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TOWARDS THE ENVIRONMENTAL GEOGRAPHY CONCEPT

Authors introduce the environmental geography concept. Environmental geography describes the spatial aspects of interactions between the human society and the natural environment. Spatial laws, trends and fluctuations make the environmental geography subject up. The paper examines briefly some regularities of this new discipline formation. As the key one among other methodological approaches the geomorphic method is selected for the watershed environment reconstruction. A relevant modeling example is introduced. A strong spatial aspect of this research implies GIS tools involvement, what is discussed in details, in particular – within human / environment interaction perspective.

Keywords: *environmental geography, human / environment interactions, landforms, earth surface processes, groundwater, data integration and visualization.*

Сергій Костріков, Катерина Сегіда. ЩОДО КОНЦЕПЦІЇ ІНВАЙРОНМЕНТАЛЬНОЇ ГЕОГРАФІЇ. *Автори подають концепцію нової предметної галузі – інвайронментальної географії. Просторові тренди, закономірності та відхилення від тренду як у фізико-географічному, так і в соціально-географічному аспектах, є головним змістом предмету інвайронментальної географії як науки. В статті коротко розглядаються загальні закономірності виникнення і становлення нової географічної дисципліни. В якості одного з її ключових методологічних прийомів розглядається моделювання рельєфу, поверхневого стоку і підземних вод на водозборі за допомогою ГІС. Роль і значення антропогенного впливу серед інших чинників довкілля обговорюється окремо із підкресленням необхідності залучення геоінформаційних технологій для його дослідження.*

Ключові слова: *інвайронментальна географія, взаємодії в системі «людина - довкілля», морфологія рельєфу, поверхневі процеси, підземні води, інтеграція і візуалізація даних*

Сергей Кострикov, Екатерина Сегида. К ВОПРОСУ КОНЦЕПЦИИ ИНВАЙРОНМЕНТАЛЬНОЙ ГЕОГРАФИИ. *Авторы представляют концепцию новой предметной отрасли – инвайронментальной географии. Пространственные тренды, закономерности и отклонения от тренда как в физико-географическом, так и в социально-географическом аспектах, являются главным содержанием предмета инвайронментальной географии как науки. В статье коротко рассматриваются общие закономерности возникновения и становления новой географической дисциплины. В качестве одного из ее ключевых методологических приемов рассматривается моделирование рельефа, поверхностного стока и подземных вод на водосборе с помощью ГІС. Роль и значение антропогенного влияния в ряду других факторов окружающей среды обсуждается отдельно с подчеркиванием необходимости привлечения геоинформационных технологий для его исследования.*

Ключевые слова: *инвайронментальная география, взаимодействия в системе «человек - окружающая среда», морфология рельефа, поверхностные процессы, подземные воды, интеграция и визуализация данных*

Introduction: the environmental geography necessity. The rate of the world natural resources loss has still increased in the first two decades of the twenty first century. The content of this loss includes forest clearing both on tropical and sub-humid climatic zones, decreasing biodiversity on the land and in the oceans, and increased pollution of main rivers and lakes, on which growing human population completely depends. All knowledge and applied tools that are contributed by the traditional subject areas intended to prevent those threatening tendencies, first of all by ecology and conservation theory, turn out not to be sufficient in both data / knowledge constructions and many practical case studies. It is obvious the mentioned trend of the growing human impact cannot be ended, but the efficient environmental education among the human society different layers can slow this trend down.

Contemporary challenges require novel areas of expertise, and the *environmental geography* field is one of them. As we see it the main contribution of the environmental geographical approach may be presenting one (or more) of the ways human society can be led to realize better understanding of its dependence on the natural environment. The better humans understand the biota and the geographical landscape functionality, the more likely they appreciate and value natural environment.

Despite starting in the early 20th century (but being rapidly developed only from eighties) in the West, due to various reasons the environmental geography stayed lastly beyond the general scope of the Soviet geographical school except probably one only exclusion [1]. It has happened that a stage, once logically intended for the environmental geography, which is a subject area with a stress on the human geography issues, was possessed by the *geoecology*, that mainly emphasizes those environmental concepts, which flow from the physical geography.

That may be why we can find later on only few traces of this approach (environmental geography) among both contemporary Russian geographers [2, 3], and their Ukrainian colleagues [4-7]. That is why **the main research goal** of our paper is to fill this gap in national scholar periodicals concerning environmental geography issues by discussing some of them with a stress on interlinks between human impact and natural environment. Such a discussion may make at least small contribution to new understandings of the ways the natu-

ral environment and the human society are related and impact each other.

Why geography becomes the environmental geography. According not to a classical definition, but to that one which is considered widely accepted, the environmental geography is a subdivision of both human and physical geography, which describes the spatial aspects of interactions between the human society and the natural ecosystems [8]. It obviously requires the realization of geology, meteorology, hydrology, biogeography, ecology, and geomorphology dynamics, as well as those directions in which humans conceptualize the natural world.

One of the other most significant peculiarities of the subject area that just concerns with human-natural interactions is a strong necessity of the modern technological tool involvement in this concern mentioned – a geographical information system (GIS). Just such kind of software may be viewed as a key, which opens for "Orthodox Geography" that desired research subject of the environmental geography.

We have already emphasized in one of our papers published before, that GIS research methods successfully entered into both environmental science and human geography subject field [9]. We also tried to analyze then, why geographical information systems have not achieved highly efficient results until recently just in transformation a set of routine spatial research perspectives into the environmental geography domain. The probable reason was called as the lack of associated with GIS modeling tools. The necessary research methodology failure had been caused from the author's point of view by the absence of such a definite research approach that might have united a strong spatial aspect of environmental researches with the GIS regional applications directly related to the realms of both physical and human geography. It may be even that crucial cause according to which contemporary geoecology in both Ukraine and Russia has not become its extended area of expertise – as the environmental geography has done in the western geographical school. The application of GIS modeling concept, which employs various natural boundaries to spatially determine the natural region of research for the assessment of changes in geographical and human landscapes is the example of that proficient spatial information handling, which may substantially assist in management of the environmental geography issues.

Environmental geography draws upon *geology*, *physical geography*, *geomorphology* and *human geography*. If we consider few general samples of the human society / natural environment interactions, what is the human geography subject, further in this paper then we would like to emphasize insights of other contributing disciplines just in this paper section.

Upon universal acceptance within the environmental geography perspective both geology and geomorphology focus on the change / formation processes, history of rocks, landforms and earth surface processes mainly caused by activity of the people. Physical geography has great influence too in the mentioned "discipline tetragon", because demonstrates a strong interest and knowledge background in spatial distribution of landforms and other earth phenomena underlined above. Moreover, it can produce the knowledge base highly efficient, if integrates with geomorphology, soils science and human geography in the agricultural land use studies. This authors introduced opinion does not contradict at all to the classical definition of geomorphology research goals: "Geomorphology is primarily concerned with the exogenous processes as they mold the surface of the earth, but the internal forces cannot be disregarded when one considers fundamental concepts of the origin and development of landforms" [10, p.3]. Thus geomorphology may be considered as one of the key discipline in environmental geography becoming, especially if we accept the ideas of the topography-landforms-earth surface processes impact on mankind development and functionality [11].

The geology mentioned as the fundamental earth science discipline drives together with geomorphology to the relevant environmental issues. If earlier geologists mainly dealt with terrain deformations and rock metamorphosis are now interested in both landforms and earth surface processes spatial distributions, contributing to environmental geography in this way. Quite a few major advanced insights of environmental geography (we have mentioned this without additional references) have been provided just in case of the GIS-modeling of the earth surface processes and landforms. In many these cases a sample of convergence between geology and geomorphology was provided. What is more, the GIS-modeling initiates necessary backgrounds for contemporary environmental management by telling, for example, to a decision-maker where and why unfavorable exogenous processes occur (extreme soil erosion rate, in particular), and where and why they do not.

Considering what are those problems of natural environment that can be efficiently solved by an environmental geographer, we refer to following two publications. One of them examines relevant case studies within watersheds [12], while another one touches basic fundamentals of the environmental geography [13]. This list aggregated includes those boundary riddles that geologists and geomorphologists have been considering for years, but mainly – *without environmental aspect* of these problems. Thus, referring to [12, 13] they may be as follows:

- soil water and wind erosion, other unfavorable exagenic phenomena;
- sediment and pollutant transport through river and gully watersheds;
- landslide generation within river valleys and along the seacoast;
- soil formation rates upon more or less human impact, particularly in relation to the natural soil erosion rates;
- lake water body pollution according to presence or absence of heavy technological developments within nearest neighborhood;
- ecology of lakes, and their bottom deposits;
- the behaviour of river deltas and estuaries, especially the transport and deposition of sediment and the creation and destruction of mudflats;
- the changes wrought by past climate change as a forecast to the possible effects of future climate

changes, and the record of climate change recorded in ice, mineral sediments, and landforms;
- the migration in groundwater of chemicals dangerous to living species.

Finalizing this paper section concerning research transfer from geography with its relevant branches – geology, geomorphology, soils science, etc. – to environmental geography, we have to remark that even in contemporary advanced Western literature in the field, it may be easy to note evident lack of connections between geography and environmental geography. Even content of some huge publications announced in the environmental geography remains purely geographical in its main text body, while few ended book sections are devoted to humans and environmental problems. What is more, the case studies is a subject of primarily consideration, while the environmental geography theory appears as the secondary item.

One of the key methodological approaches of the environmental geography. By default a broad subject area of the environmental geography would imply quite a few basic research approaches. Nonetheless all of them can be approximately divided for *two categories of natural environment – human world interactions* [8, 13, 14]. Such a divide also proceeds from that broad environmental geography definition, according to which it is the study of the distribution of factors (human-technologic activity, transportation routes, pollution distributions, zonal climates, soils and so on) within the selected natural boundaries so that to see why these factors are distributed the way they are. According to this definition extension the environmental geography is the branch of both physical and human geography that is specialized in addressing the relationship between the human society and the natural environment. If we extent this definition even further, just then we face two categories mentioned. On the one hand it is human environmental impact on vegetations, water and soils that initiates consequent changes. On another hand humans would possess and demonstrate some specific behavior being exposed to all these changes and phenomena.

A known environmental geographer R.J. Wasson introduces an example of human impact causing dangerous change, where extreme land use along a river channel within watershed boundaries drastically increases soil erosion in the area, and therefore – the solid sediment amount transported in a river [12]. Consequently this additional sediment load destroys aquatic ecosystem by infilling pools in riverbeds and infills man-made reservoirs decreasing their useful lifetime. When there is some heavy technological development on floodplains within such a watershed, natural ecosystems increase their risk sharply already to any natural hazards, which may also occur in addition to aggressive human impact. Finally it must lead to some alterations in this development planned, and such a case we may consider as an example of the second from two categories mentioned.

Introduced above in this paper section two forms of "human-natural environment interactions" makes us seek for necessary solution by applying a discipline of geomorphology, which weight for environmental geography we have already emphasized. Thus the possibility of environmental geography key research methodology lies substantially in the fact that watershed morphology and its hydrological regime are strongly connected through basin geomorphic development (water and wind erosion, soil mass movement, etc.). The understanding of a river basin as the "environmental geographical system", which is a synonym to the certain point of the "geographical landscape" definition, necessarily implies quantitative study of drainage areas, what would produce valid criteria for the system component outlining .

Historically, studying of some specific phenomena, processes, and problems, which are directly related to the environmental geography such as water resource supply, desertification and irrigation, waste water and hazardous waste management, flood prediction and control, have introduced methods based on river basins as a basic mapping unit in dealing with these geographical problems. Nowadays, swift technological growth is the main reason of a rapidly increasing demand for watershed (drainage basin) mapping. Contemporary development of advanced computer technology, geoinformation system algorithms and corresponding modeling methods have also led to increased opportunities for the proper usage of this kind of geographical information – drainage basin data.

For the whole variety of interrelated environmental geography issues just geomorphic-hydrological aspects go to the first line in modeling *human-environmental interactions.* Among these aspects next two outlined expressions possess crucial meaning: *a drainage basin* (*a river basin, a watershed*) and *fluvial topography and landforms* as the major features of a basin surface.

Authors of some corresponding reviews from those made in latest years indicate, that while early studies were directed mainly to the systematisation of channel networks and other elements of basin morphology, since approximately the eighties of the last century the main stress has been changed to the measurements and calibration of geomorphic processes in a basin together with clarification of the spatial variation in the process types [15]. These researches frequently borrow methods of exact (fundamental) sciences however their value is fairly limited by rather small spatial and chronological scope.

Nonetheless these studies match the environmental geography subject area, because their main research topics tend to be as follows: dynamics of channel flow and the underlying surface resistance to its movement, sediment yield-delivery and its accumulation in a river channel, including this process alteration upon the human impact. reconstructions of the three-dimensional geometry of fluvial sedimentary styles, and some other problems of process nature. In spite of decreased attention to the basin morphology systematisation, some papers have been devoted to the modelling of channel network properties.

This referred sample of a relevant literature survey (that can not be extended only due to limited framework of this paper) merely demonstrates different aspects of processes in a river basin, that can be potential subjects of research, but which are developed as integral attributes of one natural phenomenon – the fluvial proc-

ess caused by the water driving force [15].

One of this paper authors has already introduced the approach, which assists substantially in watershed environment reconstruction taking under consideration a channel network and watershed landform morphology only [16]. Our suggested methods were intended immediately for the GIS-platform elaboration, but in what way taking into account the mentioned watershed landscape feature may help in the complete environment reconstruction even for a territory strictly bounded (as a watershed is) we are about to explain on the following example from a seminal book of the prominent British geomorphologist, L. Leopold [17].

The following visual (Fig. 1 from [17, P. 23]) represents a modeled map of a small watershed, where several wells were drilled so that to make the database of water level in different seasons of year.

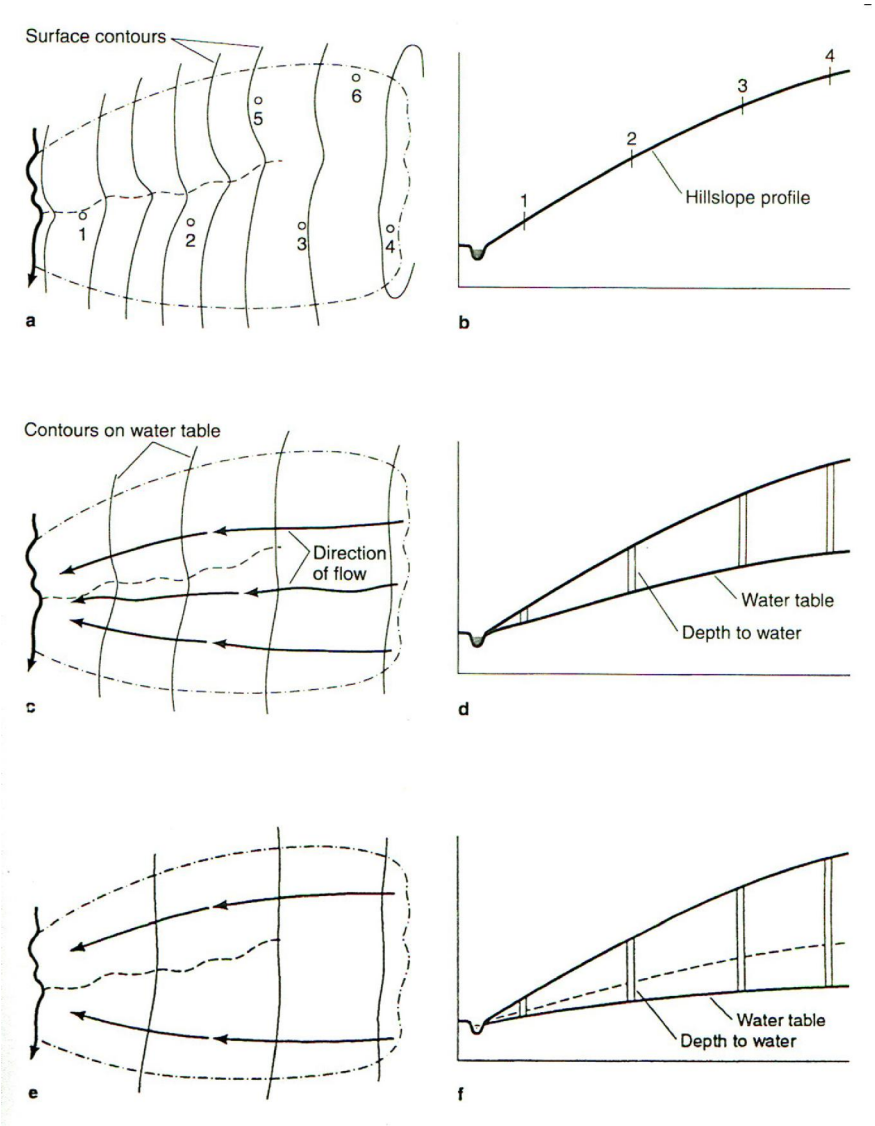

Fig. 1. A modeled watershed showing topography contours of the landforms, contours on the water table under underground conditions of high and low water table [17, P. 23]

An environmental geographer may most contribute to environmental management knowing, what exist even out of his sight in the landscape, including both underlying surface and underground. Thus he must either model with GIS-tools some virtual wells in a basin selected, or gather data from the existing ones. Well locations and the water level in them is a basic implement in the ground water research, while the latter is mandatory condition of the watershed environment reconstruction.

One should model either a virtual well location, or plan its real site disposition by taking into account spatial characteristics of those two crucial watershed features we already mentioned above: channel network and landform morphology. As a matter of fact these two features impact the changes of water level underground.

A visual above also demonstrates these changes in the different seasons of the year (see Fig.1). Part **1a** of the *figure 1* visualizes the surface topography of the watershed showing the contour lines and the location of six wells [17]. Part **1b** is a longitudinal profile of the basin surface in the plane of the wells prescribed 1 to 4. Part **1c** is the planimetric map of the saturated zone surface. In this case the contours are equi-potential lines, and those lines spacing is the gradient of the water surface. Part **1d** is the profile as in **1b**, but the depth of the water table is shown as the vertical line beneath each well. The

curved line below is the profile of the water table. This drawing represents conditions during a relatively wet season. Flow in the river channel in non-rain periods is sustained by the drainage of stored groundwater.

Thus watershed landform morphology allows us to reconstruct the underground environment, simply because water flows downhill in the direction of maximum water surface slope. Drawn orthogonal to the equipotential contours lines show the direction of groundwater flow.

Conditions modeled basing on channel network, landform morphology, underground water table level and described above in **1a-1d** for a relatively wet season drastically contrasted with the relatively dry season conditions in Part **1f** of the Figure 1. The wet season profile is drawn in a dashed line under the ground surface profile of the dry season. The depth of the water shown is obviously greater, than in the wet season. A drawn profile of the water surface has a smaller gradient toward the river channel. Therefore the flow velocity is smaller than in **1d** situation. Part **1e** demonstrates the contours or equi-potential lines on the water table. They are described for the same relatively dry season and spaced farther apart than in the wet season situation. Once again the lines drawn perpendicular to these contours indicate the direction of water flow and are depicted by arrows [17].

It is reasonable to repeat here that all six parts of Figure 1 show us in what way the geomorphological approach is involved in the environmental geography: how it is possible to reconstruct underground environment taking into account watershed land forms, channel network and random locational underground data. The simplified drawings (see Figure 1, **1a-1-f**), which can be also obtained through GIS, show how relevant date can be used by an environmental geographer to determine the rate of groundwater flow and local directions of flow. Surely the initial modeling conditions imply exclusively both an unconfined aquifer and uniform geologic rocks.

This methodological section of our paper represents the original approach, which may link computer modeling of natural environmental processes with geoinformation technology. If methods of landscape assessment follow from the environmental geography research strategy, they can introduce complex numerical algorithms of the geomorphologic-hydrological analysis. Moreover, such methods allow not only generation of the information missing in the initial data sets, but also calculation of various geomorphologic-hydrological indexes representing current conditions of the environment. A research technique like this may facilitate the solution of various problems of environmental geography, which produce a hazard for both human populations and ecosystems, including control of sediment-pollutant delivery from both point and non-point sources, water-supply reservoir allocation in arid landscapes, modelling of channel network, investigation of erosion processes - sediment yield-delivery, studies of landscape geochemistry and pollutant transgression, etc.

The human / natural environment interaction perspective through the innovative geoinformation technologies. In the previous sections of this paper we have mainly discussed those environmental geography issues, which followed from geomorphology, hydrology and physical geography thus focusing on the watershed landforms, soils and underground processes. Social constituent of the environment has been considered relatively only, while it is not only the main subject of the human geography, but also a substantial part of the environment geography area, what has been emphasized in this paper introduction.

Providing above the geomorphic research approach, we have implied that watershed landforms that respond most quickly on human impact are completed from soil and sediment rather than from rock. These landforms are usually located in the energetically most active parts of geographical landscape as along river channels and valleys [12, 18]. Therefore an environmental geographer has to pay some special attention to the short timescales – decades, centuries, one millennium at most, but all these short timescales must include the human society factor as a mandatory issue. Proceeding from sequences of deposits, the frequency of both heavy human impact, and hazardous natural events can be deduced to make the informative records on "human – environment" interactions. These records are further employed in GIS-geodatabases.

Introducing above the geomorphic approach in the environmental geography, we not occasionally have introduced the groundwater spatial distribution first of all (see Figure 1). The case is that examples of integration between environmental geography and people concerns are plural, but groundwater peculiarities are the most relevant. Sustainable groundwater use is the solution with which environmental geography can firstly contribute with the modeling technique demonstrated above to alleviation of human-environment interactions. The key approaches here are the surface water / underground water balance and understanding how pollutants can reach underground water and can be kept separate from this water table. Today reliable measuring of water balance for a territory more or less large must involve by default the GIS tools for estimation of recharge (replenishment rate) by infiltration of precipitation through soils and into underground water. Modeling sustainable groundwater consumption, a GIS user should also outline the rate of lateral inflow in the subsurface from upland, the rate of loss into river and gully channels, and the rate of extraction by wood / grass vegetation.

When environmental geography faces to solve pure tasks of human / natural world interactions, the data uncertainty grows sharply in resulting environmental models. Because of this reason too these models can not be accomplished anywhere out of a GIS shell. The necessity of presentation of human / natural environment data reliability or uncertainty needs to be coupled with a powerful mapping technology in the strategic environmental geography goal: various data integration and visualization (Figure 2).

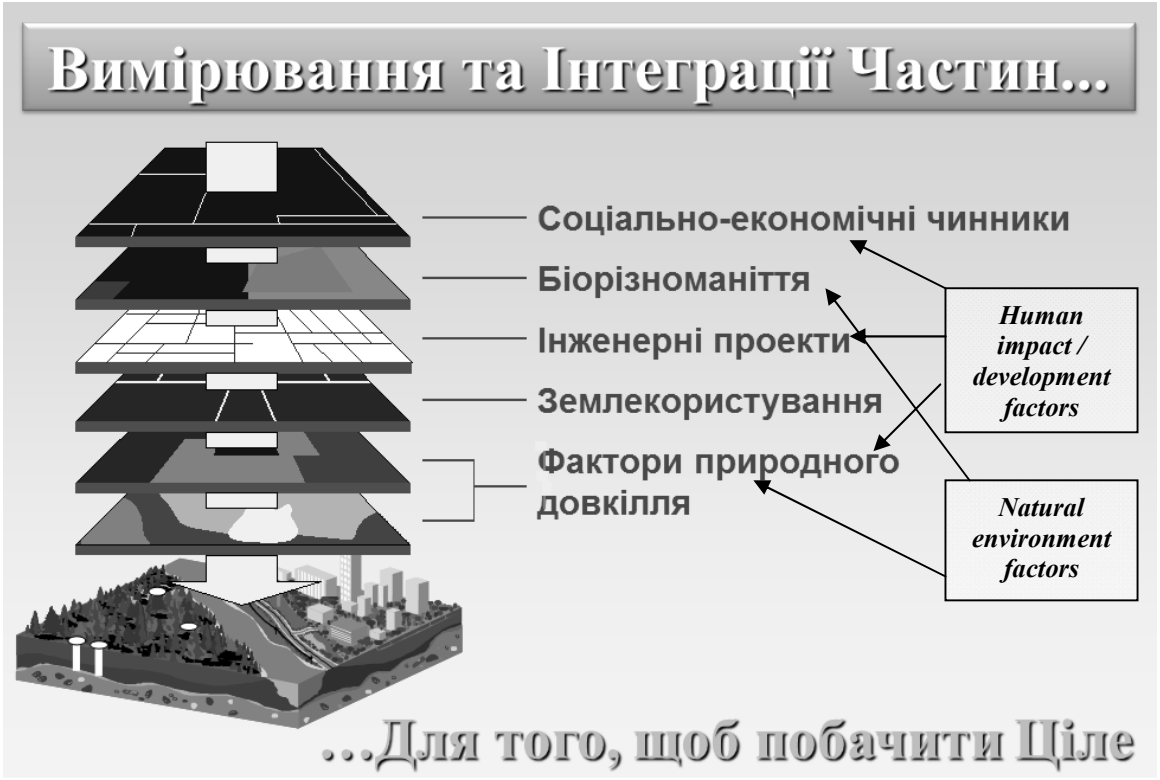

Fig. 2. Strategic goal of the environmental geography: human / natural environment data integration with further visualization through GIS. The layers sequence is presented according to the accepted GIS rules

The intention to couple data gathered at multiple human / environment interaction layers and within multiple slices of time as it generally depicted on the visual above (see Figure 2) may be impeded by data uncertainty, and this problem can not simply be solved without GIS. This idea can not be overestimated, if we are speaking about causes and impacts of groundwater pollution within the floodplains and whole watersheds and its consequent influence on human health. In this case with the GIS assistance an environmental geographer discovers the poisoning causes, locates sediment layers free of these pollutants and works with hydro-engineers and physicians to treat poisoned water so that it can be reused.

Thus environmental geography appears to be an unusual area of expertise in the way it unites social, human and biophysical sciences. This discipline has to gather data from a wide range of sciences, because, as an example, the complexity of environmental impact on the selected regional level simply can not be revealed without applying to the regional human population trends and their fluctuations [19]. Often seeming solutions of environmental issues fail because they might not apply to the existing integrity of environmental, social, political and cultural factors, while such complex conditions must be considered, when, for example, poverty - environmental interaction issues are examined in the geographical perspective [20].

Conclusions. It is obvious that many of the general characteristics of environmental geography theory provide advantages as well as disadvantages in the human / natural environment interaction applications. Through the complete text of this paper we have mainly intended stress on its advantages, only few of them can be summarized in the next way:

- An environmental geographer possesses valuable skills to bring to the study of human / environment interactions;
- key importance is environmental geographer's ability to integrate social, human and biophysical issues and take into consideration the strong spatial dimension of these highly spatial domains;
- we represent with this paper that section of environmental geography that is the study of human impact on the earth surface processes, landforms and ground water; in this case water bodies, ground waters and landforms are examined over territories of various sizes and locations;
- human issues must be accepted as the most peculiar domain of environmental geography; hazardous human impact on the environment proceeds from human behaviour and decisions; thus to make a real contribution to environmental protection and natural resource management the environmental geography must employ the social science professionals and some specialists from the humanities fields.

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Summary

Sergiy Kostrikov, Kateryna Segida. TOWARDS THE ENVIRONMENTAL GEOGRAPHY CONCEPT.

Authors introduce the environmental geography concept both within some peculiarities of its theory, and with few short examples of the practical applications. The discipline presented broadly in the Western geographical school almost was not announced at all in Soviet, Russian or Ukrainian geographical science.

Spatial laws, trends and fluctuations make the environmental geography subject up. The paper examines briefly some regularities of this new discipline formation. Environmental geography describes the spatial aspects of interactions between the humans and the natural environment.

The trend of geographical science becoming the environmental geography is introduced. According to this trend a definite research approach that would unite a strong spatial aspect of environmental researches with the GIS regional applications directly related to the domains of both physical and human geography must be developed.

As the key one among other methodological approaches the geomorphic method is selected for the watershed environment reconstruction employing channel network, landform features and surface / ground waters only. A relevant modeling example is introduced. This case is that examples of integration between environmental geography and people concerns are plural, but groundwater peculiarities are the most relevant.

A strong spatial aspect of this research implies GIS tools involvement, what is discussed in details, in particular – within human / environment interaction perspective. The necessity of presentation of human / natural environment data reliability needs to be coupled with a powerful mapping technology in the strategic environmental geography goal: various data integration and visualization.

Keywords: environmental geography, human / environment interactions, landforms, earth surface processes, groundwater, data integration and visualization.