DROUGHT AND THEIR EVALUATION
ОЦЕНКА ПОЯВЛЕНИЯ ЗАСУХИ

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ABSTRACT
Precipitation and other meteorological elements are the most important and frequently used parameters which characterise climatic conditions of the affected area for the realisation not only of water-economy projects but also for determining dimensional characteristics of irrigation constructions. Authors (KLEMENTOVA, E. 1990, LITSCHMANN, T., ROZNOVSKÝ, J. 1995) have analysed drought occurrence in their former work and now return to the same problem with new evaluation. The work presents selected illustrative examples from the Hurbanovo locality evaluating the years 1961 – 2000 by the method PDSI (Palmer Drought Severity Index). Some interesting realities were uncovered in connection with the dry period of Spring 2000.

KEY WORDS: natural precipitation, drought, water balance, Palmer Drought Severity Index.

INTRODUCTION
Long lasting non-precipitative periods or periods of long continuous shortage of soil water are events which occurred in past, exist at present and we can safely assume they will appear also in the future.
The dry period during Spring 2000 uncovered some interesting facts. One of them is that there is no official method available to quantify the drought and in such instances it may be important to assess the whole area affected and make certain operating decisions.
In our paper we shall try to estimate the period 1961 – 2000 by using the two ply model exercised by the PDSI method (Palmer Drought Severity Index). The method is very much used in the USA and there are some attempts to use it also in Central Europe (BRIFFA K. R. et all. 1994, HORVÁTH, S. et all.)

MATERIAL AND METHODS
a) *Palmer´s method for calculation water balance*
When calculating PDSI it is possible to use the two-ply model for the estimation of soil water. The upper level is that where it is possible to strip 25 mm (1“) water (from the stage of field water capacity to the point of wilting). The type of soil determines the power of the ply. Supplement in lower ply is dependant on the sort of soil and total thickness of the considered level. Calculation algorithm predicts:
- completion, (expenditure) of water at lower levels occurring after saturation of the upper level
- loss of water by evaporation occurring when it exceeds precipitation in a considered period
- loss of water by evaporation in upper levels is equal to potential
- loss of water in lower levels is the function of initial volume of water in that level, potential evaporation and available water capacity of both levels

- outlet (percolation) of water occurs at a time when usable water capacity in both levels is achieved.

b) *Entering Data*

To test if the use of Palmer´s method is sufficient, conditions from Podunajská nížina (Danube Plain) were used as data, entering daily the values of temperature and humidity of the air, number of hours of sunshine and precipitation totals at the Hurbanovo station during the period 1961 – 2000. From this data daily values of potential evaporation were calculated by the Penmann Monteith method, in spite of the fact that in the USA Palmer´s Index is used mostly for calculation of evaporation according to Thornthwait (based on air temperature).
Palmer ´s Method was used both for monthly and daily steps in chosen cases.
The soil profile was balanced up to a depth of 60cm using the assumption of 18.5% volumetric proportions of usable water capacity of the ply which is 111 mm. The result of it is that the upper ply of usable water capacity of 25 mm is nearly 14 cm (135,1 mm) thick.

RESULTS AND DISCUSSION

a) Yearly cycle balance

Palmer´s method gives rather good results. We can assume that according to valuation of water balance in separate plies in Hurbanovo country according to Fig. 1. It is visible that even without an initial condition of saturation at the beginning of the year in both plies there is a cyclic characteristic when the start of the year interlocks to the values from the end of previous year. Not all balance methods used have the same attributes. By this way it is possible to calculate the average value of reserves of soil water in separate plies during the year. In lower levels the shape of the year's cycle is the simple wave of nearly sinus character.

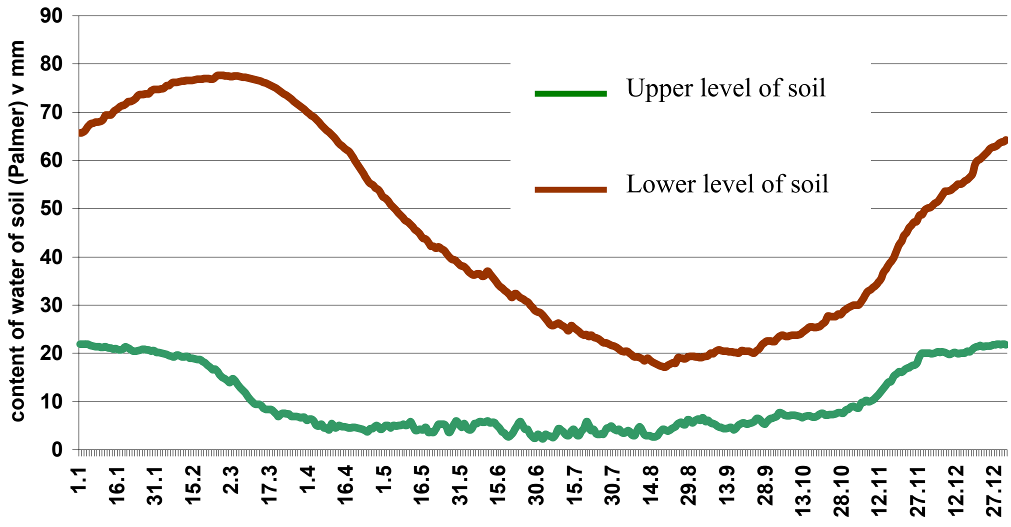

Fig. 1 Yearly movement of balance of water in the soil for separate plies in Hurbanovo country during 1961 – 2000.

It is possible to achieve a position near to vapour in mid-March. During the next period supply water drains off the soil and the gradual easy addition starts up from mid-August. In the upper ply, when we follow the long term average, there is a decline from the end of February and the addition starts only in November. This shape of line of the graph replicates relatively well generally widespread ideas about the changes in the supply of soil water during the year.

b) Development of supply soil water in 2000

Fig. 2 gives a graphic picture about supplies of soil water in both plies in 2000. After a moist period seen at the end of March and in first days of April we can watch drying of upper ply and 15. 4. 2000 volume of water declining to zero. Following that there is the beginning of water extraction from the lower ply in which storage decreased until the end of the vegetative period. Rainfall during the summer time was directly used for evaporation or added to the supply of water only in the upper ply. A dry period lasted from mid April till the commencement of more extensive rainfalls at the beginning of July which did not benefit shallow rooting crops. Plants with a deeper root system had some supply of water in the lower placed ply.

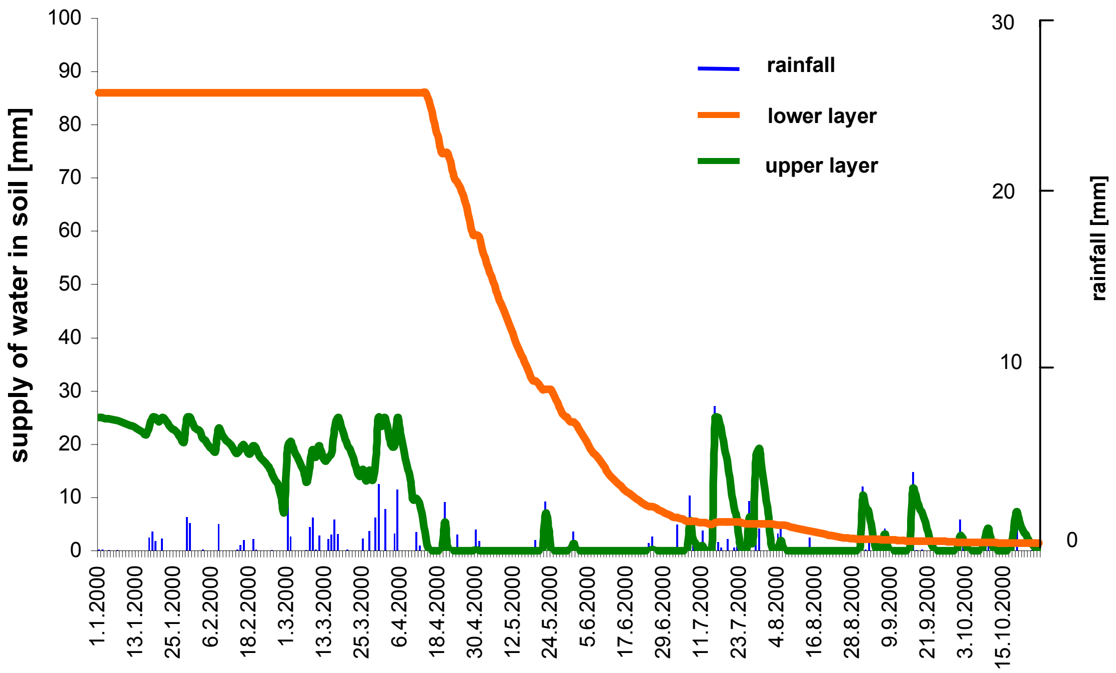

Fig. 2 Development of supply soil water in separate plies for the year 2000

c) *year 2000 by sight of past 40 years*

Using a balance method enables us to value the whole period under consideration and review extremities of separate years. It is possible to set many characteristics from the calculated values of water balance. It is also possible to rank the year 2000 within the context of other years. Fig. 3 gives the general idea about the development of water supply during the period 1961 – 2000. It is worth noting that although the water supply was replenished at beginning of each year, in some years even upper ply did not reach saturation, for instance years 1978 and 1990.

We have tried to extract some characteristics derived from soil water supplies in separate levels in which the year 2000 plays an important part in the analysed period:

1. The average water supply in lower ply during the vegetative period (IV. – IX.) - places the year 2000 9th with 24 mm. The driest years were 1990 and 1978 with 4mm and 5 mm.
2. The average water supply in the upper ply during the vegetative period (IV. – IX.) places the year 2000 12th with 3,1 mm. The driest year was 1993 with 1,4 mm. The year 1990,

which was interpreted in previous valuation as the driest overall, moved to 10th position. We can assume that during the vegetative period after a dry winter during which the water supplies were not added to, that irrigation of the upper ply took place from time to time.

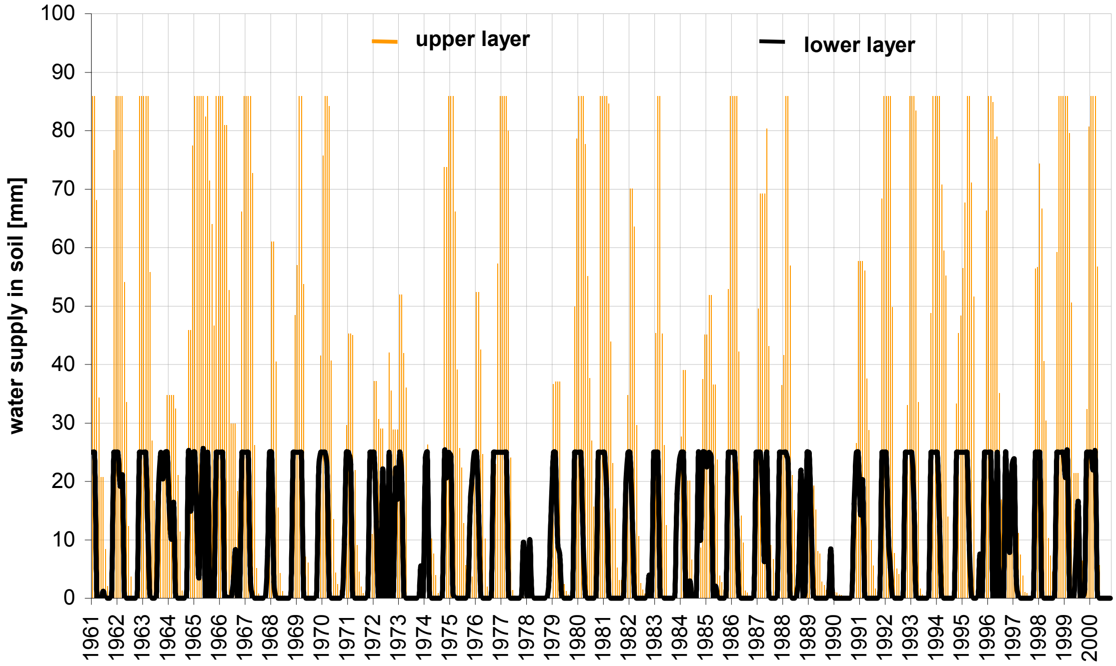

Fig. 3 Development of water supply in separate plies according to Palmer in Hurbanovo during 1961 – 2000

The two mentioned characteristics can help in assessments about the general situation of water supply in soil during vegetative periods. In addition to using average values of moisture balance it is also possible to use the number of days in which the water supply declines under a certain value as a characteristic. The mentioned characteristics give better information about the number of days over the monitored period with low water supply as an average value. We set lower quartile of all values of water balance for vegetative period as limit value.

3. The number of days during the standard vegetative period with water supply in the lower ply less than lower quartile of all measurements - the year 2000 was in 4th position with 111 days (out of possible 183), the most were years 1978 and 1990 with 183 days.
4. The number of days during the vegetative period with water supply in the upper ply less than lower quartile of all measurements- the year 2000 was in 9th position with 124 days, the most was in 1993 with 133 days.
5. To the mentioned characteristics it is necessary to add climatological characteristics which aggregate the amount of rainfall during the vegetative period: 4th position with 201 mm though the values up to total 210mm were in eight years with the lowest in 1962 with 171mm.

Besides examination of all vegetative periods it is appropriate to study also the values of separate characteristics for shorter periods, for instance specific months. This could be especially important for example for the development of cereal crops. In May the characteristics are as follows:

6. The average water supply in lower ply in May: 17th position
7. The average water supply in upper ply in May: 5th position

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CONCLUSIONS

Therefore it isn't possible to come out only from precipitation in specific period, because soil profile can be defined as water reservoir, which cumulate water in rain period and release water in dry period. It is necessary to consider also water storage in soil profile. Out of submitted processing results, that valuation of dryness intensity for irrigation is relatively. The work presents selected illustrative examples from the Hurbanovo locality evaluating the years 1961 – 2000 by the method PDSI (Palmer Drought Severity Index). Palmer ´s Method was used both for monthly and daily steps in chosen cases. The soil profile was balanced up to a depth of 60cm using the assumption of 18.5% volumetric proportions of usable water capacity of the ply which is 111 mm. The result of it is that the upper ply of usable water capacity of 25 mm is nearly 14 cm (135,1 mm) thick.

REFERENCES

ALLEY, M.W.: The Palmer Drought Severity Index: Limitations and Assumptions. Journal of climate and applied meteorology, Vol. 25, 1984 s. 1100 – 1109

BRIFFA, K., R. et all.: Summer moisture variability across Europe, 1892-1991 an analysis based on the Palmer Drought Severity Index: International Journal of climatology, vol.14 1994

CARL T.R.: The Sensitivity of the Palmer Drought Severity Index and Palmer´s Z-Index to their Calibration Coefficients Including Potential Evapotranspiration, Journal of climate and applied meteorology, Vol. 25, National climatic data center 1986

HORVÁTH, S. et all: Spatial and Temporal Variations of the Palmer Drought Severity Index in South-East Hungary.

HOUNAM C.E. et all.: Drought and agriculture. Technical note No. 138. Geneva. World Meteorological Organization 1975.

KLEMENTOVÁ, E.: Assessment of drought areas., ES STU, Bratislava 1990. 23p. In Slovak.

Et all.: CHMÚ Methodic for assessment drought on territory in CR for season IV. – VI. 2000, In Czech.

Et all:. SHMÚ Bratislava: Climatic conditions for HURBANOVO, Institute for Hydrometeorology, Prague, Prague 1960. In Slovak.

KOTT I.,:Water balance on territory for Czech Republic in years 1974-1990. ČHMÚ Praha, 1992, 125p. In Czech.

LAPIN M., ZÁVODSKÝ D., ZÁVODSKÁ, E: Quality air and changes climate. Possible fall assuming change climate on water balance in Slovakia. Gentile climatic program. Prague 1992. In Czech.

LITSCHMANN, T., ROŽNOVSKÝ, J.: Valuation aridity by the agroklimatological characteristic. In. :"Actual agroklimatology1995", MZLU Brno, 1996, s. 111-120:

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