мания) [2]. Формы нахождения тяжелых металлов определялись по методике А.И. Самчука [3].

Результаты исследований содержания тяжелых металлов в исследуемых почвах показали (таблица), что почвы городов подвергаются техногенному воздействию, что сказывается на увеличении содержания тяжелых металлов в них. Отмечено, что почвы г. Луцка характеризуются наибольшими содержаниями тяжелых металлов по сравнению с почвами заповедной территории, так, содержания Ni больше в 6 раз, Zn и Co в 5, Cr в 4, Cu и Pb в 3 раза. Содержания тяжелых металлов в почвах г. Ковеля незначительно превышают концентрацию их на заповедной территории (до двух раз). Для почв г. Бреста типичным является загрязнение тяжелыми металлами, при этом в большинстве случаев загрязнителями почв являются Ni, Zn, Cr, Cu, Co, Pb, содержание которых практически повсеместно превышает фоновые концентрации в 4–5 раз.

Таблица – Среднее содержание тяжелых металлов в почвах Волынского и Брестского Полесий, мг/кг

Элемент	Волынское Полесье, Украина			Брестское Полесье, Беларусь	
	Почвы города		Почвы заповедной территории	Почвы города	Почвы заповедной территории
	г. Луцк (n = 58)	г. Ковель (n = 62)	Шацкий национальный парк (n = 45)	г. Брест (n = 36)	Беловежская пуща (n = 35)
Mn	525	300	263	330	270
Ni	32	7	5	5	1
Co	5	2	1	2	0,5
V	37	25	17	28	12
Cr	30	7	7	8	2
Mo	2	1	1	2	1
Cu	60	39	20	12	3
Pb	55	21	19	40	10
Zn	50	10	10	45	10

Примечание. n – количество проб.

Значительной геохимической проблемой является изучение форм нахождения тяжелых металлов в почвах, что необходимо для объективной оценки степени миграции химических элементов.

Для изучения форм нахождения тяжелых металлов нами были выбраны почвы г. Луцка, так как из исследованных городов он оказался наиболее загрязненным тяжелыми металлами, а также условно чистая почва Шацкого национально парка.

В почвах Шацкого национального парка содержание тяжелых металлов в водорастворимой форме составляет 0,5–1%. Доля тяжелых металлов в обменной

форме – 8–15%; тяжелых металлов, адсорбированных гидроксидами Fe и Mn – 8–12%; органических или связанных с гумусовыми кислотами форм – 30–87%. В труднорастворимой форме удерживается 40–52% тяжелых металлов.

В почвах городских ландшафтов г. Луцка уменьшается доля форм нахождения тяжелых металлов, связанных с органическим веществом, и увеличивается содержание форм нахождения, связанных с гидроксидами Fe и Mn, а также обменных.

Таким образом, результаты эколого-геохимических исследований позволили выделить территории с повышенным содержание тяжелых металлов в почвенных отложениях, превышающие фоновые концентрации. Установлены особенности распределения тяжелых металлов, связанных с сорбирующими фракциями почв. Показано, что в условиях городской среды повышается подвижность тяжелых металлов в почвах и их миграция в сопредельные среды.

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TRACING AND IDENTIFYING SOURCES AND TYPES OF POLLUTION IN TRANSITIONAL ARCTIC SHELF WATERS

The shelf and the coastal regions is perhaps the most important transit areas within the marine ecosystems. Being the transfer zone they represent areas of the maximal biodiversity level, high biological productivity as well as the largest oil and gas deposit areas. Besides that, it is the region of the intensive navigation and shipping, maritime port construction, i.e. it is exposed to the maximal anthropogenic pressure [1]. Hence, the environmental sustainability of the marine coasts in the shelf areas is of high importance.

Anthropogenic activities impact the marine ecosystems by transporting contaminants and pollutants from different sources. The transfer of contaminants demonstrates the intensity of the anthropogenic impact on the different parts of the Barents Sea ecosystem. The most remarkable origins include following ones. First, transport of industrial and agricultural waters by the river flows. Secondly, the development of the engineering structures directly on the shelf areas which damages ecosystem. Third, the discharge of the nuclear waste disposal and industrial wastes which have extreme negative consequences on the marine ecosystems. Forth, the air emissions: gases from the fabrics and plants into the atmosphere. Fifth, the chemical particles discharged by fuel from transport, navigation, shipping and fisheries into the sea by currents and rivers. Finally, mining minerals, as well as oil and gas drilling activities which may cause incidents (e.g. oil spills).

Probably the most important type of all pollutants discharging into the world Ocean is hydrocarbon products exampling global environmental disaster [4]. First, it is caused by the increasing oil production and oil station drilling. Secondly, the current transportation within the sea as well as interconnectivity of the parts of ecosystems make oil spilling accidents affecting neighboring water surface. Discharge of the hydrocarbons products directly in to the Barents Sea waters gradually increases due to the active development and exploitation of the oil deposits as well as its transportation and accidental spills. What is more alerting, the exploitation of sea oil deposits is especially dangerous for the Arctic seas. Why? Because all chemical and biochemical process here have low speed which is caused by special conditions of the polar climate with low temperatures. Therefore, sea waters at high latitudes can be more polluted comparing to those located in tropical zones even at similar levels of pollution [5]. The additional source of hydrocarbon products is presented by currents of the Gulf Stream consisting of oil spots and spills brought from the north America and Europe. Three main zones of discharge can be noted: the Sargasso Sea, the Norway Sea and the Barents Sea.

Irregular distribution of the contaminants within the sea aquatory is caused by various factors. First, there is certain impact of geographic locations of the pollutant sources. Second, oceanographical particular features: the individual characteristics of the ocean water currents and their vertical structure. Thirds, the depth of the water column. Hence, maximal concentration of the oil pollutants is detected in the coastal relatively calm zones where they are accumulated. Forth, the proximity of the main polluting source. Thus, the concentration of the carbohydrates is significantly higher near the oil platforms and along the main transport ships routes.

The sources of hydrocarbon contaminations in the Barents Sea include shipping routes, drilling works, inflows of the polluted waters from the Atlantic ocean and White Sea. As for the contamination by pesticides and heavy metals, the most important zones of its concentration correlate with the main sources of their discharge. Three separated zones can be mentioned. 1) central deep water zone with minimal values, Spitsbergen (inflow of a-HCH with water from the thaw of snow and glaciers). 2) the archipelago Novaya Zemlya. The main source of the contamination is the nuclear testing ground. 3) the Kola Peninsula and the Varanger Fiord. The maximal concentrations of a-HCH in the Kola Bay reach 1.9 ng/l which is caused by the inflow of the

meltwater from Murmansk industrial region. The Varanger Fiord has lesser values of concentrations (1.2 ng/l) [6]. The total HCH concentrations in the Barents Sea increased after the catastrophe at the Sellafield plant. This proves that the contaminations originating even from sources located far away play critical role for the marine sustainability and can be easily transported into the adjacent seas.

The contamination of the Barents Sea by Polychlorinated Biphenyls (PCB's) indicates their uneven distribution: relatively stable zones with low level of contamination and regions with high level of PCB's contamination. Different levels of the concentrations of PCB's in the floor of the basins should be mentioned as well: the south-western, the Kola, the Atlantic and the Novaya Zemlya region. Following reasons can explain this pattern. The south-west zones with high levels of PCB's pretty clearly correlate with overall direction of the Atlantic currents. In such a way they reflect polluting sources from the western European territories, e.g. industrial and household chemical inflow from the land into the ocean basin. High values in the Kola region correlate with Kola Gulf and reflect industrial pollutions inflow from Murmansk. The Novaya Zemlya region has maximal discharge caused by the nuclear weapon tests and navy activities. The region to the north of the Cape Zhelaniya is closely connected with the dump of the military wastes. The high PCB's concentrations in the Atlantic region are caused by the coastal drainage and polluted runoff of Gulf Stream (Nordcap branch connected with the Barents basin). High values in Spitzbergen and the Franz-Josef-Land regions are explained by the ice and snow melting from the archipelagos and transfered by precipitation. Maximal HCH-concentrations are located in the coastal zones of archipelagos Spitzbergen, Novaya Zemlya, Varanger Fiord and Kola Gulf. Higher concentrations are recorded in the littoral area of Spitzbergen archipelago. Particularly, they are located within the large fiords and caused by the inflow of PCB's by melted waters from glacial and snow areas. The second largest zone of fixed heightened values ^{137}Cs is located in the shelf zone of the archipelago Novaya Zemlya. The maximal concentration of the Barents Sea waters by radio cesium ^{137}Cs is observed near the Novaya Zemlya where nuclear tests were placed [7]. At the same time it should be stressed that distribution of the ^{137}Cs´is clearly connected with types of the bottom sediments. The substances are accumulated on the ground, where better places present fine-grained silt (silty sediments)rather than coarse-grained fractions e.g. sand, gravel or pebble [8], [9]. In the last ones the concentrations of contaminants is normally low, because they are washed out from the ground almost immediately or very soon.

Current paper provided analysis and overview of the main types and sources of origin of the pollutants in the Arctic shelf. This transit region is strategically important for human activities. At the same time, it is environmentally valuable and vulnerable region. The most unstable regions under high anthropogenic pressure include the followings ones: Novaya Zemlya trough, route of intensive navigation near Murmansk, western part of Spitsbergen, area located alongside Gulf Stream branches, south-eastern parts of the Barents Sea. Since study area is located in a transit zone, the environmental instability and discharge of pollutants easily overpasses the cross-bordering areas and may have negative consequences. This paper contributed to the environmental monitoring by reporting ecological situation.

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UPHOLDING OPEN SOURCE PRINCIPLES FOR EDUCATION: USE OF QUANTUM GIS FOR TEACHING GEOINFORMATICS

The variety of data and information increases interest to the subject at students. The development of the skills and abilities to use GIS is not only important in the professional education (cartography), but also for broader formal education in any branch of geosciences. Using geoinformation technologies allows to visualize data and perform lectures at high standard as well as to integrate multi-disciplinary approach in lectures. Hence, students feel like active participants while learning process rather than passive listeners. They are able to gain new skills, to analyze and compare, to look for

data. Applying active, collaborative mode "teacher-student" in educational process enables student to discover and develop his creative potential [1].

However, the most sensitive question while using and choosing GIS is its price. Though it might not be a big problem for the corporations or big companies, it often becomes a serious challenge for students with restricted financial budget. The most popular GIS are represented by following software products: ArcGIS, MapInfo, Panorama, Neva, Erdas Imagine, GeoMedia and others. However, they are commercial software, not free of charge. In this work I am going to inform audience about the use of the GIS environment in the public domain: a Quantum GIS. The Quantum GIS is a GIS released under the license GNU (General Public License).

Use of Quantum GIS is free of charge, i.e. every student may install it on his laptop and enjoy its multi-functionality for the educational purposes. Quantum GIS allows student to create and analyze maps of countries, territories, regions, cities, to use both raster and vector data. Thematic layers can be displayed in various ways, including in the form of high-quality map layouts. Quantum GIS allows students to solve complex problems of geographical analysis based on the implementation of que-

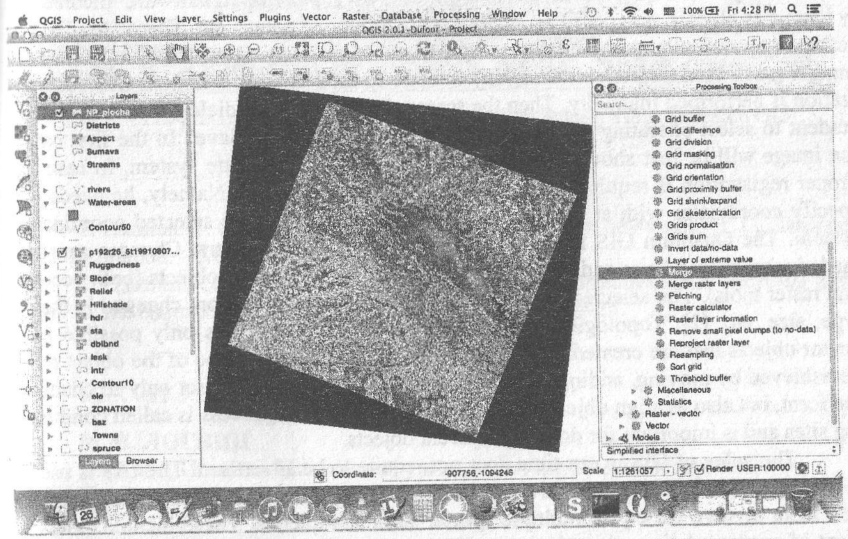

Fig. 1 – Organizing project in Quantum GIS: example of Czech National Park

ries and creation of various thematic maps, to communicate with remote databases, to export geographical objects in other GIS, etc. Thematic maps created in Quantum GIS provide broad opportunities for data analysis and design possibilities: visualizing graphical objects using colors, hatchings, line types and symbols, etc.

Methodologically, staring project from scratch often (though not always) begins at georeferencing scanned paper maps and their vectorization in order to put them into e-form and to get new spatial information thereafter. To work with bitmap image in a Quantum GIS environment student has to open it as a raster file, find appropriate coordinates and refer to them. Then they should move on objects vectorization ('View', 'Toolbars', 'Digitizing'). By manual vectorization operator student encircles each object by the mouse and save it using 'New Vector Layer' dialog in Quantum GIS that allows to define a new layer. Then student navigate and click on the menu entry Layer-New-New Shapefile Layer. The new vector layer now exists. To begin digitizing, student need to enter edit mode which is commonly required to prevent accidental deleting of important data. Edit mode is switched on or off individually for each layer by the student himself. Using such commands as 'Add Feature' for starting vectorizing, 'Move Feature' to move entire feature, 'Node Tool' to just only one part of a feature, enables student to play around with new objects.

While vectorizing contour lines it is usually enough to set up the starting point and the direction of the tracking lines. Later on, it will track the line for as long as it meets an uncertain situation (e.g. line break). Interactive vectorization is strongly related to the quality of the data source. Automatic vectorization involves direct transfer from raster-to-vector format using special software (Autotrace). However, editing is almost always necessary thereafter, as even the most sophisticated software incorrectly identifies objects, e.g. confuses symbols with groups of points, etc. There are special software specifically designed for certain types of automatic vectorization of raster images (such as maps, text information) that can be used as well. Quantum GIS vectorization is performed manually. Then the screen displays another dialog box that allows student to select operating mode with the image of: 'View' or 'Save'. In the first case the image will be just shown on the map in the default coordinate system. In case if proper registration is required, student has to register the image. Namely, he needs to specify coordinates with at least three points of the image in the selected coordinate system. The Quantum GIS has a variety of tools for editing layers. Changes can be made by activating layer and choosing any of tools for processing objects (both vector and raster tools). The selected object can be moved to a new location, changed in their type, size, etc. [2]. Topologically, performing changes in shape is only possible for vector objects that are created by the polygon tool. Change the shape of the object can be achieved by moving, adding or removing nodes which are used not only to change the form, but also to align objects relative to each other. This process is called combining sites and is important for docking adjacent objects.

The value of GIS in our time does not require to be advertised. The GIS is used in almost all kinds of human activities: be it commercial analysis or education activities. Both involve variety of multiple special tasks and queries. These include assessment of overpopulation, air and water pollution, land cover changes, natural disasters, finding best route between points, planning sightseeing, tourism, selection of the optimal location of the new office, municipal tasks, etc. The use of GIS in educational environment, i.e. at workshops, seminar, colloquia, lectures, etc. enables applying multidisciplinary approach. Thus, teacher can use information from many sources and related disciplines (e.g., a priori knowledge, in situ data, soil or geomorphic schemes, cli-

matic data, math calculations, statistics, etc.). The paper reported technical usage and some functionality of Quantum GIS for education.

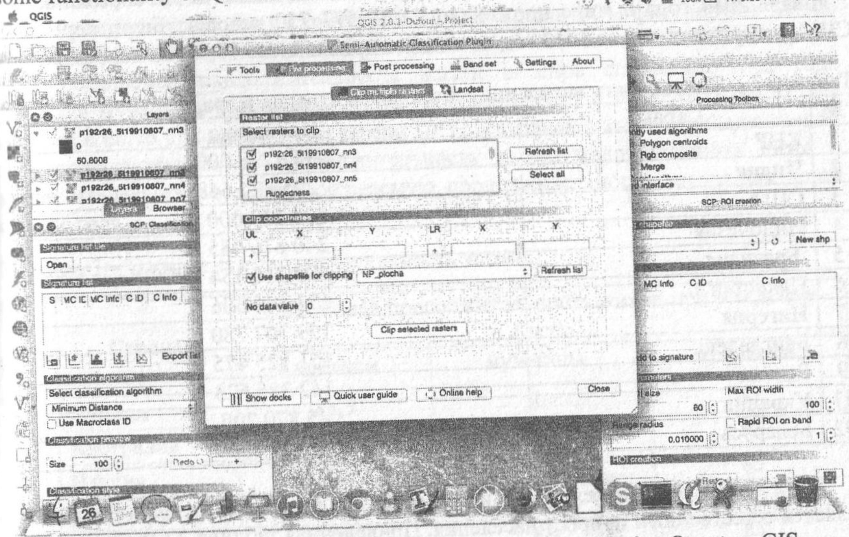

Fig. 2 – Pre-processing raster data (Landsat satellite image) using Quantum GIS

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ГЕОДЕМОГРАФИЧЕСКИЕ ОСОБЕННОСТИ СОВРЕМЕННОГО МИРА

Важной составляющей современного развития общества является исследование демографических ресурсов мира, макрорегионов и отдельных стран. Одним из главных показателей демографического развития служит общая численность населения мира, отдельных стран и его динамика (таблица 1). В первых двух странах списка – Китае и Индии – проживает свыше 1/3 всего населения