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МІНІСТЕРСТВО ЗАХИСТУ ДОВКІЛЛЯ ТА ПРИРОДНИХ РЕСУРСІВ УКРАЇНИ
ДЕРЖАВНА ЕКОЛОГІЧНА АКАДЕМІЯ ПІСЛЯДИПЛОМНОЇ ОСВІТИ ТА УПРАВЛІННЯ

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Журнал публікує (після рецензування та редагування) статті, які містять нові теоретичні та практичні здобутки в галузі екологічних наук.

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BUILDING CLIMATE CHANGE RESILIENCE THROUGH THE UNIVERSITY EDUCATION

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The climate changes are inevitable part of the upcoming future; therefore it is necessary to address corresponding issues in education of children and adults. The paper presents the overview of the implementation of CCE in university education in and outside Ukraine. The commitments of the majority of countries to implement CCE in the curriculum at different levels hasn't been fulfilled completely yet. Even the majority of European countries have only elements of CCE at the level of school training, as it was shown by the global survey across 46 UNESCO Member States. The university degrees, offered at Master level on the West include some elements of climate change issues included in training, but only 11,5% has direct relation to them as it was shown by our study. In Ukraine only tree Master degrees, indicating relation to climate changes, were offered in previous years and this demonstrates lack of attention to the development of adaptation potential among future professionals. Since there is no branch of human activity, which will not experience effect of climate changes, we consider implementation of special course in higher education a necessary response to provide graduates with specific adaptation skills. The experience of teaching the course "Adaptation to Climate Changes" is presented in the paper. The survey conducted among the students of the university has showed considerable gaps in the understanding of climate change implications for their personal and professional life and fragmented awareness of the adaptation approaches and the benefits adaptation offer. It is finally recommended to introduce similar course as elective to provide high quality of skills and competencies of future specialist, forced to life and work in challenging environment with changing climate. *Key words:* CCE, education for sustainable development, university course, adaptation potential, professional competency.

Розвиток стійкості до зміни клімату на основі університетської освіти. Радомська М.М.
Зміни клімату є неминучою частиною майбутнього, тому необхідно розглядати відповідні питання у вихованні дітей і дорослих. І студенти, і педагоги повинні усвідомити, що вони не можуть розглядати умови життя у майбутньому як подібні до нинішніх. У статті подано огляд впровадження освіти зі зміни клімату в університетську освіту в Україні та за її межами. Зобов'язання більшості країн запровадити освіту зі зміни клімату в навчальні програми на різних рівнях ще не повністю виконано. Навіть більшість європейських країн мають лише елементи освіти щодо зміни клімату на рівні шкільної підготовки, як показало глобальне опитування в 46 країнах-членах ЮНЕСКО. Університетські ступені, які пропонуються на рівні магістра на Заході, включають деякі елементи питань зміни клімату в навчання, але лише 11,5% мають пряме відношення до них, як показало наше дослідження. В Україні в попередні роки пропонувалося лише три магістерські програми, що мали зв'язок зі змінами клімату, що свідчить про недостатню увагу до розвитку адаптаційного потенціалу у майбутніх фахівців. Оскільки немає жодної галузі людської діяльності, яка б не відчувала на собі вплив кліматичних змін, ми вважаємо впровадження спецкурсу у вищій освіті необхідною реакцією для формування у випускників специфічних навичок адаптації. У роботі представлено досвід викладання курсу «Адаптація до змін клімату». Опитування, проведене серед студентів університету, показало значні прогалини в розумінні наслідків зміни клімату для їхнього особистого та професійного життя та фрагментарну обізнаність щодо підходів до адаптації та переваг, які пропонує адаптація. Нарешті, рекомендовано запровадити подібний курс як вибірковий, щоб забезпечити високу якість навичок та компетенцій майбутнього фахівця, змушеного жити та працювати в складних умовах зі мінливим кліматом. *Ключові слова:* освіта щодо зміни клімату, освіта для сталого розвитку, університетський курс, адаптаційний потенціал, професійна компетентність.

Relevance of the problem. CCE (CCE) has already become a widely discussed component of formal and informal education. In its most common definition CCE is education that aims to address and develop effective responses to climate change [1]. But in its core CCE deals with learning in the face of risk, uncertainty and rapid change [2]. This skills and knowledge are of extreme importance besides climate changes, as the modern world is evolving at the highest rates ever, offering opportunities and pressures equally. Under such conditions developing adaptive capacity of people is as important as building adaptation potential and resilience of ecosystems they live in.

It stems from ESD, which is already a solid concept and its expansion has uncovered many environmental issues of transformation for sustainability, previously not known [3]. CCE is now considered a separate field within the ESD framework due to its urgency and underrepresentation everywhere except specialized professional education [4]. Moreover, the latest Berlin Declaration on Education for Sustainable Development, proclaimed in 2021, includes commitment to include climate change studies in a formal part of all school curricula by 2025.

Problem statement. A recent study of primary and secondary education policies and curricula across 46 UNESCO Member States found that 45% of national education documents studied made little-to-no reference to environmental themes [5]. Although 92% of documents included at least one reference to environmental themes, the depth of inclusion was very

low on average. Moreover, the environmental issues are more often linked to quality of living environment than to fundamental issues, like climate and biodiversity. In particular, over half of education policies and curricula studied made no mention of climate change and only 19% made reference to biodiversity.

The same survey showed that there is higher inclusion of environmental activities and studies in upper secondary education, in contrast to primary and lower secondary education which covers the relevant issues via nature contact practices, like gardening. This demonstrates another important issue: there is a concentration of attention to CCE implementation in primary and secondary education, while higher education is out of the focus for both – the universities and promoting organizations at international and national levels.

Ukrainian education is currently going through the process of massive reforming, which creates perfect conditions for the implementation of ESD and CCE. However, the exact extent of these transformations and involvement of climate change and sustainability issue is still unclear. Thus, there is a need to invest efforts in promoting the CCE at all levels of education in Ukraine, but it must account the peculiarities and opportunities of each level of education. The given paper considers experience and perspectives of CCE in higher education.

Novelty. The paper presents the comparative analysis of the level of CCE at university level in selected countries and Ukraine. The gaps in preparation of students to professional activity and personal life under the conditions demanding high adaptation potential are demonstrated based on the survey results.

Methodological novelty. The presented experience of teaching courses covering climate changes agenda in universities might be useful for the implementation of relevant training in other universities. It is also shown that approaches used to deliver elements of CCE are universal due to global character of the problem and could be applicable to teaching students of any specialties.

Literature review. Living in the world of changing climate has already made societies reconsider their goals in both economic and environmental spheres:

• **Starting point –** 1992 UN Framework Convention on Climate Change – the goal was to realize the presence of the problem.

• **Formalization** – 2009 UN Copenhagen Climate Change Conference – the goal was formulated as "no more than 2°C".

• **Enrollment –** 2015 Paris agreement – the goal was set to implement nationally determined contributions and fit into the "no more than 1.5°C".

• **Pressure –** 2019 UN Madrid Climate Change Conference – the goal was to press the need for changes at the political level.

• **Assessment –** 2021 UN Glasgow Climate Change Conference – the first iteration of the ratchet mechanism – the goal is to raise the national obligations.

Each of these stages-goals had some important drawbacks or advantages. Thus, at the "Starting point" in 1992, the major disadvantage was that climate change was considered as a typical "conflict of interests", which should be negotiated. At the next point of "Formalization" in 2009 the climate change was again mispercieved and treated as a "chemical issue" – simple a problem of pollution, which can be tackled by technical solutions. Only in 2015 at the "Enrollment" stage the first step towards "customization" of actions in response to climate changes was done and clear split between mitigation and adaptation was shown. The stage of "Pressure" in 2019 initiated changes at the political level and presented first clear commitments at governemtal level. Moreover, expansion of the problem to the business sector also took place – voluntary obligations of 170 companies to cut their emissions or investments to meet the target of 2015. The important drawback of this stage is seeing responses to climate changes a task to be solved by high ranking officials only. The last step by now is the "Assessment" stage, at which national obligations were raised. But this has degraded the importance of adaplation in the system of response to climate change by concentrating on mitigation, equal to cutting emissions.

Thus, even at the highest level of international cooperation there is room for biases and deviations from the necessary balance between mitigation and adaptation. As a result, the interest to balancing and developing synergy between adaptation and mitigation has increased among researches and governmental entities since 2010 [6]. The works by Kane et al., Laukkonen et al., VijayaVenkataRaman et al., and Lal et al. pursuit this idea in their early publications in terms of various branches of economy and spheres of human life. At the same time, Ingham et al. highlighted the fact that too much attention is paid to the mitigation and cutting emissions, while adaptation and learning to live in the changing environment is given little to no attention [7]. Since then, the improvement of climate change literacy through sustained, active learning and teaching was formulated as a component of climate change resiliency for communities and economies [8]. The corresponding frameworks were offered and continue to be refined for both school children [9] and teachers [10]. From this point the discussion of CCE at university level was an obvious direction of progress, encompassing not only teachers but professionals on the whole [11]. However, the survey involving 212 university staff from 45 countries demonstrated high breadth of approaches and training components related to climate changes [12]. Such situation also has its advantages and disadvantages. From one side it supports diversity of ideas and strategies gives universities possibility to choose the most efficient solutions in their peculiar case. From the other side, such lack of consistency may leave considerable gaps in knowledge and skills of graduates, thus compromising their adaptation potential.

On the opposite side of the problem there are young people interested in getting knowledge. The study, conducted among 10 000 children and young people in ten countries about their attitude to climate change has showed unexpectedly high ranks of anxiety about the implications of climate changes [13]. Almost 60% of respondents across all countries reported very or extremely high concern about climate changes and 84% were at least moderately worried. 75% said that they feel helpless about threats imposed by climate changes. Leaving aside the reasons of these negative feelings, which strongly correlate with perceived inadequate government response, we can see that there is a real need to tackle this climate anxiety by teaching young people how to function efficiently under the changing climate and its effects. The other equally important part of such training should be aimed at action competence development, enabling real participation in climate mitigation and adaptation at the level of communities or professional activity. This will neutralize feelings of helplessness and make young people ready to act in response to new challenges.

Results and discussions. The efficient introduction of CCE should be considered from multiple perspectives, including:

– Availability of university degree programs related to climate changes;

– Development of training courses and curriculum components, dealing with climate changes;

– Introduction of students to new analytical methods for studying climate changes and following their consequences;

– Support of student research work and activities outside the university for the development of climate change adaptation skills and readiness to act;

– Implementation of climate change adaptation issues into the list of professional and general competencies subjects to build the understanding of climate change responses in professional and everyday life.

In Ukraine there are very few offers of the university degrees dealing with the climate changes: Bachelor of Applied Climatology, Bachelor of Meteorology, Agricultural Meteorology and Economics of Climate Change and Master of Meteorology and Climatology. These degree options are offered within the field of the Earth Sciences and only the Bachelor of Meteorology, Agricultural Meteorology and Economics of Climate Change covers wide range of issues, related to climate changes. The situation in the western world is better and our survey of the Study portal yielded 983 Master programs, which include consideration of climate changes as a part of some subjects, and 114 Master programs (11.5%) directly declaring study of climate changes, including only 6 dealing with Adaptation to climate changes (Fig.1). The most typical degrees in the field of climate change are teach general climate change issues, with special focus on climatology, physical grounds of atmospheric processes, prognosis and management of emissions. The next by popularity is Master degree in Climate Change Policy and Development, which is aimed at economic, political and social issues and thus can be also considered a part of teaching adaptation.

Given the increased interest of youth in the Western world to the climate change implications, combined with high level of activism, the number of related university degrees will probably increase in the nearest future.

As for Ukrainian young adults the level of awareness to climate changes is considerably lower, even among the university community. Thus, the survey conducted by the teachers of the Department of Environmental Sciences,

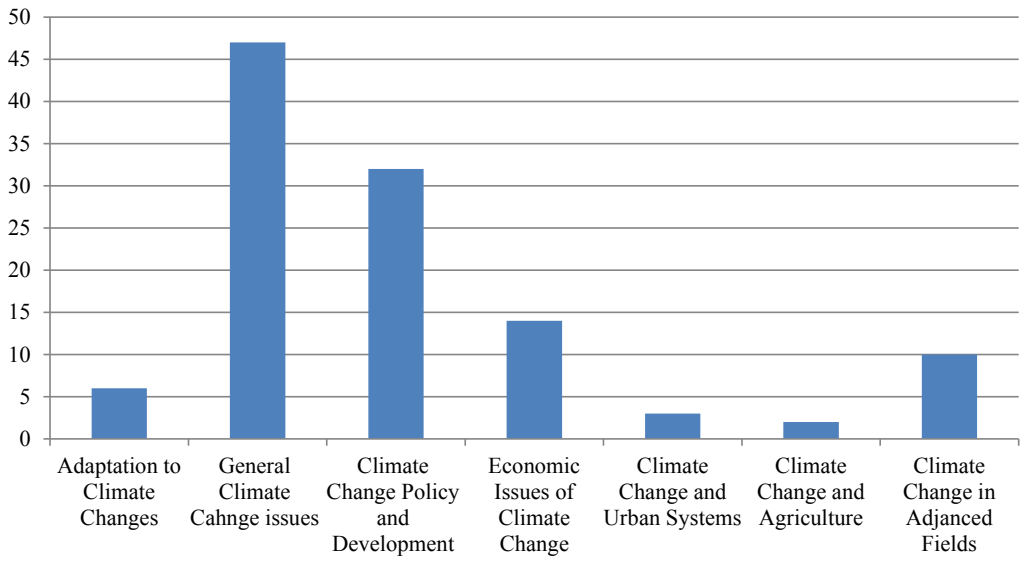

Fig. 1. Climate Changes as a core of university degree programs by specialties (based on the data from the Study portal)

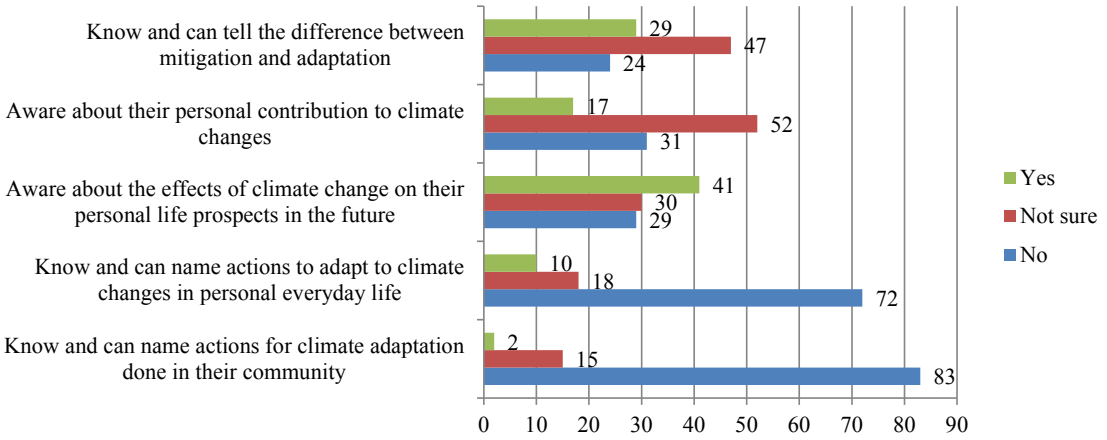

Fig. 2. Results of survey among the students of the National Aviation University on their awareness about climate change implications and adaptation

National Aviation University, in 2018–2022 among the students of technical specialties (Transport technologies, IT, Power Engineering) and Environmental sciences (total number of respondents is 253) showed that they have very fragmented competence in the problem (Fig. 2). The most prominent issue is that they have limited knowledge about personal preparedness to climate changes; thereby the level of their adaptation potential is very low. The lack of knowledge about some adaptation activities in their communities may be conditioned by a variety of reasons, apart from lack of interest to the matter. Such activities may be not well covered in mass media or really absent. However, most of them realize that their personal life can be affected by climate changes, but in most cases, it is perceived through the cost of transportation and energy supply issues. There is an obvious need to expand the presentation of climate change issues in students curricula in terms of adaptation and action competence.

To manage the low level of interest and awareness about the climate changes the Department of Environmental Sciences has introduced the course "Adaptation to Global Climate Changes" offered as an elective subject for students of Master and Bachelor students of all Training Programs (on average 5500 students a year can choose this subject) in 2019–2020, 2020–2021. In 2021–2022 and 2022-2023 it was offered as a subject of choice to the students of the Faculty of environmental safety, technologies and engineering and as an elective charged course to all students. Over this period the total number of enrolled students was 27 Masters (all from the Department of Environmental Sciences) and 103 Bachelors (all from the Department of Environmental Sciences). The absence of the representatives of the other specialties is a problem we need to tackle, since none of the economic branches can avoid negative effects of global climate changes.

The theoretical part and practical classes are primarily based on building understanding of the cause-effect-response interaction in the system of climate change. The bottom line of the course is the development of draft adaptation plan for a home community, which includes analytical part, aimed at finding and describing vulnerabilities typical for the given community, and synthetic part, in which a road map and characteristics of the necessary actions is developed. The teachers of this subject note that such project-based learning is the best way to understanding of the climate change problem and its place in personal and community life.

In parallel the training plan of the subject "Environmental Science" taught to the students of technical specialties was revised and the theme of climate changes effects, mitigation and adaptation was given separate and broader attention. The implementation of the amended program will start in the next year and after two years of running a new survey is planned to evaluate the feedbacks of students in terms of climate change understanding.

The life of the current youth will progress under the pressure of climate change complications and quality higher education must provide them with the skills of efficient citizens and community members, natural resources users and dwellers of urban environment, accounting related challenges.

Conclusions. CCE is a need of the modern world, moreover, it is one of the most important fundamental blocks for the resilience of civilization in this century. As such the CCE is one of those valuable parts of education, which clearly looks into the future and prepares people to stand challenges and thrive, even if the exact.

Climate changes have their footprint in all parts of the educational process and thus must be considered and accounted. First of all, they affect applicability of professional knowledge received by students: changing environment conditions put their limitations of the way many industries can work and output they can receive. Simultaneously, if one is aware of climate change effects of his living and professional activity and posses the skills of adaptation, this competence gradually become obsolete

as conditions are changing in unexpected way due to our inability to make reliable prognosis, lack of analogues and implementation of some mitigation strategies.

Secondly, the quality of competencies obtained through the higher education must be of highest level, but it is impossible if the realities and challenges of the global world are not disclosed to students by educators and not accounted by newly graduated professionals in their work. In these terms CCE is closely connected to ESD and may and should be inextricably linked. It is not the task for government and industry only to change the world, it is we who create consumption patterns and force industries overconsume natural resources and assimilation potential of the environment.

Thirdly, we can thrive under changing climate only if all people are investing their efforts and paying attention to their consumption and level of sustainability, therefore the results of CCE are also affected by overall students' attendance and attainment. But in this case voids in competences may affect all life of young people, apart from professional career development. This brings us to the efficiency of quality management system at higher educational institutions, which works on academic responsibility of both teachers and students. Moreover, university itself is a component of the system and must work on mitigating its contribution into climate changes and adapting its work at all levels to possible pressures of the future.

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