OUTLINE OF THE PROBLEM OF RESEARCH INTO CLIMATE CHANGE ON THE BASIS OF THE RESULTS OF GROUND-BASED METEOROLOGICAL OBSERVATIONS IN POZNAŃ, POLAND

ALOJZY WOŚ

Adam Mickiewicz University, Institute of Physical Geography and Environmental Planning, Poznań, Poland

Manuscript received December 20, 2009
Revised version February 15, 2010

WOŚ A., 2010. Outline of the problem of research into climate change on the basis of the results of ground-based meteorological observations in Poznań, Poland. *Quaestiones Geographicae* 29(1), Adam Mickiewicz University Press, Poznań 2010, pp. 85-89, Figs 7. ISBN 978-83-232-2136-4. ISSN 0137-477X. DOI: 10.2478/v10117-010-0009-2.

ABSTRACT, One of the important topics in the current discussion on causes of climatic changes is a proportion between natural and anthropogenic factors. The majority of climatologists are of the opinion that at present signs of the antropogenic factor are visible only on a local scale. An evaluation of the impact of this factor on a global scale will be possible in the future as more and more data on the physical parameters of Earth's atmosphere are to obtain using meteorological satellites.

The largest series of meteorological data, which currently constitute the basis of all analyses and forecasts concerning climate changes in the immediate and distant future, come from urban areas. The results of meteorological measurements are constantly influenced by the factor of municipal development, changes in the measurement locations within administrative borders, and also by variations resulting from the geographical location, the type of building development, and the colouring of the city. The city, depending on the dominant colour, and also on the colour of the surrounding area, does not always generate a *urban heat island*. There are areas around the globe, mainly in tropical latitudes, where the city is colder than the surrounding areas, which leads to the occurrence of a *urban cold island*.

KEYWORDS: global climatic changes, Keeling's curve, urban cold island, urban heat island, Poznań, Poland.

Alojzy Woś, Adam Mickiewicz University, Institute of Physical Geography and Environmental Planning, Dzięgielowa 27, 61-680 Poznań, Poland, e-mail: alwos@amu.edu.pl

In the distant past, global climatic changes resulted exclusively from natural causes. These causes have not been fully analysed to date. Certainly, these include astronomical factors – such as the activity of the Sun, volcanic eruptions and earthquakes, changes in the quantity of natural CO_2 in the atmosphere, etc. Natural climate change factors are characterised by periodic (cyclic) changes.

Over the past one hundred or so years, the influence exerted by man on the natural environment – which also impacts climatic relations – has become steadily clearer (Obrębska-Starkel & Starkel, 1991; Sadowski, 1996; Schönwiese, 1997). This is to be illustrated by the constant increase in the quantity of CO_2 in the atmosphere, which is shown by Keeling's curve (Keeling, 1984) (Fig. 1). It illustrates the

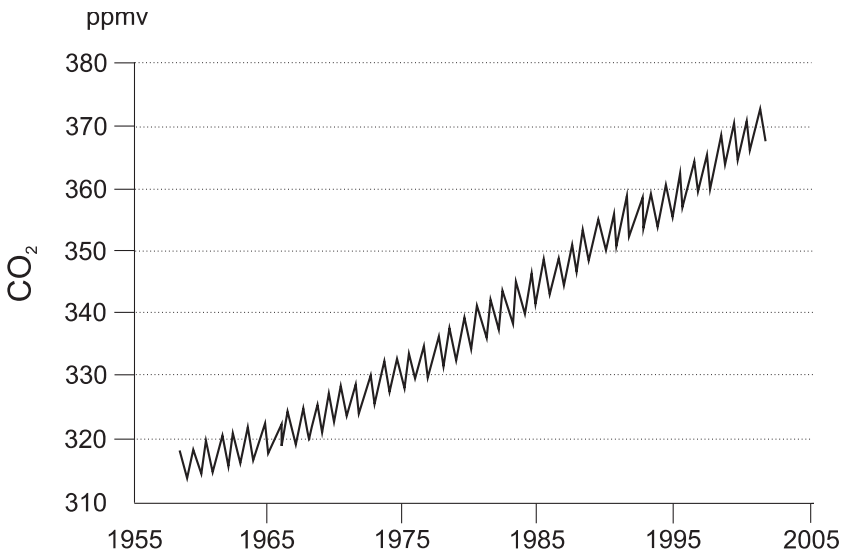

Fig. 1. Keeling's curve (cdiac.ornl.gov) presenting an increase in the atmospheric carbon dioxide level on the Mauna Loa peak in Hawaii. Data for the years 1958-2005

aggregate share of the natural and anthropogenic factors.

Currently, Ch. Keeling is of the opinion that the increase in air temperature noted in recent decades is the result of natural, cyclic climate variations, upon which the effects of man's economic activities are only superimposed.

The majority of climatologists are of the opinion that at present signs of the influence of the anthropogenic factor are visible only on a local scale. It is possible, however, that they will also influence the climate on a global scale in the future. Natural climate variability factors continue to be decisive – they control the variability of the climate on a global scale (Boryczka, 1993).

At present, we cannot quantify the share of the anthropogenic factor in local climate changes, nor – all the more so – its share in global climate changes. It is only an estimate that in the city, for example, 5-10% more precipitation is observed, the correspondingly greater number of clouds is noted, the wind speed decreases by 10-30%, higher air temperatures are noted, while the quantity of constant contaminants suspended in the air may be even 1000% times greater in comparison with the extra-urban zone (Boryczka *et al.*, 1992).

Over the past quarter century, the variability of weather situations, which is being observed from year to year, and the differences in certain meteorological indices, mainly thermal and precipitation-related, occurring in different years, have become the object of particular interest on the part of climatologists (Fortuniak *et al.*, 1992). Among others, research into these issues includes the elaboration of forecasts of climatic relations for the next few decades (Climate Change: the IPCC response strategies, 1991). The aforementioned differences in the weather regime of individual years (weather anomalies) are always local in scope.

The beginning of meteorological instrument observations more or less corresponds with the discovery and formulation of the first regularities concerning the Earth's atmosphere towards the end of the 17th century. Initially, meteorological observations were usually made at astronomic observatories. This close bond between astronomy and meteorology lasted until the middle of the 19th century.

More or less at this time, meteorological observations in individual countries started to become an organised undertaking. This ushered in a period of activity aimed at ensuring the comparability of the results of meteorological measurements and observations performed and gathered at a steadily growing number of points around the world. The first organised networks of meteorological stations started to appear.

The connection of a constantly growing body of meteorological data with research methods typical of the exact sciences and the systemati-

cally increasing quantity of ever more precise information on the orography of both proximate and distant areas of the globe helped develop a new field of knowledge – climatology.

In the nineteen sixties there commenced a period during which information on the physical parameters of the Earth's atmosphere was obtained using meteorological satellites; this was accompanied by the development of satellite meteorology. In the author's opinion, only an analysis of these data for a period of many years will provide us with convincing and unequivocal information on the direction and quantity of global changes in climatic relations for next few decades.

The largest series of meteorological data, which currently constitute the basis of all analyses and forecasts concerning climate changes in the immediate and distant future, come from urban areas, for these were the locations of the first points of measurement of the physical characteristics of the atmosphere (Lamb, 1978). Within any given township, the results of meteorological measurements are constantly influenced by the factor of municipal development, and also – this holds true for the majority of townships – changes in the measurement locations within administrative borders. In the nineteen thirties, the advent of aviation made it possible to frequently change existing points of meteorological measurements; these were often transferred to airfields, or new stations were established at airfields – however, these provided only relatively short series of meteorological data that are of limited use for research into contemporary climate changes.

For example, in 1869 the city of Poznań occupied an area of approximately 942 ha and was inhabited by approximately 69,000 people. By 1925, the number of citizens had increased to 220,000, while the area of the city totalled 6,736 ha. By 1939, the number of permanent residents totalled 274,000, while the area of the city had increased to 7,691 ha. In 1955, Poznań occupied 21,955 ha and was inhabited by 375,000 people. In 2000, the city had approximately 580,000 inhabitants residing on an area of approximately 26,100 ha (Fig 2).

Systematic meteorological observations were commenced for Poznań in 1848. The air temperature was measured in the western part of the city, on the then developed area, while precipitation was measured in the so-called lower town. In 1885, meteorological measurements were performed at No. 2 Zielona Street. In January 1911, a meteorological station was set up at one of the present-day buildings of the Adam Mickiewicz University-Collegium Minus. In 1935, the Poznań-University and Poznań-Golęcin stations were replaced by the Poznań-Sołacz stations, which nearly continuously performed observations also after the Second World War. The Poznań-Ławica station has been operational at its current location since 1948, and it simultaneously functions as the Airport Weather Office (Fig. 3).

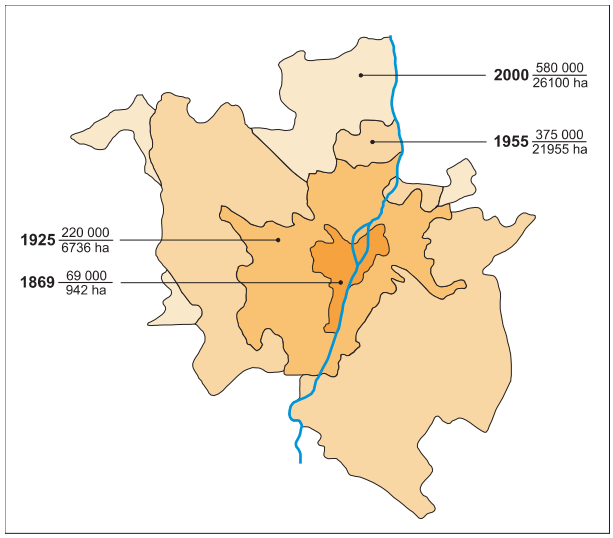

Fig. 2. Poznań – an increase in area and population

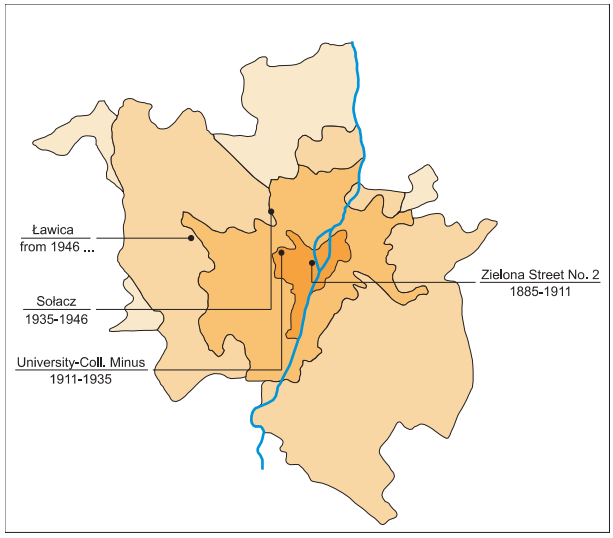

Fig. 3. Poznań – sites of measurments and meteorological observations

Fig. 4. Ia – Santorin (Greece)

The influence exerted by the municipal agglomeration on the results of meteorological measurements is also characterised by variations resulting from the geographical location, the type of building development, and also the colouring of the city, which factor continues to be completely overlooked by climatologists; the influence exerted on measurement results for cities located in the semitropical zone (*e.g.* Fig. 4. Ia, Fig. 5. Beni Isguen) and cities located in moderate or subpolar latitudes (*e.g.* Fig. 6. Bergen, Fig. 7. Thorsavn) differs considerably. In the latter municipal agglomerations, one of the most important factors shaping the local climate are the effects of the combustion of enormous quantities of energy raw materials, used to heat developed areas.

Fig. 5. Beni Isguen (Algeria)

The city, depending on the dominant colour, and also on the colour of the surrounding area, does not always generate a *urban heat island.* There are areas around the globe, mainly in tropical latitudes, where the city is colder than the surrounding areas, which leads to the occurrence of a *urban cold island.*

The problem of the influence exerted by the city on the climate is particularly important in climatological research that uses archival data, sometimes from decades ago, in order to determine the past and forecast future climatic features. The results of such analyses should be treated with an appropriate dose of criticism.

Fig. 6. Bergen (Norway)

Fig. 7. Tórshavn – Faeroe Is. (Denmark)

From the above review of only some of the issues connected with researching and forecasting climate changes on the basis of analyses of meteorological data from the past 100-200 years we can see that the problem is characterised by an exceptional level of complexity. For this reason, the hitherto presented forecasts of climate changes for the next few decades are of necessity tainted by significant shortcomings.

They do not contain convincing documentation not only as regards the value of changes in

climatic indices, but they are also devoid of uniform views as to the direction of climate changes.

This also concerns opinions expressed in the reports of the IPCC (Intergovernmental Panel for Climate Change), which suggest that there has commenced an era of domination of the anthropogenic climate change factor over natural factors. The opinion concerning the dominant role of "greenhouse" gases with respect to other climate-shaping factors is considered by more and more climatologists as difficult to accept due to the fact that it is based mainly on an analysis of long observation series, which do contain errors generated by numerous factors. The author has attempted to indicate certain of these factors in the present paper.

References

BORYCZKA J., 1993. *Naturalne i antropogeniczne zmiany klimatu Ziemi w XVII – XXI wieku*. Uniwersytet Warszawski, Wydział Geografii i Studiów Regionalnych, Warszawa.

BORYCZKA J., STOPA-BORYCZKA M., KICIŃSKA B. & ŻMUDZKA E., 1992. *Atlas współzależności parametrów meteorologicznych i geograficznych w Polsce,* t. 7. *Zmiany wiekowe klimatu Polski*. Wydawnictwa Uniwersytetu Warszawskiego, Warszawa.

Climate Change: the IPCC response strategies, 1991. World Meteorological Organization, United Nations Environment Program, Island Press, Washington, D.C., Covelo, California.

FORTUNIAK K., KOŻUCHOWSKI K. & ŻMUDZKA E., 2001. *Trendy i okresowość zmian temperatury powietrza w drugiej połowie XX wieku*. Przegląd Geofizyczny 46(4).

KEELING C.D., 1984. *Atmospheric CO_2 Concentration Mauna Loa Observatory, Hawaii 1958-1983*. U.S. Department of Energy Report NDP-001. Carbon Dioxide Information Center, Oak Ridge, Tennessee.

LAMB H.H., 1978. *Climate: Present Past and Future. Vol. 1*. Methuen, London.

OBRĘBSKA-STARKEL B. & STARKEL L., 1991. *Efekt cieplarniany a globalne zmiany środowiska przyrodniczego*. Polska Akademia Nauk, Zeszyty Instytutu Geografii i Przestrzennego Zagospodarowania 4, Warszawa.

SADOWSKI M., 1996. Globalne zmiany klimatu i ich wpływ na środowisko. In: A. Jankowski (ed.), *Metody badań wpływu czynników antropogenicznych na warunki klimatyczne i hydrologiczne w obszarach zurbanizowanych*. Katowice.

SCHÖNWIESE C. D., 1997. *Klimat i człowiek*. Prószyński i S-ka, Warszawa.