	0
JMO	45	Dubňany	190	48.9167	17.1000	0
JMO	46	Bzenec	204	48.9833	17.2833	0
JMO	47	Mutěnice	204	48.9167	17.0333	0
JMO	48	Polešovice	205	49.0333	17.3500	3
BES	49	Frenštát pod Radhoštěm	422	49.5333	18.2000	7
BES	50	Hutisko	497	49.4333	18.2167	7
BES	51	Rožnov p. Radhošťěm	374	49.4667	18.1333	7
JES	52	Bílčice	550	49.8667	17.5667	8
JES	53	Rýmařov	602	49.9333	17.2833	8

Note to Table 1: names of broad areas (the second column) are just indicative

KV	–	Karlovarsko region	VYS	–	Vysočina highland
ZAT	–	Žatecko region	JVM	–	southeast Moravia region
EL	–	Českolipsko region	BES	–	Beskydy mountains
POL	–	Polabí lowland	JES	–	Jeseníky mountains
SUM	–	south Bohemia (Šumava) region			

Actual data (the period 1961–2010) are represented by technical series of climatic elements created on the basis of measured data of a station network of the Czech Hydrometeorological Institute (CHMI). It is a homogeneous and fully completed station series which was used as basis of calculation of series of climatic elements in daily intervals for given geographical point (*Štěpánek et al., 2011a; Štěpánek et al., 2013*).

Evaluated climatological variables were computed just on the basis of mean annual and mean monthly air temperatures and precipitation totals (as an average for the fifty year period 1901–1950 and 1961–2010) due to limited data source from the historical period 1901–1950. It means that the temperature sum above 10 °C and probability of dry VP cannot be analyzed.

Except for parameters of VP, the characteristics of non-vegetation period NVP (i.e. months from October to March) were analyzed as well, to better understand the agroclimatic development in the past 100 years.

3. Results and discussion

Table 2 presents regional average values of basic characteristics of temperature and precipitation as well as limits of drought and moisture certainty for defined broad areas for the period 1901–1950. Fig. 2 shows a difference of long-term mean annual air temperature, air temperature in VP and in NVP. Fig. 3 shows a difference of long-term mean annual precipitation total, precipitation total in VP and in NVP for the periods 1901–1950 and 1961–2010.

3.1. Mean annual air temperature

Increases in long-term means of annual temperature and temperature in VP and NVP in the period 1961–2010 was found out almost in all individual

Table 2. Average values of annual temperature (T_{annual}), temperature in VP (T_{VP}) and NVP (T_{NVP}), annual precipitation total (P_{annual}), precipitation total in VP (P_{VP}) and NVP (P_{NVP}) and annual drought limit (DL_{annual}), drought limit in VP (D_{LVP}) and moisture certainty in VP (MC_{VP}) for the period 1901–1950

Broad area	T_{annual}	T_{VP}	T_{NVP}	P_{annual}	P_{VP}	P_{NVP}	LD_{annual}	LD_{VP}	MC_{VP}
KV	6.8	12.7	0.8	602	358	244	413.0	246.3	8.8
ZAT	8.5	14.8	2.2	496	317	178	464.1	296.2	1.4
ČL	7.6	13.6	1.5	669	378	291	436.5	246.6	9.7
POL	8.5	14.7	2.3	578	366	214	464.3	293.8	4.9
SUM	7.3	13.4	1.3	621	417	205	429.4	288.3	9.7
VYS	6.4	12.6	0.3	682	411	271	403.4	243.6	13.4
JMO	9.2	15.8	2.6	563	348	215	486.6	300.7	3.0
BES	7.3	13.4	1.3	944	584	361	429.0	265.5	23.8
JES	6.0	12.3	-0.3	784	464	320	390.0	232.1	18.8

stations and in all broad areas. Difference of station average values in both fifty years vary from −0.2 to 1.1 °C (mean difference is 0.4 °C) in the case of annual values, from −0.5 to 1.1 °C (mean difference is 0.3 °C) in the case of VP and from −0.2 to 1.2 °C in the case of NVP (mean difference is 0.4 °C).

Mean annual shift in broad area of Jeseníky mountains is +0.7 °C, in south Bohemia region +0.4 °C, in Karlovarsko region and Polabí lowland +0.3 °C, in Žatecko region +0.2 °C, in Českolipsko region, Beskydy mountains and Vysočina highland +0.5 °C and was not recorded in southeast Moravia region. Mean temperature increase in VP was as follows: Jeseníky mountains and Vysočina highland +0.6 °C, Českolipsko region +0.5 °C, south Bohemia region and Beskydy mountains +0.4 °C, Karlovarsko region and Polabí lowland +0.3 °C, Žatecko region +0.1 °C. In southeast Moravia an insignificant decrease of VP temperature lower than 0.1 °C was recorded. Mean increase of NVP temperature was found out in all regions as well (+0.7 °C in Jeseníky mountains, +0.5 in Beskydy mountains, Vysočina highland and Českolipsko region, +0.4 °C in Polabí lowland and Karlovarsko region, +0.3 °C in region of Žatecko and south Bohemia and +0.1 °C in southeast Moravia lowland.

3.2. Annual precipitation total

The shift of precipitation between two fifty-years period is not so evident

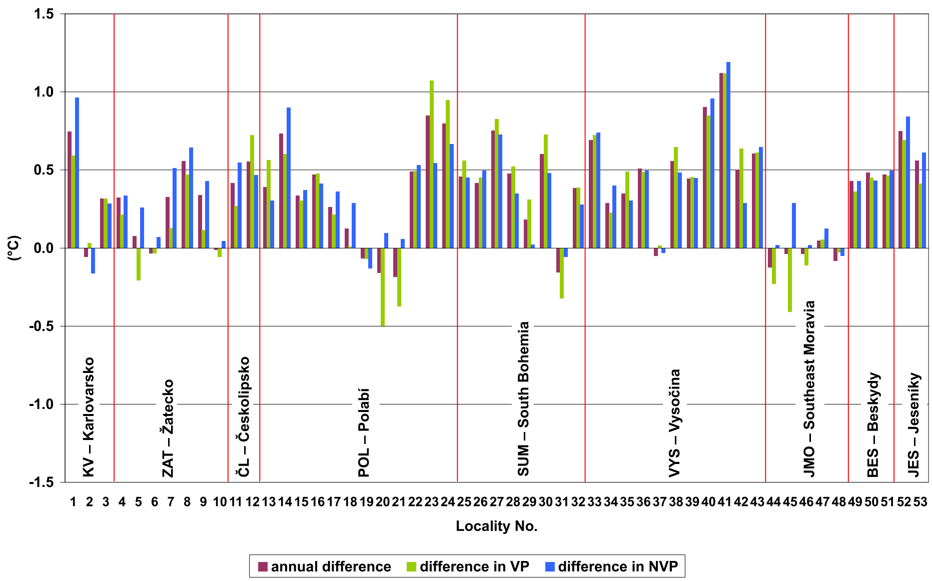

Fig. 2. Differences of mean annual temperature, temperature in VP (April to September) and NVP (October to March) between the periods 1901–1950 and 1961–2010 (value of 1901–1950 subtracted from the value of 1961–2010).

as in the case of temperature. There is an increase of precipitation in long-term point of view in some regions. For example in the driest part of CR Žatecko out an annual increase of precipitation total about 16 mm was found, in Beskydy mountains about 10 mm, in Polabí lowland about 7 mm, in Českolipsko region about 3 mm and in south Bohemia just about 0.4 mm.

On the other hand, the average precipitation total in 1961–2010 is lower in some regions. For example, the annual amount of precipitations in Jeseníky mountains decreased by about 38 mm, in Vysočina highlands and southeast Moravia about 16 mm and in Karlovarsko region about 6 mm. The shift in VP is as follows: −13 mm in Jeseníky mountains, −12 mm in Karlovarsko region, −8 mm in southeast Moravia region, −7 mm in Vysočina highland, −2 mm in south Bohemia region, −2 mm in Českolipsko region, +7 mm in Polabí lowland, +9 mm in Beskydy Mountains and +10 mm in Žatecko region. NVP precipitation total increased by about 7 mm in Žatecko region, about 6 mm in Karlovarsko region, about 4 mm in

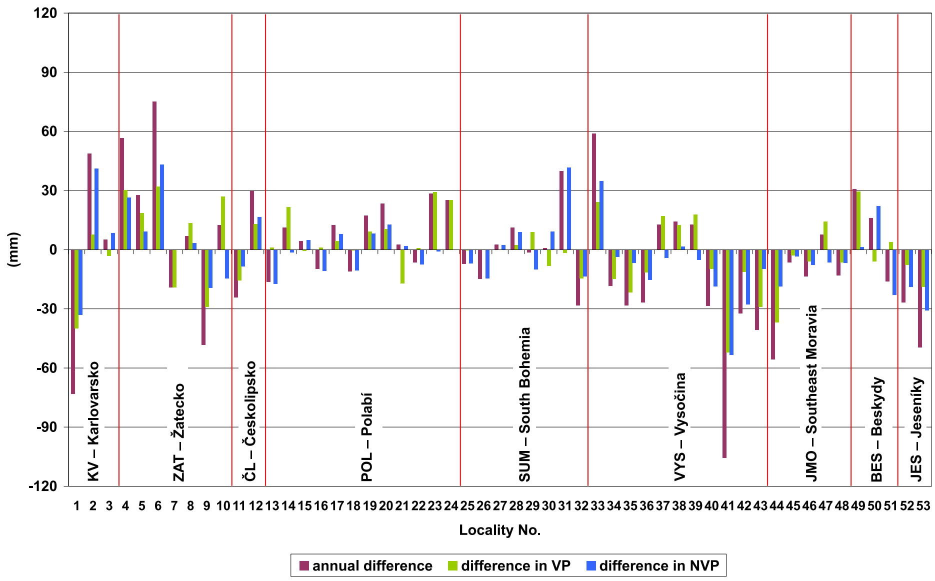

Fig. 3. Differences of mean annual precipitation total, precipitation total in VP (April to September) and NVP (October to March) between the periods 1901–1950 and 1961–2010 (value of 1901–1950 subtracted from the value of 1961–2010).

Českolipsko region and about 2 mm in south Bohemia region. On the contrary in some regions it decreased (−25 mm in Jeseníky mountains, −10 mm in Vysočina lowland, −9 mm in southeast Moravia and −1 mm in Polabí lowland. No shift in NVP values was found out in the case of Beskydy mountains.

3.3. Moisture certainty and limit of drought

Negative shift in the limit of drought from 1901–1950 to 1961–2010 means that the limit of drought is defined by lower precipitation in the second period. Positive shift contrarily means the drought risk in 1961–2010 at the higher precipitation than in 1901–1950.

Annual limit of drought increases in all broad areas (just in southeast Moravia insignificantly decreases – about 1 mm in average), except for several cases in most stations (Fig. 4). An increase higher than 10 mm was

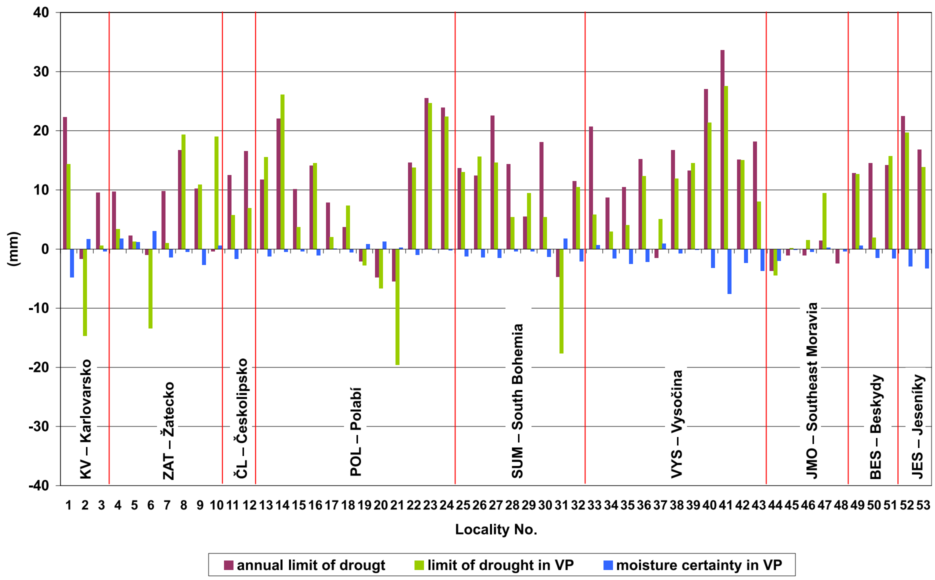

Fig. 4. Differences in long-term annual limit of drought, limit of drought in VP (April to September) and moisture certainty in VP (April to September) and moisture certainty in VP (April to September) between the periods 1901–1950 and 1961–2010 (value of 1901–1950 subtracted from the value of 1961–2010).

detected in Jeseníky mountains (20 mm), in Vysočina highland (16 mm), in Českolipsko region (15 mm), in Beskydy mountains (14 mm), in south Bohemia region (12 mm). In Polabí lowland and Karlovarsko region, the increase reached 10 mm and in Žatecko region to 7 mm). The shift in VP is also positive in all cases (+16 mm in Jeseníky mountains, +12 mm in Vysočina highland, +10 mm in Beskydy mountains, +8 mm in Polabí lowland, +7 mm in south Bohemia region, +6 mm in region of Žatecko and Českolipsko and till 1 mm).

Moisture certainty in VP decreases in all cases of broad areas (except for Žatecko region where it is about 0.3 mm higher). Mean annual shift in broad area of Jeseníky mountains is −3.1 mm, in Vysočina lowland −2.0 mm, in Karlovarsko region −1.2 mm, in Českolipsko region −0.9 mm, in south Bohemia region and Beskydy mountains −0.8 mm, in southeast Moravia −0.5 mm and in Polabí lowland −0.2 mm.

The comparison of two 50-year average values cannot be explained as a climate development from 1901 to 2010. Some of the most significant changes and shifts are obvious but due to very long time series and partly trends and difference between shorter periods are not detected.

For example the results of drought analysis in CR territory based on Palmer drought severity index (PDSI) and the Z-index during the period 1881–2006 show a tendency towards prolongation and greater severity of drought episodes (*Brázdil et al., 2009*). *Brázdil et al. (2012a)* identified dry episodes that were particularly in the mid-1930s, late 1940s – early 1950s, late 1980s – early 1990s, early 2000s etc. Seasonal and annual Czech temperature series show a generally increasing tendency with accelerated warming since the 1970s.

Thirty-year period 1980–2010 evinces a warming of 0.57 °C per 10 years in southwest Bohemia (*Kliment and Matoušková, 2008*). According to *Pokladníková et al. (2008)* the periods of 1961–1970 and 1971–1980 contain more cold months than periods of 1981–1990 and 1991–2000 when warm months prevailed in the south Moravia.

Žalud et al. (2013) analyzed temperature conditions in Žabčice (South Moravia). They stated average temperatures in 1961–1990 9.2 °C and in 1991–2010 10.0 ° with statistically significant increase in April – June (0.39 °C per 10 years) and in July – September (0.40 °C per 10 years). Annual rainfall totals increased from 480.0 mm in 1961–1990 to 496.1 mm in 1991–2010 with simultaneous statistically-significant decrease in April – June and increase in July – September.

Our findings of increased long-term averages of annual temperature and temperature in VP and NVP in the period 1961–2010 compared to 1901–1950 well correspond to findings of other authors. A statistically significant trend of warming between 0.10 and 0.15 °C per decade was identified by *Brázdil et al. (2012b)* on the base of climatic data of ten CR stations for the period of 1883–2010. *Kliment and Matoušková (2008)* analyzed a climatic development on three stations in southwest Bohemia for the period 1901–2003. By comparing average values for the periods 1901–1950 and 1951–2003, a rise in temperature from 7.6 °C to 8.1 °C in Klatovy locality was identified.

The long term change in precipitation distribution within a year is documented by a different shift of annual, VP and NVP values for example in Karlovarsko region, Českolipsko region, Polabí lowland, south Bohemia region. *Brázdil et al. (2012b)* state a statistically insignificant linear trend of precipitation totals for the period 1876–2010 at fourteen stations in CR.

The increase of annual and VP limits of drought is most momentous mainly in areas regularly damaged by agricultural drought. It means intensive agricultural areas in lower altitudes. The most significant decrease of moisture certainty in VP was detected in higher altitudes (500 to 600 mm in Beskydy mountains). Due to overall higher precipitation total the impact is not such serious as in the case of lower decrease in arid lowland areas (Polabí and southeast Moravia).

Many authors deal with trends of temperature, precipitations and drought risk mainly during the last 50years. Difference of precipitation parameters for 78 locations in period 1961–2000 in east and west parts of CR were described by *Moliba et al. (2006).*

The results of CR moisture conditions in 1961–2000 show that the lowest locations at about 300 m a.s.l. were characterized by long-term values below 45% of the available water holding capacity (AWHC), and the typical values for central locations up to 600 m a.s.l. are 60% AWHC. The analysis revealed a decreasing trend of soil water reserves (*Kohut et. al., 2010*).

Occurrence of a dry period with negative impact on field crops production is a significant characteristic of Czech climate. The amount of available soil water was calculated by agrometeorological model AVISO at 21 experimental stations for the period 1975–2007 (expressed as % AWHC). Decrease in available soil water (decrease of % AWHC up to 24%) in a growing season for the long term trend was observed at 20 out of 21 stations (*Středa et al., 2011*).

Drought events may occur in the case of long-term lack of precipitation coinciding with hot weather. Analysis of several temperature and precipitation indices and their changes in the second half of the 20th century in Hungary with emphasis on agriculture was done by *Pongrácz and Batholy (2006).* Their results showed that regional intensity and frequency of extreme precipitation increased, while the total precipitation decreased in the region and the mean climate became drier.

Increasing temperature accompanied by intense evaporation and significant fluctuation of precipitations will probably cause frequent problems with the lack of water (*Matejka et al., 2004; Rožnovský and Kohut 2004*).

Higher risk of drought occurrence in CR is predicted in the future. Climate-diagrams in the study of *Mužíková et al. (2011)* showed possible rising drought hazard for all assessed localities in Czech Republic towards future periods. *Štěpánek et al. (2011b)* dealt with simulations from the ALADIN-Climate/CZ regional climate model. No statistically significant trends of precipitation and length of dry period over the whole period 1961–2100 in CR were predicted. Trends for increase in air temperature and number of hot days were statistically significant. Computation of potential evapotranspiration indicates a significant increase of aridity in CR till 2100. Estimation of moisture indexes predicts a higher drought risk in South Moravia, central and northwest Bohemia, lower and central Polabí lowland and Povltaví lowland (*Kalvová et al., 2002*).

4. Conclusion

The main task of the study was to assess, describe and explain the shift of agroclimatological variables used for official land appraisement in CR. Increases in long-term means of annual temperature and temperature in VP and NVP in the period 1961–2010 were found out in all broad areas (up to 0.7 °C) and almost all individual stations where they vary from −0.2 to 1.1 °C. In the case of all broad areas the shift is regularly distributed within VP and NVP.

The shift of precipitation is not such evident as in the case of temperature. There is an increase of precipitation in long-term point of view in some regions (Žatecko, Beskydy, Polabí). On the other hand, mountains decreased by about 38 mm, in Jeseníky, Karlovarsko, Vysočina and southeast Moravia is lower and almost constant in Českolipsko and south Bohemia. The long term change in precipitation distribution within a year is documented by a different shift of annual, VP and NVP values.

The most significant decrease of moisture certainty in VP was detected at higher altitudes (500 to 600 mm). Due to overall higher precipitation total, the impact is not such serious as in the case of lower decrease in arid lowland areas.

The results well document that the valid methodology of land appraisement is not actual from the climatological point of view. All 50year averages of investigated parameters had changed in 1961–2010 compared to the mean of 1901–1950.

The need of actualization is not given just by a shift of basic climatological factors but also by a technical development of measurement technology, more quality, dense and fully automatic climatological network. CReg. parameters defining the drought just by very simple "climatologic way" (i.e. based only in temperature and precipitation) should be replaced by more complex "agroclimatological characteristic" (which take in to account also basic pedological and plant characteristics), for example AWHC.

A length of representative period should be considered. Often recommended longest time data series possibility need not express the actual situation the best. Also a probable climatic development should be taken into account. Different long period should be confronted with climate development predicted by scenarios to find out the most representative and appropriate period.

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