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## THE GENERAL KNOWLEDGE AND UNDERSTANDING OF SOME CLIMATOLOGICAL PHENOMENA

*Abstract:* The group of three hundred young people (students of the last year of secondary schools) were examined. A specially prepared test including questions about some fundamental climatological and meteorological phenomena was used. On the basis of the exam results, some conclusions about perception of chosen climatological processes were drawn. Misinterpretation of some climatological phenomena is usually caused by wrong description, which can be found in many books and articles. Wrong (or with mistakes) explanations of particular climatological processes which have been found in some international books and articles, were described and analysed in this paper.

*Key words:* misunderstanding, precipitation, temperature, greenhouse effect.

### 1. Introduction

Man's historic efforts to overcome the adverse aspects of his environment are deeply interwoven with his attempts to understand the nature and behaviour of the atmosphere. During last decades the environmental problems have become very important and have to be solved (or at least to be under control) in the near future. Intelligent management of our planet's environment and its resources for sustainable development and improving life quality is perhaps our most critical need at present time. The Earth atmosphere is an extremely important medium which "connects" the other elements of environmental system. There are permanent fluxes of exchange of energy and matter between the Earth surface and the atmosphere. Due to these fluxes, one can recognise the atmosphere as a mirror in which the present conditions of the Earth surface environment has been "reflected". On the other hand, the condition of the environment can be modified by the state of the atmosphere, both in short and long time interactions.

Because of such great importance of the influence of the atmospheric processes on the Earth environment in the global and local scale, it is extremely significant to understand some basic climatological and meteorological phenomena. During the last couple of years it has been found that this kind of general knowledge of young people graduated from secondary schools, is very limited and often wrong. Therefore, a group of 300 young students was asked about their understanding of some climatological data and phenomena.

## 2. Method

The test used in the experiment consisted of 10 “questions” divided into 4 subject blocks: from 1 to 3: temperature, from 4 to 6: precipitation, from 7 to 9: greenhouse effect, 10: geo-climatology.

For this publication, for easier and faster reading, the structure of answers has been reconstructed. Answer “a” is always correct and the other answers (always wrong: b,c,d,e) have been ordered from seldom to more frequent used

The test consists of the following questions and answers (Idtk, means “I do not know”):

1. The global average temperature of the Earth surface is equal to:  
A: 15°C B: 23°C C: 0°C D: Idtk E: 8°C
2. In Poland the annual amplitude of air temperature increases with direction from-to:  
A: W-E B: S-N C: N-S D: E-W E: Idtk
3. The average annual temperature in Poland is equal to:  
A: 8°C B: 0°C C: 23°C D: Idtk E: 15°C
4. The annual precipitation (in mm) in Poland is equal to:  
A: 600 B: 60 C: 1800 D: 1200 E: Idtk
5. The territory of Poland can be considered as the are a of:  
A: relatively low precipitation, which causes the shortage of water resources  
B: very high annual precipitation in comparison with other European countries  
C: relatively high precipitation, which causes the richness of water resources  
D: Idtk E: A, B, and C is wrong
6. In average in Poland the maximum sum of precipitation is noted during:  
A: summer B: Idtk C: winter D: spring E: autumn
7. The increase of concentration of one of the greenhouse gasses, CO<sub>2</sub>, is caused mainly by:  
A: intensive fossil fuels burning  
B: very intensive emission of CO<sub>2</sub> from greenhouses

C: intensive agriculture production

D: Idtk            E: photosynthesis process reduction caused by intensive deforestation

8. The greenhouse effect consists in absorption by the greenhouse gasses of:  
 A: long wave radiation emitted by the Earth surface            B: sun radiation  
 C: ultraviolet radiation reflected from the Earth surface            D: Idtk  
 E: sun radiation reflected from the Earth surface
9. The greenhouse effect in the Earth atmosphere:  
 A: has always existed            B: is more intensive during windy night  
 C: can happen only during daytime, during the night it does not exist  
 D: Idtk            E: was caused by the human activity
10. The regions in middle Africa close to the equator are:  
 A: areas where one of the highest average annual rainfall has been noted  
 B: areas where the strongest wind on the Earth has been noted  
 C: Idtk  
 D: the driest regions of the Earth  
 E: areas where the highest temperatures on the Earth have occurred

Students from different secondary schools and different villages and towns were asked to answer the above 10 questions. All the students were asked to use the answer “I do not know” (Idtk) if they were not sure about the right answer. If somebody answered in the wrong way it rather means that he really thinks so (if the answer Idtk was not used).

### 3. Results

The results of the test are shown in Figures 1, 2 and 3. In Figure 1 are shown the percentage results of the 10 questions of the test: a) for good, wrong and “do not know” answers and b) for good and wrong (“do not know” was added to wrong answers). Additionally, in Figure 1a and b some numbers were added which describe the percentage of good or wrong (including “do not know”) answers as average for all 4 blocks of questions described in the previous chapter.

In Figure 2 the same results are shown but this time the percentage of good, wrong and “do not know” answers has been presented in detailed distribution (possible answers: A, B, C, D and E). As it was mentioned previously for whole 10 questions the answer “a” (white bar) was always the good one. In Figure 2 all grey bars are showing the percentage of wrong answers and the black bars the percentage of the answer “do not know”.

In Figure 3 the results of distribution of good answers for different groups of students are shown. Two criteria were taken into account: the kind of secondary school and the size of the town the students come from.

### 4. Discussion and Concluding Remarks

The results of the test show very poor knowledge of young students mainly about precipitation (Fig. 1). Only about 40% know the value of the annual precipitation in Poland (question 4 – q.4) but even less (25%) know the reality about the water balance of Poland (q. 5) and only 12% have any idea about the yearly distribution of precipitation

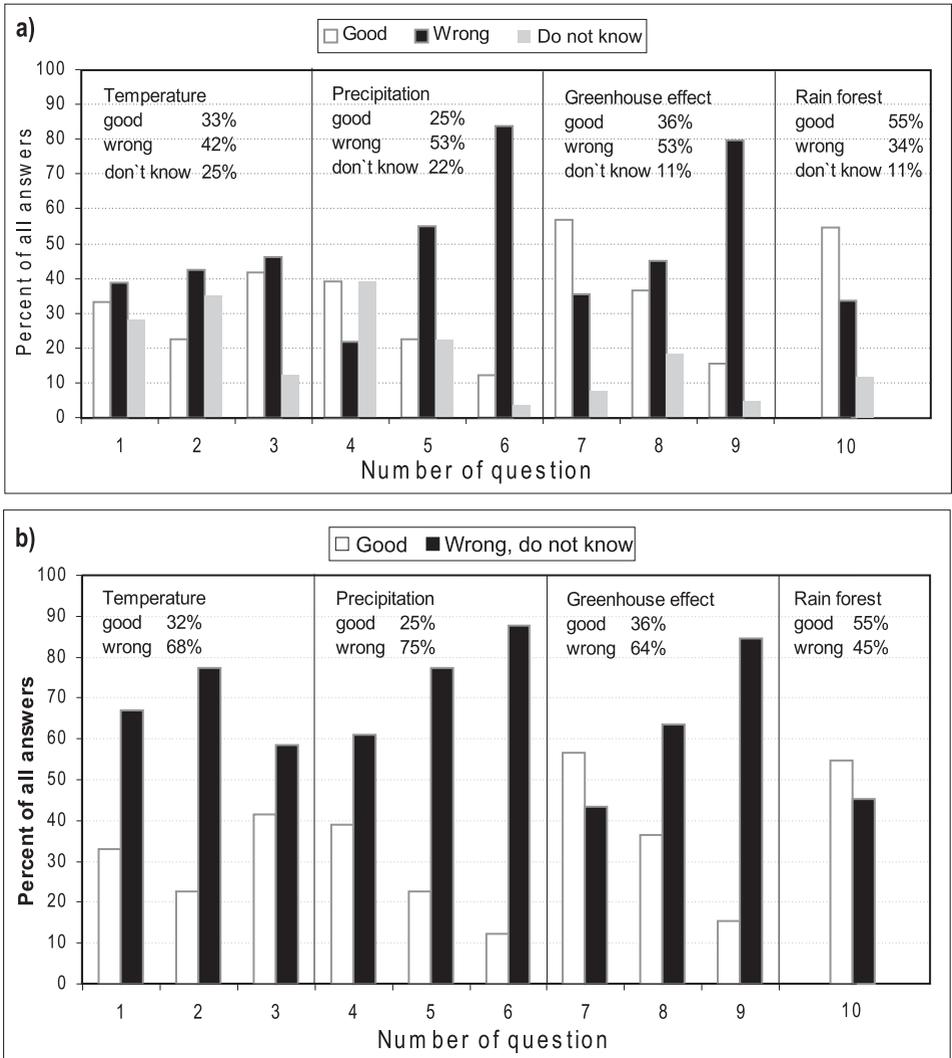


Fig. 1. Percentage of good and wrong answers in climatological test. In part “b” the answers “I do not know” were added to wrong answers in part “a”. The numbers of the average results for all four subject blocks are also shown.

(q. 6). The answers to the question about the maximum of precipitation in Poland (q. 6) show that the students are sure that the maximum of precipitation in Poland occurs in autumn (only a few percent used the answer “do not know” – Fig. 1a).

Only a little bit better answers were received as far as the subject of temperature is concerned. Here (q.1 to q.3) 32% of all the answers were good. It is interesting that almost the same percentage (about 40) of students know the annual average temperature in Poland and also about 40% have wrong information about that (less than 20% used the answer “do not know”).

Answers to the questions about the greenhouse effect (from q.7 to q.9) show a very strange state of knowledge. For question 7 (about the source of CO<sub>2</sub>) one of the best results has been achieved, but at the same time, for question 9 (about the understanding of greenhouse effect in general) one of the worst results has been achieved (more than 75% of wrong answers plus some percent of “do not know” answers).

Looking at the distribution of different answers (: A, B, C, D and E) to all the questions (Fig. 2) it is easy to see that for 4 examined subjects the distribution of good, wrong and “do not know” answers looks very different. Only for questions 6 (precipitation distribution) and 9 (greenhouse effect) less than 5% of students used the answer “do not know”. Simultaneously these questions have the worst result of good answers (12 and 15% respectively). It means that in both cases the students are sure they know the correct answer even if they are wrong. For example, in question 6 most of them think that the maximum of precipitation occurs in autumn and not in summer, as in fact. One can suppose that this kind of knowledge comes from the student’s own observations but incorrectly interpreted. During autumn we really have a lot of rainy days but the amount of water which reaches the earth surface is far more

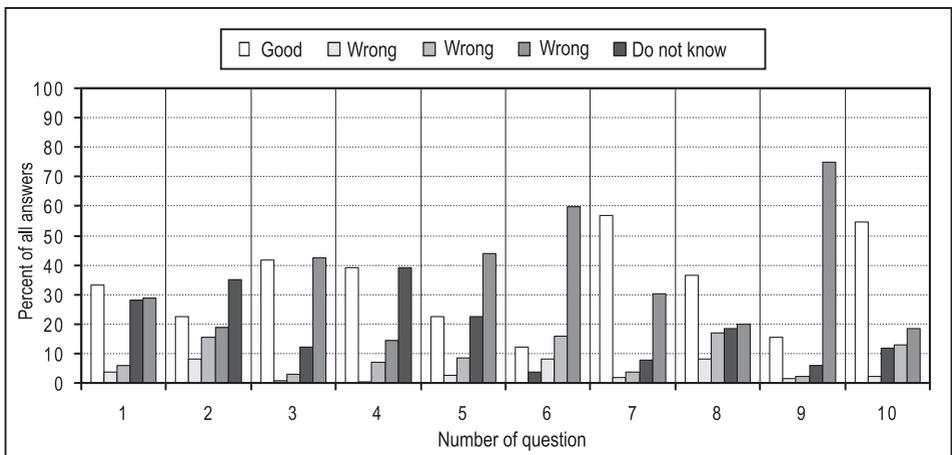


Fig. 2. Percentage of good and wrong answers. All possibilities of wrong answers are shown separately.

smaller in comparison with summer time. Looking at the structure of the answers to question 6 one can assume that here the time of rainfall occurring was mixed with the amount of water which is measured as precipitation. Unfortunately, also the structure of answers to two other questions about precipitation (q.4 and q.5) is not good enough. Especially a very important problem of relatively low precipitation in Poland and rather poor water resources is not recognised by the young people (q.5 – only about 20% know that).

The knowledge about the greenhouse effect is also very poor. Less than 40% of students know that the greenhouse effect exists because the greenhouse gases absorb the long wave radiation emitted by Earth surface. More than 50% think that it is not the Earth long wave radiation but the sun radiation or reflected sun radiation or ultraviolet radiation. One can be sure that the wrong knowledge of students about the greenhouse effect arrived from numerous errors in scientific and pop-science publications. The figures which describe the greenhouse effect very often suggest that the sun radiation reflected from the Earth surface is trapped in the atmosphere, and therefore less and less of energy leaves the Earth-atmosphere system to the space. As an example, both of these errors can be found in Veit and Wolfrum (1992). A similar error is repeated by many authors who describe the greenhouse effect as the absorption of long wave radiation reflected from the Earth surface (Jaworowski 1998, 1999). The Internet, so often used by young people, is an additional source of incorrect information about greenhouse effect: “the atmosphere traps the infrared rays from the sun” ([www.geocities.com](http://www.geocities.com)) or “the atmosphere traps the sun radiation reflected from the earth surface” ([www.ids.pl](http://www.ids.pl)). These are only a few examples of a very bad explanation of greenhouse effect but one can add many poor or false information based on spectacular news broadcast by TV. The final influence of this kind of propaganda on the education of young people is terrible - more than 80% (!) does not recognise the greenhouse effect as a positive phenomenon owing to which, life is possible on our planet. The students recognise this effect as negative one and created by human activity (q.9, answer E).

An additional comment is required by question number 10, concerning the rain forest in Africa. Here one of the highest results of good answers was noted (A, about 55%) but more than 1/3 of students used answers D and E. They think, the regions of middle Africa close to the equator are the driest or hottest regions on the Earth. The authors suppose that it can be a result of generally poor level of geography in schools. In many books which are used in Polish schools we found many very detailed subjects and information (e.g. detailed hydrology, changes in soil retention, industry production, changes in population etc.) and simultaneously not very interesting descriptions of some fundamental phenomenon (not only from climatology) which should be understood by young pupils.

In Figure 3 the average results of the test of students from different schools is shown. In general, the percentage of good answers is equal to 33.4%, but it differs significantly for different groups of students. Students from specialised secondary schools obtained the best results. Most of them came from forestry, horticulture or agriculture secondary schools, which explains the higher level of knowledge about

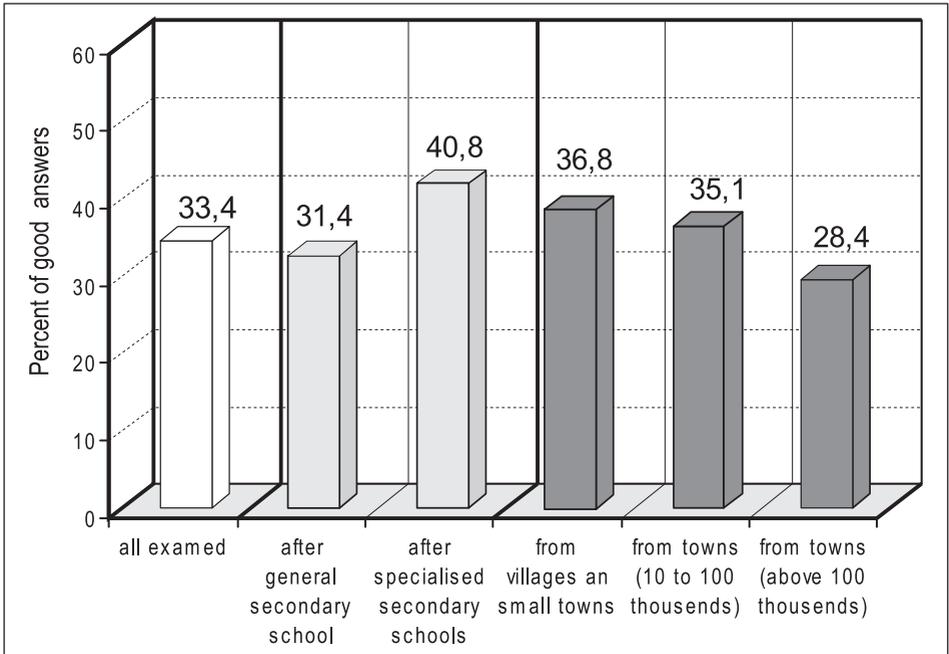


Fig. 3. Percentage of good answers according to school type and the size of settlements the students are coming from.

climatology. The surprising conclusion arrived from comparison of the test results with the size of the town the students came from (last 3 bars in Fig. 3). There is a significant difference between students from small and big towns. The level of good answers for students from small towns and villages is better by 8.4% than those from big towns.

In general, it can be concluded that the overall knowledge of pupils about the fundamental climatological data and phenomena is extremely poor, which can have bad influence on the future environment conditions. Understanding of atmospheric phenomena is one of the most important keys in the future managing of the environment.

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