СЕКЦИЯ:
ЭКОЛОГИЧЕСКОЕ ОБРАЗОВАНИЕ И ВОСПИТАНИЕ МОЛОДЕЖИ

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ATLAS "WEATHER HAZARDS IN BELARUS" AND ITS APPLICATION IN TRAINING ENVIRONMENTAL ENGINEERS

***Аннотация.** В статье рассматриваются особенности и перспективы использования Атласа опасных метеорологических явлений на территории Беларуси в учебном процессе при подготовке студентов, магистрантов и аспирантов по специальностям природоохранного направления.*
***Ключевые слова:** Weather Hazard, Atlas, Ecology, Training Students.*

Every year weather hazards are registered in Belarus. These are natural phenomena and processes in the air that are generated by various natural factors or combination of factors. They can cause damage to people, livestock and crops, economy, and the environment. As they have been occurring more often lately, economic losses have been increasing. According to the assessment of the World Bank's experts, annual economic loss resulted from weather hazards in Belarus is about $90 million. Agriculture of Belarus suffers mostly from such meteorological hazards as showers, squalls, hail, and ground frost. Forestry is mostly endangered by droughts which are often a cause of forest fires. Annual damage from fire in Belarus accounts for about $900,000. Qualls are also hazardous for forests as they lead to windfalls and further devastation. Communal services experience a lot of damage. Power transmission lines fail. Conditions for maintaining roads and buildings worsen and their service-life period decreases due to more frequent freeze-thaw cycles. As the average annual number of days with heat waves increases, system of heat absorption at power stations operates

less effectively and involves additional expenses on air-conditioning. Change of glaze loads influences the stability of electric power supply.

Therefore, it becomes necessary to reassess possible loads that can surpass the norms (so-called "overloads") due to negative effects from the changes in recurrence of weather hazards. It is also important to define conditions under which weather hazards form and to determine patterns of their time-space changes. Pointing out the regions of the country with the most frequent recurrence of particular weather hazards is of practical interest.

In order to describe weather hazards in Belarus, it is necessary to determine its physiographic features.

The Republic of Belarus lies in the western part of East European Plain in the catchment area of the Pripyat, the Neman, the Viliya, the West Dvina, and the Dnieper Rivers. It covers 207,600 km^2 and stretches for 650 km from west to east and 560 km from north to south. Its absolute elevation varies from 80 m in the Neman basin on the border with Lithuania to 345 m (Dzerzhinsk) on the Minsk Upland. The mean elevation is 160 m.

The territory of Belarus is a part of the Russian Plain. The terrain is predominately plain with flat and undulating flatlands. The northern territory is Belarus lake district with elevation varying from 120 – 170 m to 250 m. The western and central parts of Belarus are uplands with 200 – 300 m elevation. These areas comprise a third of the country. In the south there are moraines and aqueoglacial plains and a flat swamped alluvial plain of Polessie.

Belarus is considered an area with sufficient humidity, its average annual precipitation being 600 – 700 millimetres. The highest annual precipitation is in Novogrudok Upland – 769 mm. Deviation from the norm could be 100 – 200 mm in particular years. Absolute maximum of precipitation was registered in the town of Vasilevichi in Rechitski district (1115 mm), while absolute minimum was in Bragin (298 mm).

70% of total annual precipitation coincides with the warm season (April – October) when there are a lot of showers. During a year most precipitation falls in July (75 – 95 mm), the least is in February (30 – 40 mm). Absolute maximum was registered in August (329 mm) in Pruzhany. Sometimes precipitation which is a norm for a few months can fall in a few days. In particular years there is no precipitation for a month or longer.

There is a necessity to study weather hazards that may occur in Belarus. Hydro-meteorological hazards in Belarus involve meteorological, agro-meteorological, and hydrological phenomena which are intensive and prolonged enough to cause quite a lot of damage to the national economy and even can threaten people's well-being or life. These include poor visibility, low cloud cover, strong wind, glaze and hard rime, snowstorm, shower with much precipitation in an hour, heavy rain, squall, whirlwind, thunderstorm, hail, freezing rain, upslope fog, etc. Strict definitions are provided for each meteorological hazard. They establish utmost limits for the intensity of each weather phenomenon. If a critical limit is reached or overreached, a weather station informs about a weather hazard.

According to [1], hydro-meteorological phenomena are the result of the processes taking place in the air, on the land surface and the objects over it, in the surface water (rain, snow, hail, glaze, hoar frost, fog, dew, snowstorm, dust storm, thunderstorm, squall, whirlwind, ground frost, drought, spring high water, flood, freshet, ice, river ice breakup, etc.).

The criteria characterizing meteorological hazards defined in [2] are as follows:

- Severe frost – decrease of minimal temperature up to – 35°C and below;
- Heat wave – increase of maximal temperature up to 35°C and above ;

- Heavy rainfall – falling of at least 50 mm precipitation in less than 12 hours;
- Heavy snowfall – precipitation that falls in the form of snow or sleet at more than 20 mm for less than 12 hours;
- Strong wind – a gust of wind of at least 25 m/s;
- Hazardous glaze ice and hard rime – glaze diameter on the wire of the ice accretion indicator is more than 20 mm, mixed type (glaze and hard rime or wet snow) is more than 35 mm;
- Thick fog – it lasts for at least 6 hours with visibility of less than 50 m;
- Severe snowstorm – a snowstorm with strong air gusts of at least 15 m/s that lasts for at least 12 hours;
- Dry wind (sukhovey) – air temperature is high for at least 3 days (25°C or above in the daytime) but relative humidity is low (less than 30% during the day) with wind gusts up to 5 m/s or more (wind speed is calculated as mean within 2 or 10 min);
- Drought – precipitation is less than 5 mm per day for more than 30 days, with high air temperature (over 25 ºC in the daytime) during at least half of this period.

In 2016 the authors of this article published Atlas of weather hazards in Belarus (in Russian) [3] which includes general description of 15 hazardous weather phenomena most often occurring in Belarus from 1975 to 2012. The issue was meant for meteorologists, climatologists, and experts in various areas who are involved in studying climate changes. What is more important is that the Atlas found wide application in training undergraduate and postgraduate students who study ecology and water resource management.

Integration of Belarusian higher education system into the Bologna Process has provided a lot of opportunities for academic mobility and student exchange. One of the tools to implement the policy of the European Union in educational cooperation with the countries of Eastern Europe is the Tempus Programme.

Tempus is a European Union programme designed to help the process of higher education reform in Partner Countries. It supports projects between the higher education sector in the EU and its 27 partner countries to facilitate university modernisation, mutual learning between regions and peoples and understanding between cultures. The Programme promotes voluntary convergence with EU developments in the field of higher education deriving from the Lisbon agenda and the Bologna process.

Tempus partner regions are:

- Western Balkans
- Eastern Europe and Central Asia
- North Africa and the Middle East

Specific programme objectives:

- To promote the reform and modernisation of higher education in the partner countries;
- To enhance the quality and relevance of higher education in the partner countries;
- To build up the capacity of higher education institutions in the partner countries and the EU, in particular their capacity for international cooperation and for a permanent modernisation process, and to assist them in opening themselves up to the society at large, the world of work and the wider world;
- To overcome the fragmentation of higher education between countries;
- To enhance inter-disciplinarity and trans-disciplinarity;
- To enhance the employability of university graduates;
- To make the European Higher Education Area more visible and attractive in the world;
- To foster the reciprocal development of human resources;

• To enhance mutual understanding between peoples and cultures of the EU and of the partner countries.

The Tempus Programme funded by the European Union has been investing billions of euros into the reforms of higher education systems in nonmember countries of the Union by encouraging European universities to share their experience and knowledge.

The Tempus Programme is very coveted by European universities and in 2013 from the 930 proposals only 160 were selected for funding, including the RETHINK project. With a budget of 1.3 million euros the RETHINK project allows the consortium to reinvent and to redefine academic curricula within 22 partner universities from Portugal, Spain, Netherlands, Germany, Armenia, Azerbaijan, Belarus, Georgia, Moldova, and Ukraine.

RETHINK (Reform of Education THru INternational Knowledge exchange) project intends to link the United Nations strategy of Education for Sustainable Development, the "Europe 2020" strategy, and the Bologna Process with the Tempus' programme objectives for modernization of higher education institutions in the EU's neighbouring area. For the Eastern Neighbouring Area (ENPI East) ENVIRONMENT and SUSTAINABILITY are the selected priority for the RETHINK project; however, they are intertwined with BUSINESS and EDUCATION. In fact, the RETHINK project encompasses these two themes, and also integrates the concept of the knowledge triangle "education/research/innovation" from an environmentally sustainable perspective. The project RETHINK intends to rethink the curricula of the partner universities - in the priority area of ENVIRONMENT - through the development of innovative Joint (Masters and Ph.D.) Degrees in the fields of:

1 – Architecture/Urban planning

2 – Climate Engineering/Environmental Sciences

The coordinator of the project is Faculty of Architecture, University of Lisbon (Portugal) - FAUL: http://rethink.fa.ulisboa.pt.

Introduction of double (or joint) Master's or Ph.D. degrees into higher education system of partner universities involves:

1) publication of education materials for double (or joint) Master or Ph.D. degrees in English;

2) a course of technical English for both students and teachers;

3) providing classrooms for distance education (e-Learning) so that teachers from the EU's universities can deliver lectures to students from partner universities in non-European countries;

4) student mobility from non-European countries to the EU's universities for practical course "Innovation/Entrepreneurship" included into the curricula for double (or joint) Master or Ph.D. degrees;

5) teachers mobility from non-European countries to the EU's universities to develop their skills in delivering lectures and acquiring new experience in teaching in English;

6) introduction of the quality standards at higher education institutions that correspond to Quality Assurance System.

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Brest State Technical University (BrSTU, Belarus) participates in the programme RETHINK in the field of "Climate Engineering" with the aim of providing an innovative joint Master Degree together with University of A Coruña (UDC, Spain). In 2016 BrSTU enrolled first Master Degree students for speciality 1 – 33 80 01 "Ecology". At present this project is being implemented both in Belarus and Spain.

Training for joint Degree is conducted in English that is why it is necessary to supply quality education materials in English (textbooks, manuals, learning guides, maps, etc.) to train Master Degree students at high academic level.

Since the Atlas is used for teaching such academic disciplines as "Power Resources and Energy Saving", "Environmental Management", "Modern Research Methods in Environmental Sciences", etc., the authors have prepared a layout of the Atlas "Weather Hazards in Belarus" for publication in English. It contains 35 thematic maps with 15 meteorological phenomena analyzed from 1975 to 2015 as well as photographs illustrating them. The terms used in the Atlas correspond to the standard terminology of the Republic of Belarus [2] and meet the requirements of the World Meteorological Organization. The maps in the Atlas allow students to perform practical tasks concerning extreme climate impact on both the environment and the economy of Belarus. The map data are often used in working on Master and Ph.D. theses.

In conclusion it is worth mentioning that the Atlas might be of interest for the scientists and experts in meteorology, climatology, geo-ecology, etc. who study climate fluctuations and their consequences. It can be used in curricula for international programs of academic mobility and student exchange or academic projects of double (or joint) degrees at partner universities to train undergraduate and postgraduate students in different research areas.

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