Digital environmental information sources for creating augmented reality in education

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Abstract. To complete the ecological educational content in the context of augmented reality, the digital means of modern electronic publications were screened. Educational materials in the form of public services, interactive cartographic materials on topographic, geological, hydrological features, functional zoning of the territory, natural-climatic characteristics and environmental pollution are offered. On a practical example are given explanations on the use, interpretation of data on the territory and in the conditions of Novokuibyshevsk, Samara region. The definition of ecological situation analysis in the context of augmented reality is proposed for discussion. The procedure of description of its main components is shown. A classification table of educational content elements with digital sources of their formation is compiled.

1 Introduction

Augmented Reality (AR), which has become widespread in many branches of modern human activity in the last quarter century, continues to provide effective interaction between the real and virtual world [1]. There are literature reviews on the application of AR in maintenance for adaptive user support [2], applications in medicine [3], agriculture [4], and industry [5]. However, the exceptional opportunities, the most potential and realized options are in the field of education [6].

Augmented reality resources allow modern educational solutions to be developed using mobile devices and computers. Augmented reality as a completely new technology allows interacting with digital information on the basis of context-aware devices [7], creating a sense of reality, expanding the possibilities of gaining experience unavailable in real life, increasing student interest [8].

AR technology is of particular importance in building students' research skills because of the difficult-to-understand scientific constructs, and visual representations help to increase students' interest in science [9], master complex abstract concepts [10], and understand objects through three-dimensional volumetric representation [11].

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AR models superimpose virtuality elements and their interaction on the event parameters of the real world. Technologies of modeling mechanism are represented by elements of the game process, supporting research and learning endeavors of students [12]. Interactive technologies and tools ensure successful mastering of educational material, student motivation, enjoyment and autonomy [13]. It is believed that ecosystem-based education with augmented reality is a flexible tool for learning [14]. However, research on the optimal types of content and its impact on learning outcomes is considered quite challenging [15]. To fill the educational content, current government programs and environmental safety projects are addressed [16].

The work experience in the environmental education disciplines implementation testifies to the difficulties of students in performing tasks on situational analysis of modern environmental problems. They often provide outdated literary materials, erroneous, inaccurate and untenable data from electronic sources. This is absolutely unacceptable considering the federal state educational standard requirements, which provides for research, project-production, expert-analytical and other professional activities for graduates.

The modern digital tools, cartographic materials, official publications allow to compile a comprehensive, reliable and visual educational content of useful information for the forming of students' professional competencies, analytical abilities, research skills.

2 Purpose, objects, methods and materials of research

The purpose of this study is to analyze the available digital tools of modern electronic publications to offer them in the formation of educational content on the principles of relevance and visibility in the training of bachelors. The objects and materials of the study were digital means in the form of public services, interactive cartographic materials on topographic, geological, hydrological features, manifestation of dangerous exogenous geological processes, functional zoning of the territory, natural-climatic characteristics and environmental pollution. To verify the objects of the study considered real examples of interpretation of environmental conditions and the state of the natural-anthropogenic environment in the territory of Novokuibyshevsk, Samara region. We used general scientific methods: analysis when considering individual factors of the environment, generalization of individual elements in the general educational content, modeling in real examples of environmental conditions interpretation, classification of educational content elements. Among the methods of empirical cognition we used description to record information about the objects of study, comparison for the correlation assessment of different components of the educational content.Research results

For spatial positioning of a particular study area modern services of search engines (2GIS, Yandex Maps), various cartographic materials, geoinformation portals, websites, photo and video images and other sources of visualization of the environment, its objects, components and their condition are widely used. For spatial positioning, the studied territory of Novokuibyshevsk is illustrated on Yandex Map (Fig. 1).

The city territory on Yandex Map is represented in the "hybrid" layer, which combines satellite information, road network, natural and anthropogenic objects (vegetation, water bodies, buildings and structures). The eastern part - mainly residential area and the western part - mainly industrial area with large industrial facilities - Novokuibyshevsk Oil Refinery and Novokuibyshevsk Petrochemical Company - are clearly enough divided. This service when zooming in the map allows you to evaluate street panoramas, visualize the surrounding objects and their external condition, determine the distance between objects with the "ruler" option, the area of the land plot in the "planimeter" mode, get and other information for general use, related to navigation, terrain detailing. Even in general terms to assess the composition and condition of the vegetation cover. For example, Figure 1 shows pronounced

woody vegetation in the sanitary protection zone separating the main residential and industrial zone of the city. Around industrial facilities there is mainly herbaceous vegetation, and there is no vegetation on industrial sites.

Fig. 1. Territory of Novokuibyshevsk on Yandex Map. *In https://yandex.ru/maps.*

The study area is depicted on an interactive topographic map (Fig. 2).

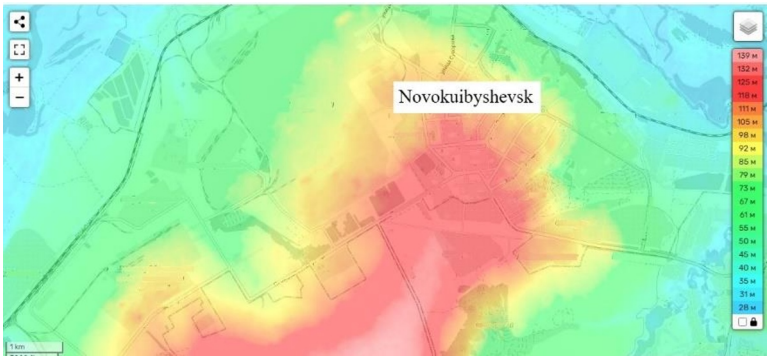

Fig. 2. Territory of Novokuibyshevsk on the interactive topographic map. *In https://ru-ru.topographic-map.com.*

The service of free topographic maps, elevations and relief has a search function by destination country and settlement. The interactive topographic map uses color and sign design. Red and brown colors inform about elevations, while green and blue colors inform about depressions of the terrain. As can be seen, the terrain varies greatly with elevations ranging from 140 m to about 50 m, i.e. the elevation difference is significant and amounts to 90 meters. There is a noticeable slope from the south-eastern part to the north-western part of the town. At the same time, the residential area is located on an elevation from 130 to 90 m above sea level, and the main industrial area in the lower part - from 100 to 50 m above sea level. The given comparative accuracy of geographical heights determination is achieved by the presence of a function on this resource, when clicking the cursor on the electronic map in a particular place displays the altitude above sea level.

Ecological-geological, ecological-hydrological and other ecological conditions of the studied area can be familiarized with the example of other additional visual cartographic materials. On the Internet resources, the Institute of Geology of the Russian Academy of

Sciences (Moscow) is the publisher of the state geological map, and the hydrological zoning map - the A.P. Karpinsky All-Russian Research Geological Institute (St. Petersburg). A.P. Karpinskii All-Russian Research Geological Institute (St. Petersburg) on the Geokniga Geological Portal. The visual aids offered for public use are relatively small scale, so the geological map including the central part of Samara region in the state register under number 38(39), in the execution of information on groundwater status, has a scale of 1: 1 000 000.

To detail the images and text placed in the map legend, we turn to the zoom function of the interactive map publications and match them with landmarks on the ground for a more precise location of the study area (Figures 3 and 4).

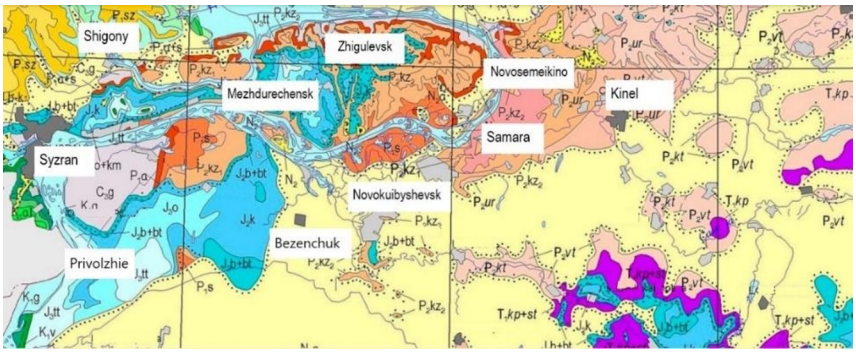

Fig. 3. Fragment of the state geological map of Novokuibyshevsk and its surroundings. *In https: //hgepro.ru/mapgis/subekt/samara/11_geol_sam.pdf.*

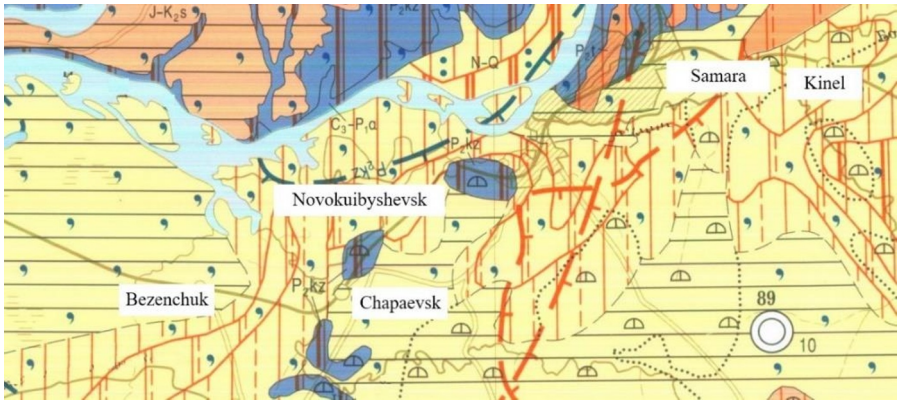

Fig. 4. Fragment of the map of hydrological zoning of Novokuibyshevsk and its surroundings. *In https://www.geokniga.org.*

According to the state geological zoning, the surrounding area is represented by the upper Pliocene section of the Neogene system. According to the map legend, the N2a designation attributable to the study area corresponds to the data of the Akchagyl regiogeorus composed of sands, clays, siltstones, pebbles and other materials.

The investigated area is characterized by complex geological and hydrogeological study by 1:200 000 scale surveys. In the hydrological zoning scheme it belongs to the hydrological area of the Zhigulevsko-Pugachevsky arch of the Volga-Ural artesian basin. Aquifers are represented by pore-plast water in sandy-clayey with subordinate other sediments. The prevailing water conductivity ranges from 50-100 to 100-500m2/day. According to the degree of mineralization, waters are fresh (0.1-1.0 g/kg), and according to ionic composition waters are mottled with the degree of mineralization up to 3.0. The predominant anionic composition is sulphate.

Accounting of hazardous exogenous geological processes occupies an important place in ecological and geological surveys. Official assessment and registration of dangerous exogenous geological processes (DEGP) in our country is carried out within the framework of the state monitoring of subsurface conditions (GMSN). Information about them can be found in the interactive map of their manifestation by the search query of the territory, color scale and map legend with the list and activity of DEGN. When the cursor is pressed on the key of the corresponding WGPA, a window with a color indicator and indication of the degree of manifestation of the processes appears at the bottom of the map. On figure 5 it is possible to see that the considerable territory of the western part of Novokuibyshevsk city is represented by developed manifestation of karst-suffosion processes, especially places of Novokuibyshevsk refinery location, other large petrochemical productions, but by the degree of activity of these processes they are considered to be low. Greenish color marks the area of gully erosion, which is more widespread in the eastern and southeastern part of the city with a medium and low degree of.

Fig. 5. Fragment of the map of manifestation of dangerous exogenous geological processes on the territory of Novokuibyshevsk. *In https://gmsnmap.geomonitoring.ru.*

Functional zoning of the settled territory is the most important condition for ensuring environmental safety. At the legislative level in our country for the development of municipalities the development of a fundamental document - the Rules of Land Use and Development is envisaged.

The current Urban Planning Code of the Russian Federation in Article 30 states that this document is aimed at creating conditions "for sustainable development of territories of municipalities, preservation of the environment..." and other. The rules of land use and development on the resources of the municipal Geoportal (in the current version of the Decision of the City Duma of Novokuibyshevsk № 93 of 17.06.2020) sets out a detailed characterization of functional zones on the territory of Novokuibyshevsk in graphical and textual form. The presented document contains cartographic materials for the city district as a whole: urban planning zoning, sanitary protection zones of enterprises, facilities and other objects, zones of action of restrictions established for the protection of water bodies, protection zones of engineering and transportation infrastructure, location of cultural heritage sites.

The urban planning zoning map of the city allows visualizing the entire territory and functional zones.

The peculiarities of town-planning regulations, the procedure for regulating land use and development in textual form are prescribed for each functional zone in the Rules of Land Use and Development.

The Ministry of the Russian Federation for Civil Defense, Emergencies and Elimination of Natural Disasters oversees an interactive service with a variety of information about

incidents on the territory of the Russian Federation, including monitoring of emergency situations.

To assess the current state and situational analysis of environmental conditions by weather and climatic characteristics, the degree of pollution of natural and anthropogenic environments, it is possible to refer to Internet resources to the materials of the Ecological Bulletin, in particular, of the Samara region. It is published in the form of an annual official publication in the form of a brochure (report). The value of information from the bulletin is that it is a primary source, which is formed as a result of professional work of Roshydromet - the state hydro-meteorological service according to the approved methods.

The official publication for 2023 contains sections on characterization of the environmental situation in Samara Oblast on atmospheric air in 9 urban districts, including Novokuibyshevsk. This publication also contains sections on the state of surface water, hydrobiological condition of water bodies, soil and radiation situation.

The website of FGBU Privolzhskoe UHMS along with other various environmental information of operational nature contains information from the sections "Hydrometeorology", "Environmental Pollution Monitoring", "Monthly Environmental Information", "Annual Review", "Environmental Maps".

When you press the active key "Environmental Bulletin for the Samara Region for 2023", a fully analogous official printed publication appears.

Official information on the state and pollution of the natural and anthropogenic environment of the subject of the Russian Federation and its municipalities can be used from the materials of the annual annual report "On the state of the environment and natural resources of the Samara region" for a certain year on the electronic resource of the Ministry of Forestry, Environmental Protection and Nature Management of the Samara region.

As educational content for situational analysis of environmental conditions, it is possible to apply real-time digital resources. When constantly operating digital computing devices (meteorological radar stations) are used, reflecting real physical processes that cannot be stopped or postponed in time. With the definition of the coordinates of precipitation, type and direction of its movement, maps of water temperature in reservoirs, current agrometeorological conditions on the territory of Russia, and more. Hydrometeorological Center of Russia offers in open access to use the actual data and weather forecasts on the website "About weather at first hand". Where, along with other relevant materials, you can familiarize yourself with an animated map of weather phenomena for the last 3 hours according to radar observations.

Actual materials on weather and climate parameters in real time and in animated form are presented by the specialized service Yandex Weather or the website "Global map of cataclysms".

For complex situational analysis of special interest is the resources of the global map of cataclysms, where you can study the results of measurements of temperature, precipitation, cloud cover, wind speed and direction, atmospheric pressure, air humidity, snow cover and others. This resource allows you to study air pollution, with specifically identified pollutants, their values, and by controlling by pressing the cursor and in a particular place.

3 Discussion

Situational analysis in environmental studies can be considered as a method of analysis for recording the current ecological state of the natural-anthropogenic environment, components and factors determining its stability and dynamic changes in the operational format, as well as in real time, the latter being especially positively perceived by the educational audience. Digital educational content, even in an aggregated format, in ecological situational analysis is very abundant and diverse (tab. 1).

Table 1. Elements of digital educational content for environmental situation analysis and its visual sources of formation. *The table is prepared by the authors.*

№	Elements of educational content	Sources
1.	Spatial positioning	2GIS, Yandex Maps, photo and video images
2.	Relief	Interactive topographic map - topographic-map.com
3.	Geological conditions	Interactive geological map - hgepro.ru. Interactive map of HMSN - gmsnmap.geomonitoring.ru
4.	Гидрологические условия	Geological portal Geokniga - www.geokniga.org
5.	Area zoning	Regional and municipal geoportals - Rules of land use and development
6.	Weather and climatic conditions	Environmental Bulletin of Roshydromet - pogoda-sv.ru, National report of the Ministry of Natural Resources of the Russian Federation "On the state of the environment and natural resources", Regional reports of the territorial bodies of the Ministry of Natural Resources of the Russian Federation of the constituent entities of the Russian Federation "On the state of the environment and natural resources".
7.	Natural and anthropogenic pollution	Atlas of Hazards and Risks of the Ministry of Emergency Situations of the Russian Federation - atlas.mchs.gov.ru, Environmental Bulletin of Roshydromet - pogoda-sv.ru, National report of the Ministry of Natural Resources of the Russian Federation "On the State of the Environment and Natural Resources", Regional reports of the territorial bodies of the Ministry of Natural Resources of the Russian Federation of the constituent entities of the Russian Federation "On the state of the environment and natural resources".
8.	Real-time system	Roshydromet website "About weather at first hand" - meteoinfo.ru, Yandex Weather website - yandex.ru/pogoda/maps, Global Map of Cataclysms website - priroda.inc.ru.

The research materials present only a basic and incomplete list of both the elements of digital educational content for environmental situation analysis and the sources of its formation. Filling the educational content with varied and differentiated content is seen in the multiplicity and complexity of branches of environmental studies and in its problem field.

4 Conclusion

Modern digital tools, cartographic materials, official publications allow to compile comprehensive, reliable and visual educational content of spatial positioning, visualization of topographic, geological, hydrological, weather and climatic conditions, zoning of the

territory, natural and anthropogenic pollution using real-time system. Application of new educational content in environmental situational analysis contributes to the formation of students' professional competencies, analytical abilities, research skills.

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