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УДК 551.577 (438)

Variability of air temperature and precipitation in Katowice between 1931 and 1996 in relation to urban development

Аналізується вплив швидкого розвитку процесу урбанізації, що відбувається в останні десятиріччя в Польщі, на атмосферу на прикладі даних м.Катовіце та м.Александровіце. Акцентується увага на вирішенні проблем так званого "теплового анклава" температури та зменшення природньо притаманного даним регіонам рівня опадів у роки швидкої індустріалізації.

The aim of this paper is an attempt to answer the question whether or not the rapid urban growth affected the course of changes in air temperature and precipitation in a period 1931 – 1996 being analysed. Changes in climate (on a local scale) resulting from great urbanisation growth have been more and more often mentioned recently. It has been demonstrated that the rapid development of cities resulted in changes of thermal conditions over big urban areas and contributed to creation (where proper atmospheric conditions occurred) of the so-called urban warmth enclave. In order to explain some aspects of variability of precipitation and air temperature in relation to urban changes, comparative researches have been performed of the data recorded in Katowice and Aleksandrowice – a station representing urban conditions.

Synoptic station Katowice – Muchowiec is located in the centre of Upper-Silesian Industrial Region (Gyrnośląski Okręg Przemysłowy) at the altitude of 285.4m above sea level. It operates in the airfield at the south-western border of the city and, although it is not subject to city's direct influence, an assumption can be made (based on the fact that GOP can be treated as one big city as far as distribution of dense structure of buildings is concerned (Kruczała, 1972)), that it represents the climate of an urbanised area. Aleksandrowice is situated a few kilometres south-west of the centre of Bielsko Biała. Despite the neighbourhood of that industrial centre, the station in Aleksandrowice represents rural conditions as it is situated on a swell (399m alt.) about 40m above the level of the city, within the airfield outside the urbanised terrain.

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Lengths of periods used in this paper reflect availability of sources. Data included herein is taken from Climatic Atlas of Poland (Atlas Klimatyczny Polski), Meteorological Year-Books (Roczniki Meteorologiczne) and Precipitation Year-Books (Roczniki Opadowe 1930-1937; 1954-1981), database of IMGW (Institute of Meteorology and Water Management) (1966-1996) as well as archive materials of IMGW in Krakyw (data from the period 1992-1996).

The matter of long-term variability of precipitation was described by analyses of seasonal and yearly total rates of precipitation. The values were averaged by the method of ten-year consecutive averages and variability factors were calculated for them.

The matter of long-term variability of air temperature was presented basing on the analyses of: yearly averages (Tśr) and seasonal averages of air temperatures during the period 1931-1996 as well as yearly average maximal (Tmax) and minimal (Tmin) temperatures. It was possible to gain the full set of data only in case of monthly average temperatures, although those for periods 1939-1943 and 1945-1946 were reconstructed by the authors of Climatic Atlas of Poland (Atlas Klimatyczny Polski, 1971).

Yearly amounts of precipitation

In a long-period course of yearly amounts of precipitation there was a long-lasting wet phase during 1958 – 1981, with a peak in 1974 – 1977. The wet phase in Aleksandrowice also began in 1958, but it lasted shorter, i.e. until 1977. In 1960s and 1970s precipitation surplus was recorded all over Poland (Kożuchowski, 1984; Przedpełska, 1988). Small amounts of precipitation occurred in both analysed stations at the beginning of the analysed period (1951-1957). Next period of reduced precipitation began in 1980 in Katowice and in 1978 in Aleksandrowice. A beginning of a wet phase has been observed in the considered stations since 1994.

Summer precipitation

Long-term variability of summer precipitation reflected the variability of yearly amounts, with only minute deviations.

A wet phase in Katowice included summer periods in late 1950s and early 1960s (1957-1961) as well as from mid-1960s to the end of 1970s (1966-1980). Particularly low summer precipitation was recorded in early 1950s (1951-1954) and during the second dry phase that began at the end of 1970s (1978). Low precipitation in Aleksandrowice occurred in early 1950s. Another period of low precipitation began in 1975. A wet phase in Aleksandrowice began in late 1950s and lasted until mid-1970s.

Winter precipitation

The highest winter precipitation in Katowice was recorded during the 1976/77 season, while that in Aleksandrowice occurred unexpectedly on the turn of 1951 and 1952; basing on the year amounts of precipitation, these years belong to a dry phase. On the other hand, the lowest winter precipitation in both Katowice and Aleksandrowice occurred in the 1953/54 season. It is also worth mentioning that amounts of precipitation in Aleksandrowice and Katowice have been virtually equal. The situation resulted from the increase in winter precipitation in Katowice, which, in turn, may have been an evidence of influence of the city

Autumn precipitation

Amounts of autumn precipitation in Katowice and Aleksandrowice were characterised by similar course of variability in the long period 1951-1996. The highest amounts of precipitation in both stations occurred during autumn of 1952 and the lowest ones in 1959.

Spring precipitation

No clear variability has been observed in a long-term course of spring precipitation, especially in case of Katowice. Slightly higher variability characterises the precipitation in Aleksandrowice, where a wet phase occurred during 1960-1968.

Air temperature in Katowice

Reflecting the theory of global warming of the climate, the average air temperature in Katowice shows a tendency for growing. It increased by about 0.4°C in the period from 1931 to 1996. However, the tendencies of temperature changes varied in different seasons.

- **Winter season** – the temperature increased by as much as 1.6°C during the analysed period
- **Spring season –** an increase by 0.8°C in average temperature was observed
- **Summer and autumn seasons** – analysed values did not show an increase. The results were close to zero and had negative values

Analysed maximal and minimal averages from the period 1947-1996 underwent a general increase. Bigger rate of changes in minimal temperatures as compared to maximal temperatures is also noticeable.

Course of temperatures in Katowice and Aleksandrowice

Differences regarding average temperatures between 1951 and 1996, which occurred between Katowice and Aleksandrowice, are very interesting. The air temperature in Katowice increased by almost 0.3°C during that period. The temperature was higher in Aleksandrowice in 1950s, but the difference started to decrease gradually from mid-1960s and finally the temperature became higher in Katowice in the following years. It is worth mentioning that Katowice has had the character of the great city since mid-1960s.

A growth of air temperature in Katowice in comparison to that of Aleksandrowice can also be seen while analysing maximal temperatures (an increase by 0.3°C during 46 years) and minimal temperatures (an increase by 0.6°C during 46 years).

Summary

Comparative analyses of precipitation in Katowice (being a representative of urban conditions) and Aleksandrowice (situated in the foreland of Sącz Beskids (Beskid Sądecki)) showed that the differences between amounts of precipitation in Katowice and Aleksandrowice decreased significantly during the period of the highest industrial development of GOP (about 1972-1983). This situation may have resulted from the city's impact on the amount of precipitation through the increase in number of condensation centres in the atmosphere the more so because the discrepancy between amounts of precipitation in the discussed stations increased again during next period which started in mid-1980s (this is when industrial activities decreased). Basing on the researches on long-term changes in air temperatures, it has been found that they show a tendency for growing. Local factors can be responsible for that process. One of them is urbanisation interpreted as changes in population. An impact of urbanisation on air temperature changes in Katowice appears in two ways. Firstly, it is demonstrated by the increase in the yearly air temperature average in Katowice in comparison to rural conditions. Secondly, a tendency for gradual decrease in fluctuation of the yearly air temperature average as well as the minimal and maximal air temperature averages during the period of rapid growth of the city has been observed.

For a fuller description of urban organism's influence on profiling long-term changes in precipitation and air

temperature, it seems necessary to consider also air contamination (especially dustiness) and distribution of buildings in the city.

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УДК 572 : 504

The Role of Anthropopression in Formation of Ecosystems

Since man had appeared on the Earth and begun to create organized societies, exploiting solar energy accumulated there the anthropopression is spoken to begin. It is understood to be a human impact on environment leading to modification of naturally created ecosystems and landscapes. As our species developed the impact deepened. Nowadays there exists the opinion that once homo sapiens was a united element of environment depending on mutual connections with others, but today he is first of all a consumer making use of natural resources of the planet. This does not mean that he became more powerful than nature. He still is not be able to subordinate the powers of nature and stays in mutual equivalent connections with nature. Human performances may be compared to natural phenomena mostly of catastrophic character. However disasters cause unbalances in ecosystems what could lead to their degradation but also this could create conditions for development of new biocenosis.


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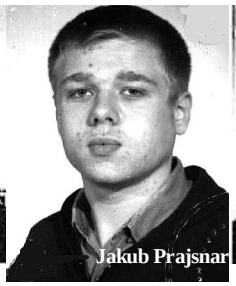
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At the beginning of Holocene after retirement of glacier from the area of Europe there took place the succession of vegetation, in result of which forests covered the prevailing part of Europe. At the beginning of Middle Ages situation began to surrender to essential changes caused by man. He began to cut out forests under cultivation and pastures. The man need also wood as fuel for metallurgic furnaces. This situation reminded natural fires. Those performances influenced the modification of climate. It was change from humid into drier and continental. Such a change allowed numerous sorts of animals to pass from the eastern and north - east regions to the area of western and central Europe. Those species spread out and found their new place in new environment so that it would be difficult to determine their origin today (Reichholf, 1999). Those very often are the species, which appear completely natural for landscapes of our villages e.g. red poppy, cornflower bluebottle, and corn cockle. Together with plants there came insects: *Polyolymmatus bellargu, Colias hyale, Melanargia galathea*. It seems interesting that about half of our day butterflies belong to newcomers (Reichholf, 1999). There came also mammalians: mice(*Apodemus flavicolis*), hamsters (*Cricetus cricetus*), hares (*Lepus europeus*) and birds: partridges(*Pardix pardix*), larks (*Alauda arvensis*), owls (*Asio otus, Bubo bubo, etc.,)*. Without fields and species linked to them our environment would be impoverished by one third of species (Reichholf, 1999). Cultivated fields arose under anthropopression. There operated natural rules that had been in force at the beginning of Holocene. The same expansion of species was provided on the burnt areas being a resultant of great fire e.g. in central and east Europe.

The other and not necessarily negative indication of anthropopression is the formation of numerous artificial reservoirs. The best example may the pond Rontok Wielki situated in USIR (GOP) near Goczałkowice Zdrój. For many years it has been performing the role of a basin for salt waters coming from the mine KWK Silesia. In the reservoir the salt mining waters are mixed with fresh water. This is analogical to nature. Because mixing of salt waters with fresh waters takes place in river estuaries to the sea. Mixing causes the temperature of water to raise. This effect is increased by numerous shoals occurring around the pond described. Therefore the environment conditions of the pond Rontok Wielki are similar to environment of seashores e.g. Baltic sea. That's why there are present birds familiar for the seashores more than for the inland pond. There was observed the following species of birds: *Tringa, Actitis, Larus, Calidris,*