ACTA CLIMATOLOGICA
Universitatis Szegediensis, Tom. 28–29., 1995.

PERSISTENCE PROBABILITY OF THE DROUGHT INDEX MADE BY PÁLFAI FOR FIVE REGIONS OF THE HUNGARIAN GREAT PLAIN

by
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A Pálfai-féle aszály-index megmaradási hajlama a magyar Nagyalföld öt körzetében

E dolgozatban szerzők egy speciális aszály-index (*PAI*) statisztikai jellemzőit vizsgálták az 1901–1992 közötti időszakra. Kiszámították a 92 éves átlagokat a Magyar Alföld 5 régiójára. Ezt követően megmaradási valószínűségeket definiáltak külön-külön, azon esetekre, amikor a kiindulási év száraz, illetve nedves volt – három különböző módon: 1. elméleti valószínűségeket határoztak meg (*E*), függetlenséget feltételezve az egymást követő évek között, 2. kiszámították az anomália előjelének megmaradását (*A*), 3. s az anomália előjelének megmaradását abban az esetben, ha a kiindulási év nagyon nedves volt (alsó kvartilis, Q_1), vagy nagyon száraz volt (felső kvartilis, Q_4). Az eredményeknek prognosztikai értékük lehet néhány esetben a Magyar Alföld egyes régióiban.

With making use of a special drought index (*PAI*), the authors investigated its statistical characteristics for a period of 1901–1992. For five regions of the Hungarian Great Plain the 92 year averages were calculated. Then the persistence probabilities were determined if an initial year was wet or dry, respectively, in three different ways: 1. theoretical probabilities, assuming independence between successive years (*E*), 2. the persistence of sign of anomaly (*A*), 3. the persistence of sign of anomaly if the initial year was very wet (lower quartile, Q_1) or very dry (higher quartile, Q_4). The results may yield prognostic value in some cases and some regions of the Hungarian Great Plain.

Key-words: drought index, prediction of drought, persistence probability

INTRODUCTION

Pálfai (1988) developed an index (PAI) for characterizing drought which takes into consideration on the one hand mean temperature of the vegetation period (April-August), on the other hand total precipitation during the vegetation period and the previous months. Its definition is as follows.

$$PAI = 100 * t_{IV-VIII}/P_{X-VIII}$$

where *PAI* – drought index (centigrade per 100 mm)
$t_{IV-VIII}$ – mean temperature of the period between April–August
P_{X-VIII} – weighted precipitation amount of the period between October–August.

The weighted coefficients are as follows. October: 0.1, November: 0.4, December–April: 0.5, May: 0.8, June: 1.2, July: 1.6, August: 0.9.

As it has been established (*Pálfai and Boga*, 1992; *Koppány and Csikász*, 1994), both the drought index and the aridity index of Budyko show that the Hungarian Great Plain, mainly the middle part of this region, is the most arid region of Hungary. This is why the examination of the PAI – drought indices was limited for the Hungarian Great Plain and a little eastern part of Transdanubia (*Pálfai, Boga and Lábdi*, 1993, 1994). The Hungarian Great Plain was divided into 5 regions and mean *PAI* – drought indices were determined for these regions, respectively.

In order to predict dry and wet years the first step is considered to investigate persistence probability. The time series of *PAI* – drought indices for the period of 1901–92 are used as data base in this paper.

METHOD

Means of *PAI* – drought indices for the period of 1901–1992 are determined separately for 5 regions of the Hungarian Great Plain (Nyírség–Szabolcs, North Transtiszania, Northern part between Danube and Tisza, Southern part between Danube and Tisza, South Transtiszania, *Fig. 1*). After this, probabilities (frequencies) were counted for the *PAI* – drought indices to be lower than mean (wet year) or higher than mean (dry year). On the basis of substituting extreme precipitation and temperature data into the *PAI*-formula, it can be stated that drought index is dependent mainly on

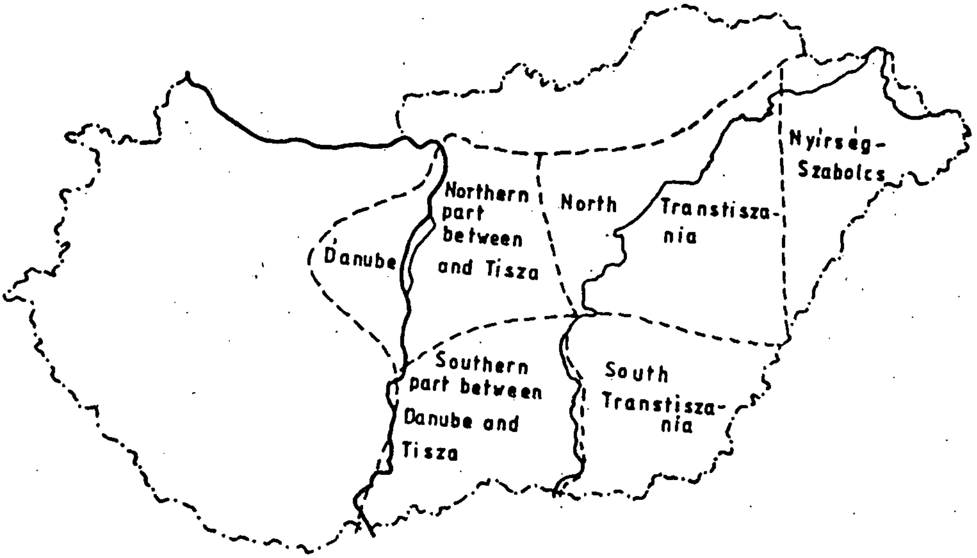

Fig. 1 The examined regions in the Hungarian Great Plain

precipitation. Consequently monthly sums of precipitation fluctuate within much wider limits than mean monthly temperatures. After this, rank-analysis of PAI – drought indices was performed. In this way it was possible to determine lower and higher quartiles for each of these 5 regions.

Taking into consideration basic probabilities of wet years ($PAI < PAI_{mean}$) as well as dry years ($PAI > PAI_{mean}$) theoretical persistence probabilities were counted for one, two, three, four, five successive years following wet or dry years, assuming independence. The used formula was as follows:

$$q_i = q^{i+1}$$

where q_i is probability of the event with q basic probability in the i-th year following the initial year.

Question is as follows. After a wet or dry year – in comparison with theoretical possibility – what is the probability of continuing the series of wet or dry years: 1. if the PAI – drought index is lower (wet year) or higher (dry year) than the 92-yearly mean, 2. if the *PAI* – drought index is in the interval of the lower quartile (Q_1 : very wet year) or in the interval of the higher quartile (Q_4 : very dry year) in the initial year.

RESULTS

Table 1 shows *PAI* – drought indices for the 5 regions of the Hungarian Great Plain, as well as lower and higher quartiles (Q_1 and Q_4) furthermore basic probabilities of wet and dry years.

Table 1
Basic statistics for the examined 5 regions of the Hungarian Great Plain (1901–1992)

	Nyírség–Szabolcs	North Transtiszania	Northern part between Danube and Tisza	Southern part between Danube and Tisza	South Trans-tiszania
PAI_{mean}	4.49	5.1	4.97	5.02	5.09
Q_1	3.46	4.07	4.05	4.0	4.02
Q_4	5.42	6.08	5.7	5.79	5.9
wet year, basic probability	0.56	0.55	0.55	0.54	0.51
dry year, basic probability	0.44	0.45	0.45	0.46	0.49

It can be established that for the examined 92-year period the least arid region was Nyírség–Szabolcs but the most arid one was Transtiszania. It is apparent that frequency of wet years is higher than that of dry years in each region. The asymmetry is lowest in the region of South Transtiszania but highest in Nyírség–Szabolcs.

Fig. 2a–e show probabilities counted for each region. In those years which were considered only by the sign of anomaly of their *PAI*-drought index, but not by the value of anomaly, persistence probabilities are shown by diagrams marked with *A*. Diagrams marked with Q_1 or Q_4 show persistence probabilities of years, *PAI* – drought indices of which can be found in the intervals of lower or higher quartiles (very wet or very dry years).

According to the examinations actual persistence probabilities are well higher than values to be expected theoretically (*E*), for almost each region. Actual persistence probabilities are extremely high in the first and second year, in comparison with theoretical persistence probabilities. In the third year actual persistence probabilities generally decrease significantly and hardly differ from values to be expected theoretically, except South Transtiszania and following wet years Southern part between Danube and Tisza, North Transtiszania as well as Northern part between Danube and Tisza. In the fourth and fifth years actual persistence probabilities decrease below 0.1 , except the region of South Transtiszania (see *Table 2*).

Table 2

Persistence probabilities following the years of lower quartile (Q_1) as well as higher quartile (Q_4) (1901 - 1992)

Nyírség - Szabolcs		North Transtiszania	Northern part between Danube and Tisza	Southern part between Danube and Tisza	Souht Transtiszania
Q_1					
1.	0.565	0.61	0.56	0.52	0.56
2.	0.348	0.35	0.39	0.26	0.26
3.	0.174	0.26	0.26	0.13	0.17
4.	0.087	0.087	0.13	0.13	0.086
5.	0.043	0.043	0.04	0.04	0.0
Q_4					
1.	0.52	0.44	0.44	0.39	0.39
2.	0.26	0.17	0.17	0.17	0.26
3.	0.087	0.0	0.0	0.04	0.17
4.	0.087	0.0	0.0	0.0	0.13
5.	0.0	0.0	0.0	0.0	0.087

By the help of *Fig. 2* and *Table 2* statistical predictions can be performed in some cases considering drought. In the first year following a wet one *PAI* – drought index lower than mean can be expected with a probability of 57–60% in the regions of Nyírség–Szabolcs, North Transtiszania and Northern part between Danube and Tisza.

Values of persistence probabilities do not differ significantly following years which belong to A and Q_i categories. Persistence probabilities for wet years decrease remarkably in the third year, even much more for further years. In the regions of South Transtiszania and Southern part between Danube and Tisza values of persistence probability for wet years are generally well higher in the first, second and third year than values to be expected theoretically. Probability of four successive wet years is practically 0, or very low (but in the region of Northern part between Danube and Tisza this value is 26%).

In years following dry years probability of arid (dryer than mean) weather is well over the value to be expected theoretically, but persistence probability of it is much lower than in case of wet years. Practically it cannot be expected for the series of dry years to continue for four successive years – only the region of South Transtiszania has a remarkable probability (13–20%) for persistence of arid (dryer than mean) years for four successive years.

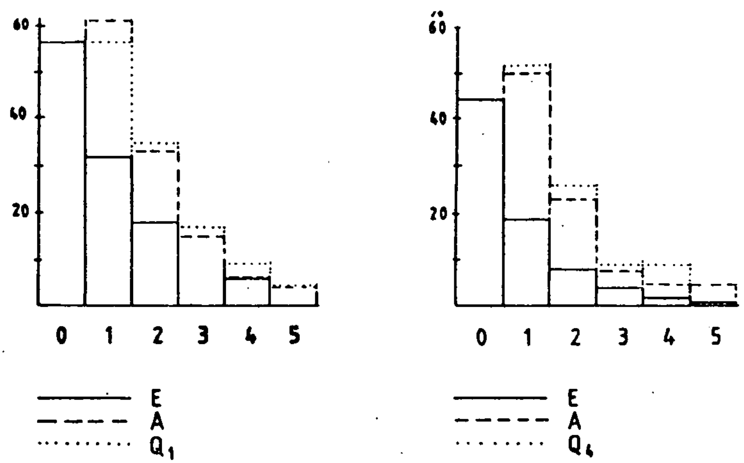

Fig. 2a Persistence probability of the PAI-drought indices in the region of Nyírség–Szabolcs (1901–1992)

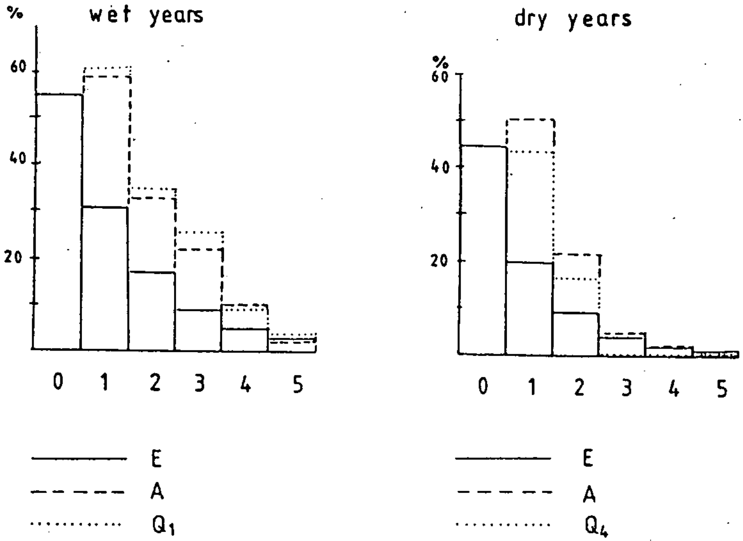

Fig. 2b Persistence probability of the PAI-drought indices in the region of North Transtiszania (1901–1992)

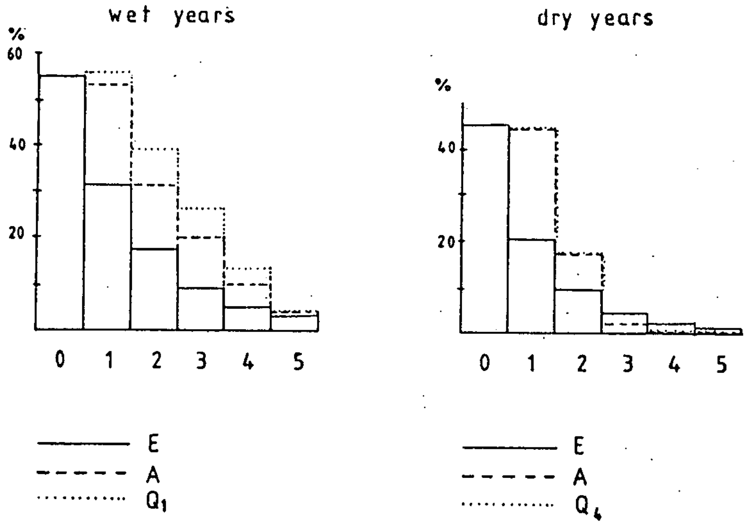

Fig. 2c Persistence probability of the PAI-drought indices in the region of Northern part between Danube and Tisza (1901–1992)

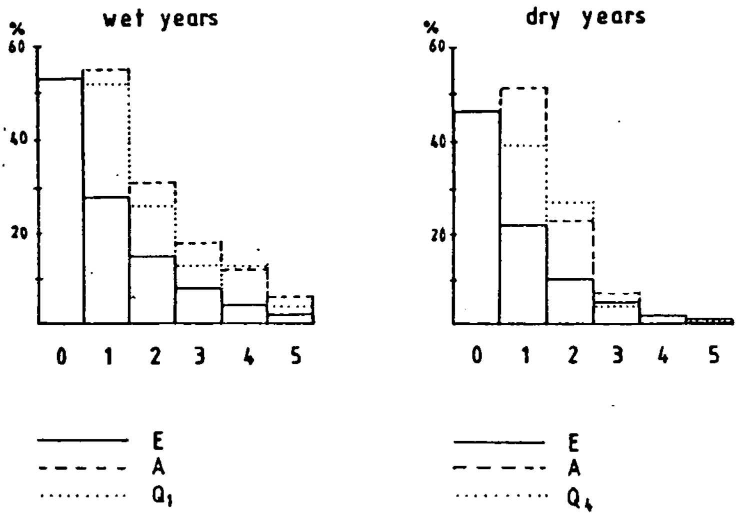

Fig. 2d Persistence probability of the PAI-drought indices in the region of Southern part between Danube and Tisza (1901 – 1992)

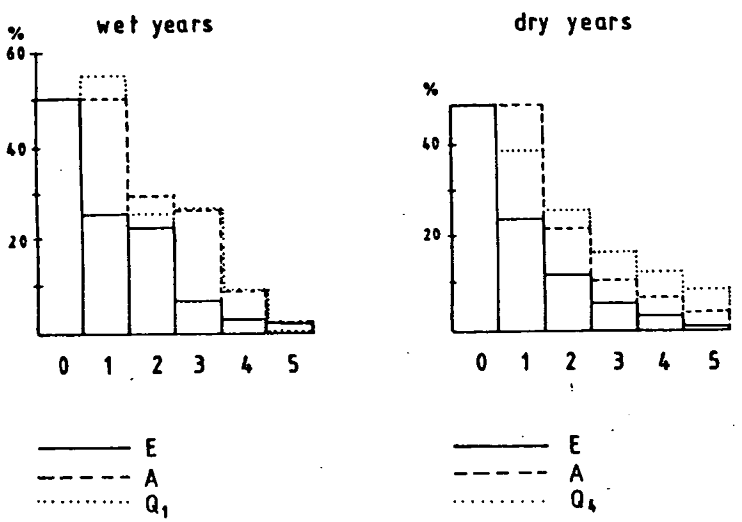

Fig. 2e Persistence probability of the PAI-drought indices in the region of South Transtiszania (1901 – 1992)

CONCLUSION

According to the experience persistence of wet or dry years is well higher for at least 2–3 successive years following the initial year than values to be expected. High persistence probability for the first year following the initial year, as well as low or 0 probabilities counted for three, four, five successive years can be used for prognostic aims. Namely the latter shows break of the series of anomalies with the same sign, that is to say it shows increased probability of *PAI* – anomaly with opposite sign.

Acknowledgements

This paper was supported by the OTKA Foundation, as the research subject No. T 4115.

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