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THE CLIMATE OF NORTHEASTERN BULGARIA AS A PREREQUISITE FOR THE OCCURRENCE OF ADVERSE AND HAZARDOUS (RISK) PHENOMENA

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Abstract: The geographical area of Northeastern Bulgaria boasts a specific climate conditions. They are a prerequisite for the expression of adverse and hazardous natural phenomena. This report analyses the genesis and location of the adverse and dangerous meteorological, climate and hydrological phenomena within the Northeastern Bulgaria, which determined by climate conditions.

Keywords: Northeastern Bulgaria, climate conditions, adverse and hazardous meteorological, climate and hydrological phenomena

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Introduction

Adverse and hazardous natural phenomena are subject to greater interest in the last few decades, not only scientifically but also by practical application point of view. The reason is their negative impact on other branches of the economy: agriculture, transport, tourism and others. Phenomena with a similar effect, which run a small or negligible speed, defined as adverse. Under the influence of certain factors such phenomena may acquire extreme values in space and time and can cause substantial damage to natural complex and society, and to cause casualties. Treat them exactly dangerous, or hazardous (risk) natural phenomena.

Northeastern territory of Bulgaria characterized by diversity in terms of natural conditions (relief, climate, water, soil), a prerequisite for the expression of different origin, scope and extent of adverse phenomena. We present the climate conditions and the conditioned by them adverce phenomena with meteorological and hydrological origin, characterized by their genesis and location.

The geographical area of Northeastern Bulgaria emerging from the following limits: northwest of the Danube River between the towns of Ruse and Silistra, northeast — terrestrial border with Romania between the city of Silistra and Cape Sivriburun of the Black Sea. That is politically determined. Western boundary is marked by the watershed between rivers Yantra and Rusenski Lom. Reaches south eastern parts of the Predbalkan, as emerging from the northern approaches of Antonovski Heights, Lilyaksko Plateau, Preslavska and Dragoevska Mountains and the valley of the river Golyama Kamchia. East territory borders on the Black Sea. Within those limits, Northeastern Bulgaria represents about 20% of the country's territory. The predominant relief is lowland-plateau and ridged [2].

Climate of Northeastern Bulgaria

The climate of Northeastern Bulgaria is moderate-continental and along the coast of the Black Sea (up to 20-30 km off the coast) it is continental-Mediterranean. The moderate-continental area includes two regions – Ludogorsko-Dobrudzhanski and the Danube lowlands, while the continental-Mediterranean includes Varna and Dobrudzha Black Sea regions [1]. In the moderate-continental regions the climate is characterized by significant continental and dry

features. During the summer this area is witnesses lower levels of rainfalls compared to other parts of the Danube plane since the air masses, coming from northwest, already lack humidity when they reach these spots. On the other hand, the openness of the plane on the northeast allows for easier access of cold air masses from the north and northeast during the winter. What is more, the moderate-continental climate in Southern Dobrudzha sometimes displays features characteristic of the steppe climate. Those climate features are aided by the remoteness from large orographic barriers such as Stara Planina and the Carpates, as well as by the restricted influence of the hilly lay of the Predbalkan area and the large extent of neutralization, caused by climate influence of the Black Sea through the air flow, mainly coming from the northwest. The stronger continental features of the climate are further confirmed by numerical data of the climate elements, mostly temperatures and rainfalls. The average temperature during January is around - 2° C, and the average temperature during July is from +24° C to +25° C, the temperature amplitudes (dayli and annual) increase in the North. The most extreme temperature levels have been measured in the town of Rouse (+43,7° C; -27,7° C) and in the town of Silistra (+41° C; -32° C). The annual precipitation varies between 500-600 mm (June maximum; February minimum). Despite the low altitude, the snow stays for 2 to 3 months. During the summer there are very hot days combined with minimum of precipitation and dry winds which leads to drying up and causes significant losses to the farming and agricultural industries. Sometimes, during the winter, the strong wind forms snowstorms, which blow away the snow from agricultural areas, and this, combined with low temperatures, leads to destruction of crops. Field protection mechanisms are designed for crop preservation. Along Varna and Dobrudzha Black Sea coast the average July temperatures are lower (Varna +22,6° C; Shabla +22,5° C) from the ones in the mainland, while the average January temperatures are above zero (Varna +1,2°C; Shabla +0,6°C). Temperature amplitudes are also lower. The annual precipitation is lower – 440 and 520 mm. The average wind speed along the Black Sea coast is above 2 m/sec., and this is one of the windiest areas in Bulgaria.

Adverse and hazardous meteorological and climate phenomena

Against the background of moderate-continental climate of Northeastern Bulgaria, observed the event of adverse meteorological phenomena in the warm and cold half. Of them consider

droughts, heavy precipitation, hail, dangerous and sharp cold spells, late spring and early autumn frosts and ground frosts, iciless and consequenses of snowfalls.

Droughts are associated with the regime and the quantity of rainfall. As a meteorological term are long periods of 10 or more consecutive days in which rainfall is no more than 0.1 mm/ 24 hours. Over Bulgaria sometimes accommodating typical tropical air masses, formed over North Africa and Asia Minor. More often, however, is the impact of the transformed in the summer over South-Russian steppes air masses, acquiring continental features, from the north and northeast, causing a sharp drought and high temperatures. Because neighbours of Northeastern Bulgaria with extensive continental land of Eastern Europe (especially steppe regions of Ukraine and Southern Russia), plain relief and peculiarities of atmospheric circulation, droughts in this region are annually phenomenon. Northeastern Bulgaria is one of the most dry regions in the country in terms of periods without rain lasting over 10 days. Eastern parts are characterized by one of the smallest annual rain amounts (less than 500 mm). According to Velev (1990), most often occur in Dobrudzha droughts and Varna coast, as the frequency is 8-12 times the average. Their duration is usually 10 to 20 consecutive days. Droughts during the warm part of the year, combined with high temperatures, intense solar radiation and low relative humidity, soil dry and significantly impede the normal development and growth of agricultural crops. Therefore droughts be studied during the active growing season of vegetations (April-October). The greatest incidence is on the Black Sea coast to 20 km inside in the drought, followed lowlands near Danube River, Dobrudzha and the northern part of the Ludogorie. Lowest number is in the southern part of Ludogorie and the Eastern Predbalkan. Drought periods lasting over 20 days occur on average once (throughout the Northeast Bulgaria), while those lasting more than 30 consecutive days — once every 3-5 years. The most extensive droughts (over 50 days) were observed very rarely-once 20 and over 20years [3].

Regarding rainfall amounts from April to October, which are also an indicator of the degree of drought, indicators are: most are small amounts along the sea coast (250-270 mm), because daily breeze prevent the formation of convective cloudiness. The summer rainfall, which is a factor for autumn-summer drought here. However, the relative humidity is increased because of the proximity of the sea, and temperatures are not as high as inside the region. Therefore droughts

here are somewhat alleviated. In Dobrudzha and areas of Suvorovo, Provadia and Dalgopol, rain amount is 300-350 mm, while in the rest, most of Northeastern Bulgaria (Ruse, Ludogorie, the region of Shumensko Plateau), it was 370-390 mm [3].

Droughts in Northeastern Bulgaria are most frequent in the summer and early autumn, in conjunction with the annual minimum of precipitation. At least through May and June due to annual maximum of rainfall when the most brief. Their average duration is increased gradually to August and September.

As a risk we can determine particularly strong and prolonged droughts, which are sometimes observed. For example during the years 1986, 1990, 2000. In 2000, dry period occurs in July and August, accompanied by high temperatures, with frequent winds from the south and south-west carrying tropical dry air. The effects — significant damage to agriculture and forestry fund occurred because of fires.

Intensive precipitation, i.e. brief, but heavy falls, fell on a small geographical area, often have a negative effect — leading to a sharp increase in water levels in rivers and dry valleys, and settlements flood agricultural land, causing problems in transport and sewerage infrastructure, an intensive erosion-accumulative processes, activation of landslides and others. Often they relate to particularly dangerous weather phenomena, the consequences are of the natural disaster. Although Northeastern Bulgaria is one of the most drought regions in the country, here are observed with intense rainfall a significant rate, which is an indicator of past and future consequences of natural complex and society.

The heavy precipitation most often fall under cold front well developed cyclones or occlusion as a cold front is ignition cyclones [4]. In such cases are rare heavy rainfalls as a result of the development of powerful convective cloudiness in the same air mass. Be observed mainly in the warm half, when the effect of the cold front is reinforced by heat convection. The territory of Northeastern Bulgaria are reported and cases with extremely large quantity of record on irregular rainfall-over 250 mm/24 hours. For example in Varna in August 1951 (258 mm), Druzhba (342 mm). The consequences of this precipitations is the formation of sediment cone-delta, jutting 300

meters in the sea, as the wash out by winter storm in 1953 was a sandy-wide beach strip 10-20 meters.

Most overnight maximum rainfall are heavy, is outperformed the amount 20-25 mm, which is considered lower bound for the climatic conditions of Bulgaria [1]. According to other authors [5], for such a limit is taken 50 mm/day. Rainfall levels often fall for a relatively short period of time. The rainfalls are considered intensive, when the amount is higher than 0.18 mm/min [4]. Origin is similar to that of the maximum overnight falls. Are associated with powerfull, highly developed in unstable air mass rain cloudiness (Cumulonimbus).

Intensive, potentially risky precipitation are observed most often in May and the most dangerous rain fall mainly in the summer (July and August). Intensity of rainfall depends on intensity of rain cloudiness in passing cold fronts, and the impact of local orography. In genetic terms intensive rainfall (and especially the maximum overnight rainfall) in the spring and summer to justify invasion of a damp and unstable ocean air at the cold fronts of Atlantic cyclones. They are concentrated in the open north and north-west foot slopes of the eastern windward the Predbalkan (Preslavska, Dragoevska Mountain), the plateaus and in the higher hypsometric zone (over 200 m). i.e. location for this type of precipitation has a significant impact orography.

The region of Varna, the riverside of the Danube River between Ruse and Silistra are "preferred" places in which very intense rainfall for a short time [5].

It should be noted that heavy fall occur during the winter months, but are mainly from snow and have no immediate risk nature of causing flooding and high waves in the river beds. Negative effect occurs when intense snow melt.

As an example of extremaly heavy overnight rain, will display heavy rainfalls in 2005, caused significant damage-destroyed buildings, roads, railways, activation of landslides, flooded homes, evacuated people and even casualties. 3 in the case of precipitations day for more than 50 mm was recorded in Ruse, Razgrad and Shumen. [6]. In some areas overnight precipitations exceed 100 mm. This happened not once but in four separate rainfall emergencies. Moreover,

throughout Northeastern Bulgaria were reached new absolute overnight maxima for the entire period of observation, respectively in Targovishte — 153.8 mm on July 4th, in Shabla — 122.7 mm on September 22nd, and Kaliakra — 127.8 mm on September 22nd.

Preventive measures that can be taken for the protection of emergency after intensive rainfalls are: regular cleaning of river beds, proper management of dams and avoid the construction of buildings, facilities, industrial, agricultural and other buildings, floodplain terraces in the river valleys, especially in foots of northern and north-west slopes of the mountains, heights and plateaus.

Hail in Northeastern Bulgaria are mainly front, as well expressed cold fronts from the northwest-west, with well-developed than in May and June, July. Often observed in the region of Ludogorie and mountains of the Predbalkan. For the scope of hail be judged by their claims on agricultural lands. This indicator with the greatest range in the period May-August, occur in the territory of Ruse region. Black Sea coast is the least threatened by hail during the warm half because of the effect of sea-standing influence.

Damage caused by hail may be reduced through prevention activities, such as anti-hail protection, agricultural insurance, etc.). The territory of Northeastern Bulgaria is not yet built poligon for the hail and this needs to be done in Razgrad and Ruse area, where the frequency and intensity of the phenomenon is big every year and show substantial damage to agriculture [2].

Of adverse events during the cold half consider snowfall and snowcover, iciless, dangerous and sharp cold spells, early autumn and late spring frost and ground frosts. Typical of Northeastern Bulgaria is that the phenomena observed relatively more frequently than in the rest of the country with similar landscape and causing substantial material damage, hinder agriculture, affect the human body and, in certain cases and take victims [7].

Formation of **snowcover** heigh above 10 cm is negative phenomenon in terms of transport difficulties. Most often this is formed in the regions of Ruse, Razgrad and Shumen (average of 3 times per winter), the Dobrudzha (2 times), as the most rarely reached such a height in the Black

Sea coast (1 case of 2 winters). Almost every winter snowcover in the area of Ruse, Razgrad and Shumen reached a height over 20 cm. Unlike the coast, where substantial snowcover can be formed by early December until the end of March, in the rest of the territory possible period was significantly a longer — by the end of October to mid-April. The average number of days with snowcover is the lowest in the Black Sea coast about 30 kilometers inside in the land (12-16 days) and rises to 30-38 days in the lowlands near Danube River, Dobrudzha and region of Shumen. More than 40 days with snowcover is reported in Ludogorsko Plateau and Predbalkan [7] .

Heavy snowfalls in Northeastern Bulgaria are most frequent in the regions of Ruse and Shumen, followed by Razgrad, Silistra and Dobrich [7]. In combination with strong winds, they cause blizzard, the formation of snowdrifts with significant thickness. To create disaster situations almost every winter, associated with blocking the road network, damage to lines and others. Prevailing wind direction during the snow from northeast, north or northwest. Blizzard and snowdrifts in fresh and dry snow are formed even in moderate winds (6-10 m/s). For the region of Ruse almost half the cases with winds accompanying the snow are a speed 11-15 m/s., and near Varna — over 20 m/s. Along the seacoast 70-80% of cases with snowcover and snow are characterized by winds with speeds over 14 m/s, lowlands near Danube share is 33-40%, and the rest of the Northeast Bulgaria — 20%. In Dobrudzha for the proper and over allocation of snowcover helped protective forest belts.

Accumulation of wet snow and ice occur in the region where air temperatures are around $0^{o}C$ northeast and strong winds. Under such conditions in Dobrudzha have formed deposits on power transmission lines with a diameter of ice mass 8-10 cm [1].

Especially adverse in cold half is the combination of the snow, snowcover over 10 cm and strong winds (over 14 m/s). Most often this occurs in the region of Ruse — almost every winter in the regions of Silistra and Varna (typically once in two winters). This combination of adverse weather elements are usually observed in January.

Iciless in Northeastern Bulgaria does not monitor each winter. Most often the compilation are due to the fall of ice pellets or rain, drop-down on overcooled surface. The most favourable conditions for their formation are in the Dobrudzha. Here interact warm and moist air masses over the Black Sea and cold air continental masses, coming smoothly from the north and north-east of the plains of Ukraine and Moldova. Iciless on the Black Sea coast are very rare phenomena.

Dangerous and sharp cold spells relate to the adverse winter phenomena not only because of the danger of frost bite of agricultural crops, but also in terms of bioclimate comfort. The sharp decrease in temperatures to -15, -20^{o}C can cause frost bite of agricultural crops in terms of not very cold winter, snowcover and scarce variables thermal conditions.

Terms of strong cold spells in Northeastern Bulgaria are created in areas with anti-cyclone centers over Scandinavia and the European part of Russia, as the intrusion be conducted on their eastern and southern periphery. Heavy cold spells without snowcover are possible because of openness in the territory for penetrating continental cold air masses and plain relief. Advection the north and north-east are the most low heat level in the areas of the Ludogorie and Dobrudzha [7].

Decrease in temperatures below 15^{o}C occurs most often in the regions of Ruse and Shumen (once every 3 winters), twice less chances for the region of Silistra, while the Black Sea coast-every 15-16 winters (Tetovski, 2006).

In connection with hazardous cold spells are the values of absolute minimum temperatures, which are closely related form of relief. In areas with low altitude, close to rivers and valleys extensions figures of around -26, -30^{o}C (Ruse, Silistra, Popovo), in a positive or found in plain areas, even with greater altitude, they do not fall below 22^{o}C (Samuil, Omurtag, Tervel).

To adverse events during the semester cold, fall **late spring and early autumn freeze and ground frost** which have a negative agro-climate effect.

Reasons for lower temperatures below $0^{o}C$ before the end or the beginning of the active growing season of plants can be advection of cold air masses, radiation cooling of the ground atmospheric layer or combined advective-radiation decrease in temperature [2].

Late spring frosts are mainly advective-radiation and early autumn frost-radiation in genesis. In the spring, 60% of frosts were due to invasions of north-west and west, and 35% — from the northeast. In the fall, northwestern and western invasions have the same share, and northeastern reduced (23%) [1]. Therefore, in the eastern parts of Northeastern Bulgaria relative share of late spring frosts increased to share the early autumn (Shabla — 85%, Varna — 100%, Gen. Toshevo — 56%, Suvorovo — 51%). Valley decreases of the rivers account for at least the freedom of time free of frost, because here are recorded at later dates middle of last spring frosts and the early dates of the first autumn frosts.

Unfavourable and hazardous hydrological phenomena

River swells are characteristic element effluents regime of rivers in Northeastern Bulgaria. The biggest swells causing floods and speeds erosional-denudation and accumulative processes. These extreme events are genetically determined by synoptic emergencies with significant intensity and repetition rainfalls and snow melting. A major role in swells during the warm half have rainfall emergencies in cold fronts (or occlusion) of Atlantic cyclones and inner mass rain and during the cold half-fronts on hot (or occlusion of this kind) of Mediterranean cyclones. Monitor is extremely large swells, as a result of torrential rain during the warm half related to the Atlantic cyclones and snow melt or melt with rains in cold half, connected with the Mediterranean cyclones. The likelihood of flooding during the cold half grew stronger in advection hot air when the place and create foehn occur rapid melting of snowcover. The most significant increase in temperatures and offers nearby lands north of it (Shumen) [7]. Dangerous are the cases where warming is accompanied by intense rain. Risk are the river valleys in the southern part of Northeastern Bulgaria (Golyama Kamchia, Provadiyska, Vrana), spring from areas where formed in thick snowcover and are affected by foehn winds. Between 1997 and 2005 in surveys region as a result of the above reasons were caused three heavy winter floods and early spring ones

Other prerequisites for swells are the geological, geomorphological and soil-plant traits, because they affect water control of the territory. For example data for high waves show that they are observed, especially when he enters the rivers in the plane (Provadiyska River, the outcome of Samuilovski Heights, Golyama Kamchia River after Preslavska Mountain), here are collected moving apace on the slopes waters.

Anthropogenic changes also have an impact, especially degrade of soils and forests, urban, geomorphotehnogenesis. Swelling are most during the spring-summer high waters (March or February, June or July), and at least during summer-autumn low waters (August-October). Degrees of swell rivers are in five categories (I — least swell to the V — most swell) [2]. In Northeastern Bulgaria least swell (Category I), with an average 2-3 times a year, are the small rivers under 200-300 meters altitude. At low torrential (Category II) with an average rate to 4-6 cases a year, concerns such as river Rusenski Lom. Upstream of the Golyama Kamchia River has much high waters (V category I) with a frequency 8-9 cases per year.

For those parts of the drainage areas, which are characterized by a higher water delivery must implement active measures to limit erosion.

Cases of irregular, very large swells, accompanied by catastrophic floods, cause substantial damage to society and the natural complex. In Northeastern Bulgaria is highlighted some of the heavy flooding in large material damage and casualties, especially at the beginning of the XX and XXI century. They are the result primarily of heavy rainfalls. For example, as a result of these rains in July 2005, the rivers Provadiyska and Golyama Kamchia flood agricultural land, buildings and roads. Because of heavy rains in September, Rusenski Lom River also flooded villages and fields. Torrential rains in August 2007 caused distress in the municipality Tsar Kaloyan transfusion because of micro dam overflow, causing Hlebarovska River, a tributary of the Beli Lom, to run out of it course. Along flooded buildings and roads, it takes 8 victims.

As mentioned, the measures to protect rivers from flooding, are building systems of protection facilities, regular cleaning of river beds, proper management of dams and others.

Conclusion

Based on this analysis, it can be summarized that the territory of Northeastern Bulgaria, is showing a large number of adverse and hazardous phenomena with meteorological, climate and hydrological origin. The main prerequisite for the event are their specific climatic and hydrological conditions, but in combination with the characteristics of the terrain and soil-vegetation cover. Diversity in natural conditions determine the extent of features and dynamics of adverse developments, as it contributes significantly and anthropogenic influences.

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