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RELATIVE ATMOSPHERIC HUMIDITY AND MAJOR RELATED RISK PHENOMENA IN ALBA IULIA – TURDA DEPRESSION

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***ABSTRACT*.-Relative atmospheric humidity and major related risk phenomena in Alba Iulia – Turda Depression.** The local geographical characteristics of the Alba Iulia – Turda Depression, which benefits from a Foehn regime, show many specific aspects in the time and space variation of relative air humidity. The study followed the annual and monthly mean and maximum and minimum annual values of relative air humidity, the frequency of days with different relative humidity characteristics (r) ≥ 80% at 1.00 hr. p.m., ≤ 50%, ≤ 30% at one of the observation hours. The results obtained have both a theoretical and practical relevance, describing the conditions in which these phenomena may have a negative influence both on people's health and economic activities.

Key words: relative atmospheric humidity, risk phenomena, Alba Iulia – Turda Depression.

1. Introduction

In order to point out the major risks involved by air moisture, the study opens with an outline of the manifestations of this climatic element in Alba Iulia – Turda Depression. Sheltered by the Apuseni Mountains and crossed by the Mureş River, the Depression is one of the main areas in Romania in which the Foehn blows, its influence affecting also atmospheric humidity.

Atmospheric humidity represents the quantity of vapours existing in the air, a quantity that varies in terms of the complexity of the air masses and the particularities of the active surface. Whereas air mass fluctuations produce hygric oscillations at regional scale, the evaporation and evapotranspiration of permanent humidity sources, e.g. water courses or forest lands, contribute to maintaining much of the air moisture at local scale.

The variables analysed in this paper are aimed at distinguishing the regime of relative atmospheric humidity, its annual mean values, the maxima and minima

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over the year, mean values at 13.00 hrs and minimum values at observation hours. Final calculations had in view the occurrence frequency of days which do not cross certain hygrometric thresholds, that is days with relative air moisture ≤ 30%, ≤ 50% and ≥ 80%.

Observations made at the weather stations of the region: Alba Iulia, Turda, Aiud, Ighiu and Sebeş have been compared with the data found at Blaj, a station situated on the Târnava Plateau at some 15 km away from Alba Iulia-Turda Depression.

2. Relative atmospheric humidity, annual mean values

The distribution of *annual mean values* depends on the local physical-geographical conditions of the respective weather stations, especially on the presence of humidity sources. The highest annual mean values (77-80%) have been recorded at Aiud, Blaj, Sebeş and Alba Iulia stations situated on the terraces and slopes of the large valley corridors of the Mureş and Târnave rivers. The values registered by stations without humidity sources in their neighbourhood, e.g. Ighiu and Turda, were under the 77% threshold (Fig. 1).

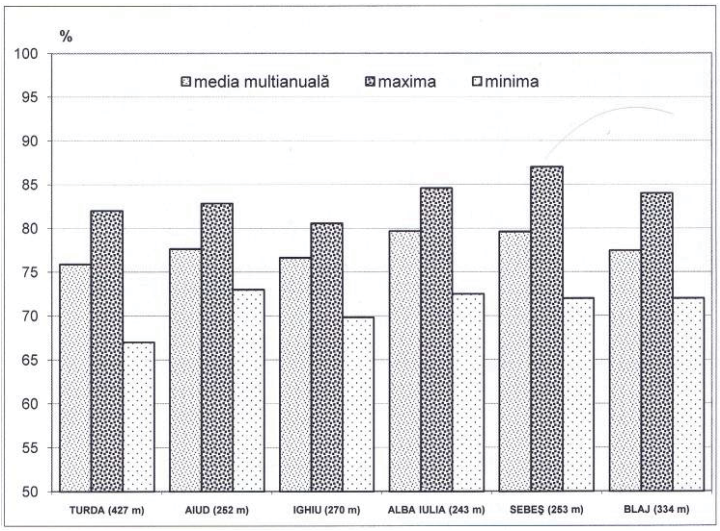

Figure. 1. Distribution of annual relative humidity mean values.

If compared to the multi-annual means, *value variations by the year* (see Fig. 2 graphs) show some positive deviations, but mostly massive negative ones. The territorial distribution is uneven, obvious similitudes existing only in the synchrounous oscillations found at Turda and Sebeş, while the fluctuations recorded at Blaj Station were clearly different. The highest and lowest deviations registered by the three

stations in distinct years, underlines the decisive role played by local active surface particularities in the relative atmospheric humidity regime. Thus, Sebeş Station, situated at the confluence of two big water courses, registered the highest proportion (62%) of elevated values (> 80%), with Blaj and Turda having some 60% of medium values (76-80%), respectively. At Turda, about one-third of the relative humidity values were under 75%, an indication of severe dryness specific to this site and, by extension, to the piedmont sector of Alba Iulia – Turda Depression (Fig. 2).

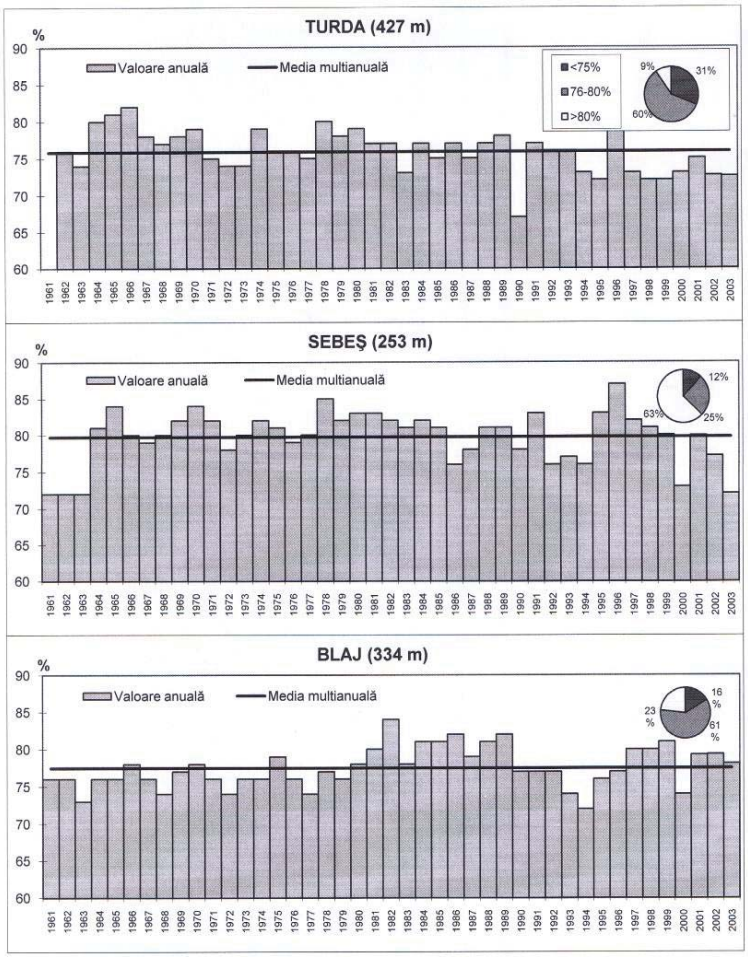

Figure. 2. Variation of annual relative humidity mean values (1961-2003)

All stations had an over 80% record at this indicator. The pattern was similar to that of the multi-annual specific distribution, namely, higher values at Sebeş (87%) and Alba Iulia (84.6%) stations and lower ones at Ighiu (80.6%) and Turda (82%).

The lowest annual mean value fell under 75% at all stations, e.g. about 72-73% at Aiud, Alba Iulia, Sebeş and Blaj and even under 70% at Ighiu and Turda.

3. Variation of relative humidity over the year

The annual and daily regime depends primarily on relative air moisture versus air temperature, the relation between the two being inversely proportional. Annual variation, therefore, is higher in winter than in summer.

In order to assess the annual regime as accurately as possible the analysis resorted to the multi-annual monthly means, as well as to the highest and lowest means of each month.

The evolution of the multi-annual monthly means shows a sudden decrease of maximum relative humidity, from winter (over 85%) to a minimum in spring (under 73%), values staying under the 75 % threshold until September, when there is a slight increase until December (Fig. 3).

The highest monthly values (see graphs) suggest a nuanced annual evolution. Maxima are still specific to winter months, but some increases above general summer levels occur in June and July due to heavy rainfalls and intense evapotranspiration.

As far as lowest monthly means are concerned, unevenness appears mostly over the year, with high disparities between the winter maximum (about 80%) and the minimum (under 60%) possible to occur in any of the warm six months of the year.

Maximum of relative humidity/year, basically the main maximum, reaches 86-90%, December being usually the apex, because it is then that the Mediterranean cyclones, carrying a warm and moist air up to the latitude of Romania, are very active and frequent.

There were situations when December and January relative humidity exceeded 95%, which is actually a secondary maximum (Fig. 3).

The annual maximum of lowest monthly values (79-84%) is in December, a secondary one occurring in January at Alba Iulia and Sebeş.

The annual minimum of relative humidity. Multi-annual monthly means over the year have a *main minimum* in April (67-72%), a particular situation not only for Alba Iulia – Turda Depression, but for the Transylvanian Depression, too (70-71%). What triggered this evolution was a change of direction in the general atmospheric circulation and higher wind velocity which contributes to dissipating the water vapours. In Alba Iulia – Turda Depression, the April minimum oscillates between under 70% (lowest value at Turda, 67.4%, due to the Foehn effect) and 72.3% at Alba Iulia and 72.5% at Sebeş stations which have plenty of moisture (Fig. 3).

The highest monthly means continue to have a main April minimum at Turda, Sebeş and Ighiu, with secondary minima at Blaj in May, March and June at Alba Iulia, and also in July at Turda and Aiud, all values running in the range of 77-83%.

The lowest relative humidity monthly means (under 60%) are registered between March and August: 56% in May at Aiud, 53% and 56% in August at Turda and Alba Iulia, respectively, 58% in July at Ighiu, or even 55% in June at Sebeş.

A series of positive or negative humidity deviations are associated to the oscillations of various masses of air. Having in view that lowest relative humidity values are of practical interest, a table of *minimum values during observation hours* by each month and year they occurred in has been worked out.

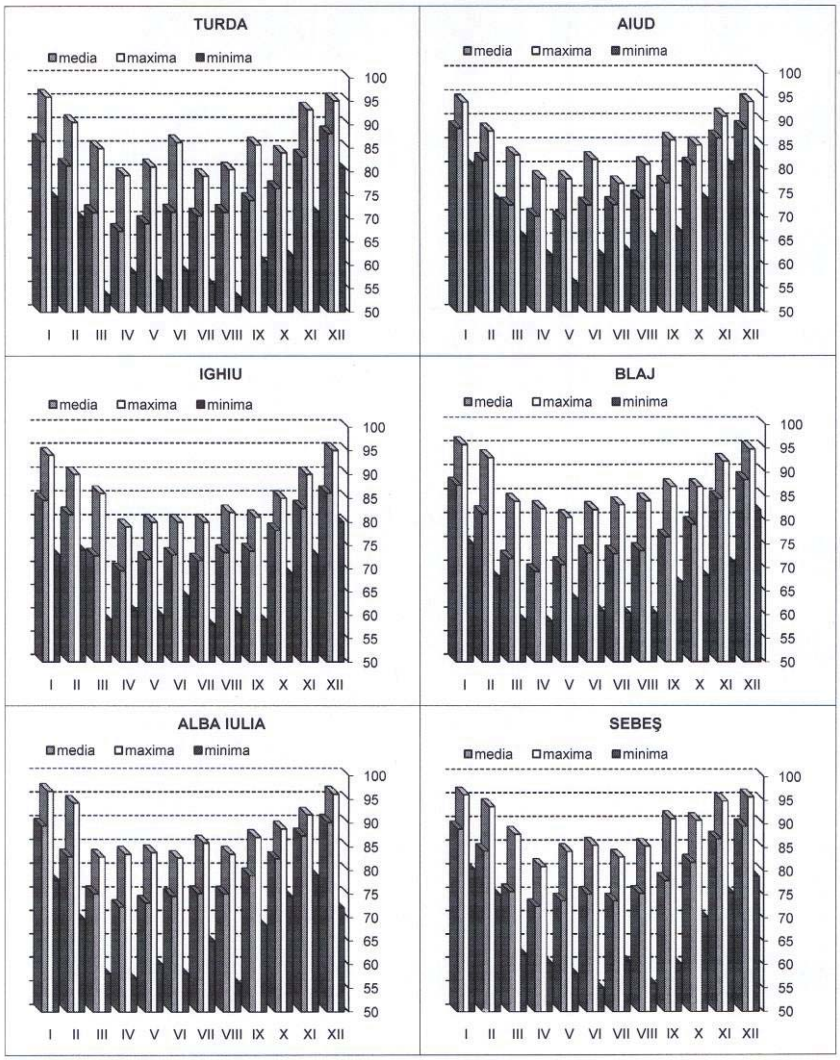

Figure. 3. The annual relative humidity regime (%)

The findings have revealed that at all study-stations relative humidity may temporarily drop to under 30% nearly the year round. Lowest minima during observation hours: 5.0% on March 19,.1994 at Turda; 12.0% on August 22, 1986 and

September 27, 1992 at Sebeş; 13.0% on March 25, 1999 at Alba Iulia; 16.0% on April 19, 1987 at Aiud; 18.0% on April 10, 1973 at Ighiu and 18.0% on April 21, 1964 and September 10, 1967 at Blaj. The time when absolute minima were registered: either early spring (March and April), or end of summer and beginning of autumn (August and September), dryness and drought over the past few years having been present in Alba Iulia – Turda Depression (Mărculeț, Mărculeț, 2005).

Mean relative humidity variation at 13.00 hrs. The diurnal regime of this variable is influenced primarily by temperature, but also by insolation, evaporation and evapotranspiration. Since diurnal relative humidity distribution is inversely proportional to temperature, it has a maximum in the morning and a minimum at noon (13.00 hrs). The relative humidity regime of that hour was calculated and represented on the graph of monthly and annual means, as well as monthly and annual extremes (Fig. 4).

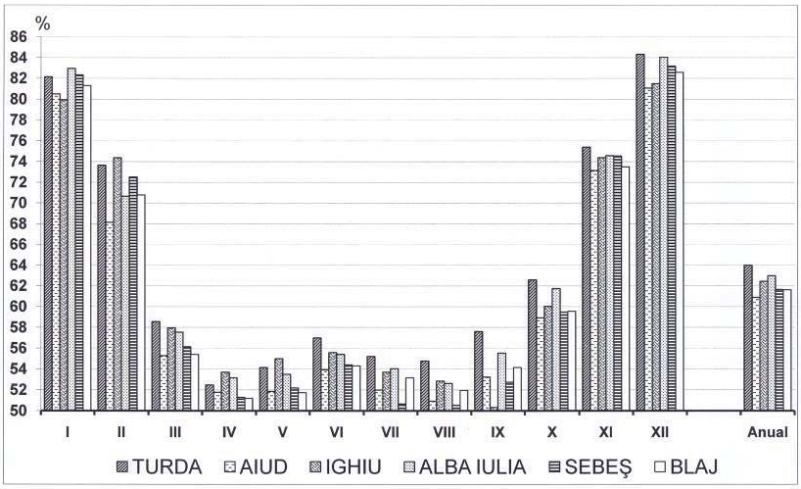

Figure. 4. Mean relative humidity variation at 13.00 hrs

Multi-annual means over the year oscillate between 60.9% at Aiud and 64% at Turda, which illustrates very much dryness at all study-stations.

There are very great differences over the year between the annual maxima of December and January (more than 80%) and the very low values (under 60%) from March to September. The annual means were slightly over 50% in several months: April at Turda (52.5%) and Blaj (51.2%); July at Sebeş (50.7%); August at Alba Iulia (52.6%) and Aiud (50.9%) and even September at Ighiu (51.8%).

Highest and lowest relative humidity means at 13.00 hrs indicate extreme variability, from maxima of 88-97% in December and January to minima of 26-39% often in August, but also in July and September when temperatures are elevated and dryness is enhanced by the Foehn effects.

Looking at the diurnal relative humidity minimum at 13.00 hrs of 44% in the Bărăgan Plain and over 50% on the Subcarpathian slopes reported in the work *Potențialul climatic al Bărăganului*, with the values found by us for the Alba Iulia – Turda Depression (slightly over 50%) it appears that some similitudes do exist, because the Foehn is active in both areas.

4. Major hygric risk phenomena

Relative humidity variations, developing against the background of great climatic variability generally, may reach extreme values that are distinctively different at one moment or another of the year, or of the day. Thus, oscillations from very high values, of over 80%, even at 13.00 hrs (the warmest moment of the day) to very low ones of under 30% at one of the observation hours did occur. These extreme values, having negative effects on the environment and human body alike, do represent climate risks.

Hygric risk phenomena through excess of atmospheric humidity or dryness of the air have been calculated in terms of the *frequency of days with relative humidity in excess of characteristic thresholds: ≤30%, ≤50% şi ≥80%.*

Days with ≤ 30% relative humidity. Atmospheric humidity under 30 % indicates severe air dryness characteristic of droughty periods when synoptic situations, dominated by an anticyclonic regime, usually result in the absence of precipitation.

In Alba Iulia – Turda Depression there are few dry days, as shown by the low *annual mean number* of days of relative humidity ≤ 30%; annual means of 25 days/year have been registered only at Sebeş, the other stations, influenced by a wet oceanic climate specific to the western and central regions of Romania, have a 15 days/year-record. However, the territorial distribution of the annual means varies widely in terms of the local physical-geographical conditions of each station (Fig. 5).

The annual distribution, assessed in terms of monthly means, shows a main maximum in April (1.1 days at Aiud and 5.1 days at Sebeş) and a secondary one in September (2.2 days at Ighiu and 0.7 days at Aiud) corresponding to the droughty periods of spring and autumn. From March to October, when days of relative humidity (≤ 30%) occur on a clear-sky-and-high-temperature background, such days, characteristic of June, become ever fewer, while precipitation days are more numerous. Between November and February, days with a very dry atmosphere are extremely rare (0.1-0.3 days), or are absent altogether (Fig. 6).

The influence of low relative humidity levels on the human body, mainly on the respiratory system, is obviously negative, because the mucous membrane drying up, looses protection to pathogens so that one is more exposed to illnesses. With values of ≤ 30% the risk becomes eminent.

If relative air moisture under 30% lasts for a longer time and is associated with high temperatures, intense evaporation and evapotranspiration during droughty periods, the biological cyle of plants is affected and crops might be totally or partly compromised.

Days with ≤ 50% relative humidity. If relative atmospheric humidity drops under ≤ 50% at least at one of the observation hours, it means that the average dryness interval in Alba Iulia – Turda Depression is of 112-138 days/year. The uneven territorial distribution, which is maintained, reveals the decisive contribution of local particularities: fewest such days (under 115) at Turda and Ighiu stations situated close to the mountain and benefiting from its moderating influence; most days in this category (over 135) occur at Sebeş and Aiud, which are located at lower altitudes (Fig. 5).

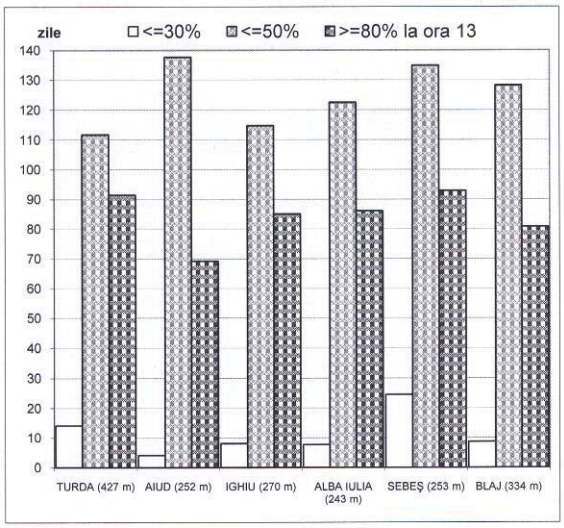

Figure. 5. Comparative variation of the mean number of days/year with various relative humidity characteristics (%)

More than one-third of the month, basically from March to September or October, is the annual interval when ≤50% days are very frequently occurring. Over fifty percent of all days in the warm season of the year (6 months) are dry due to heat-induced intense evaporation and evapotranspiration. Most days usually occur in April – 16.2 days at Ighiu, 17 days at Turda, 18 days at Blaj and 18.9 days at Aiud, but also in May – 18 days at Alba Iulia, 18.1 days at Blaj, with a secondary maximum in August – 17.9 days at Sebeş. Fewest moist days ≤ 50% are registered in December, a month in which the Mediterranean cyclones are very frequent and particularly active (Fig. 6).

Humidity values under 50%, associated with prolonged insolation, favour the development of pests and if drought stays on for several weeks, fires may break out in forested areas, cropped fields, stubbles and pasture-lands.

Days with relative humidity ≥ 80% at 13.00 hrs, when the diurnal temperature is at its peak, indicate great or excessive moisture.

The annual mean of such high-value days is of 70-93, which comes close to what is characteristic of the lowland regions (*Geografia României*, 1983). The fact that there are few very humid days is once more a proof of the influence of the Föehn effects in Alba Iulia – Turda Depression (Fig. 5).

The maximum monthly duration of such days (18-21) basically some 60% month, is registered in December, when there are numerous advections of Mediterranean humid air and low temperatures. As a matter of fact, from November to February, the monthly incidence of these days is much higher than in the March-October interval, when only 5 are recorded. In August, there are no

more than 2-3 days with relative humidity ≥ 80%, because the frequency of an anti-cyclonic regime and of hot dry air advections is at its height (Fig. 6).

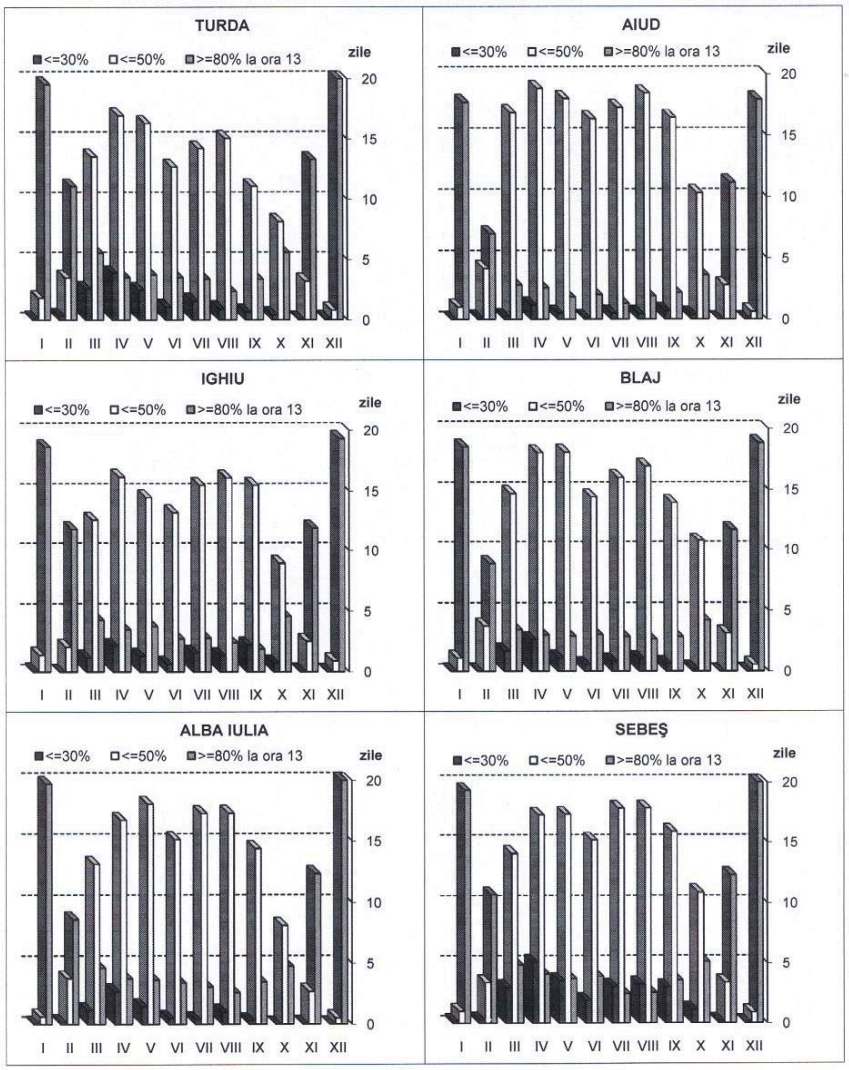

Figure. 6. Annual variation of the mean monthly number of days with various relative humidity characteristics (%)

The negative consequences for vegetation (diminished crops) and human health are felt when relative air humidity reaches exceptional levels.

High relative humidity conditions augment the risk of plant pests in crops (e.g. the proliferation of the mushroom which infects the vine and thus affects the

quality and quantity of productions, reducing them because of impaired vines (Ulea, 2005). Overmoisture in the air stops the ripening phase in cereals, diminishes the dry substance gathered in the leaves and impairs flourishing, polenisation, and fruitition, again depleting the quality and quantity of outputs. Storing food products may result in sprouting and mouldiness, or mushroom-induced diseases (Dragomirescu, Enache, 1998).

Too much relative humidity (≥ 80%) is detrimental to the human body, too, favouring the onset of rheumatic diseases, enhancing the chronic affections of the respiratory system and paving the way for seasonal breathing illnesses. Most such states are stress-induced by overmoist discomfort, which is much more difficult to cope with than a dryness-related stress ((Teodoreanu et al, 1984). High air moisture increases the risk for the development and transmission of viruses, infestation with acarids, the proliferation of bacteria and mushrooms, all of which lead to states of cold, flue, bronchitis, pneumonia, bronchial asthma and tuberculosis.

Negative effects have high relative humidity associated with high summer temperature (Temperature Humidity Index over 80 units). In this situation discomfort sets in through retardation of bodily heat loss by the evaporation of sweat, disturbing the thermoregulation mechanism, fact that perturbs human metabolism to the point of loss of life.

Summing up, we would say that the high incidence of dry days (≤50%) present some one-third of the year indicates that the Alba Iulia – Turda Depression, known for the manifestations of the Foehn effects, is more often exposed to dry air risks.

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