

system's (GIS's) algorithm to extract the river basins boundaries based on the open digital elevation model (DEM) SRTM HydroSHEDS. It will be the first time in Ukraine, when obtained GIS layers of the delineation will be freely available for verification and discussion.

Keywords: geospatial data infrastructure, hydrographic delineation, D8, SRTM.

Глотка Д. В. Усовершенствование карты гидрографического районирования территории Украины на основе SRTM HydroSHEDS. Для создания национальной инфраструктуры пространственных данных (НИПД) Украины необходима кооперация между отраслевыми специалистами для работы над отдельными тематическими блоками геоданных. В 2013 году представлена методика и карта гидрографического районирования территории Украины [1], которые являются фундаментом для развития гидрографического блока. В статье предложено использовать автоматизированный алгоритм получения границ бассейнов рек в геонформационных системах (ГИС) на основе открытой цифровой модели рельефа (ЦМР) SRTM HydroSHEDS. Полученные ГИС слои районирования будут впервые в Украине выложены в свободный доступ для верификации и дискуссии.

Ключевые слова: инфраструктура геопространственных данных, гидрографическое районирование, D8, SRTM.

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NATURAL ENVIRONMENT OF KIELCE CITY (POLAND)

– STATE, THREATS AND PROTECTION

**– ОХОРОНА ДОВКІЛЛЯ В КЕЛЬЦАХ (ПОЛЬЩА) –
СТАН, ЗАГРОЗИ І ЗАХИСТ**

Keywords: natural environment characteristics, threats, urban area

Introduction. Contemporary management of urban natural environment, especially while preserving the rules of sustainable development, needs a profound and multidirectional evaluation of the state of its preservation, defining the real and potential threats, as well as the acquaintance of the forms and ways of its protection. For this purpose a numerous scientific works and publications resulting from existing law regulations are being worked out. Identification of those contemporary and archival works, including cartographic materials, can lead to identification of the most important threats of the urbanized area. This type of analysis was performed on example of Kielce, in addition to individual components of its natural environment. In the analyzed area those components are exceptionally well recognized, in particular in publications from the last 20 years. Problems concerning geology and terrain relief have been described by R. Cywicki (1990), M. Hojny-Kołos (2002), M. Studencki (2006), B. Jaśkowski et al. (2008), A. Barbacki et al. (2009) and T. Ciupa (2009a), Wałek (2012, 2014b), Ciupa and Wałek (2013). Soils condition have been analyzed by A. Świercz (2005), T. Ciupa and T. Biernat (2006), et al. The works of G. Żarnowiecki and G. Szałach (2001), H. Olszewski (2006), M. Kwinkowski et al. (2007) and U. Chmura et al. (2010) describe topoclimatical and aerosanitary conditions of the area. State, threats and protection of surface waters have been undertook by E. Bezak-Mazur et al. (2001), T. Biernat et al. (2004, 2007a), T. Ciupa (2009b), M. Janiszewska (2010), R. Woźniak et al. (2010), Wałek (2014a), and groundwater by J. Prażak (1994, 1997), J. Prażak and K. Janecka-Styrcz (2007), Jakość... (2011) and others. Investigation results concerning flora and fauna preservation and biodiversity were presented by E. Bróż and B. Maciejczak (1991), J. Wypiórkiewicz (2005), J. Barga-Więcławaska (2006), K. Zarzycki and Z. Szeląg (2006), B. Maciejczak (2008) and A. Przemyski (2009). Moreover, a

number of valuable publications in form of monographs describing various aspects of the city's environment have been made in recent years – T. Ciupa (2009a), B. Szulczewska et al. (2009), M. Józwiak et al. (2010), T. Ciupa et al. (2011).

The aim of this paper is the identification of natural environment characteristics in Kielce and resulting from it conditions of environmental threats.

To solve this problem a query of available scientific publications (in form of text and cartographic materials), archival works (including implementation works), and law regulations have been made. After the verification of collected materials, further analysis was based on more than 200 publications. Their list is available in T. Ciupa et al. (2011). The results of performed analysis, including features of natural environment and its problems, which often take form of threats are in simplified form presented in Table 1.

Study area. Kielce is a capital city of Świętokrzyskie Voivodeship in central Poland. It covers an area of 109.45 km². According to statistics from Central Statistical Office in 31.12.2013 almost 200,000 citizens lived in the city. This puts Kielce on 17-th position among Polish cities (<http://www.stat.gov.pl/bdl>). Kielce are located on the metropolis list in the most important, long-term strategic document concerning land management and planning in Poland (Konceptcja... 2011). It states that contemporary structure of local economics has remarked influence on forming of environmental problems existing now and on environmental policy in the future.

Kielce, in contrast to other Polish cities with over than 100,000 inhabitants, distinguishes by big contribution of protected areas within its borders. In that respect they lead among Polish cities. From among 10 environment protection forms mentioned in the law enactments (Ustawa... 2004), there are 8 in Kielce. Noticeable involvement of the city authorities in environment protection issues does not eliminate all environmental problems in the city, which is pointed out by the following identification.

Results. Natural environment characteristics of Kielce, along with formulated problems are presented in Table 1. Presently the most existing environmental problems in Kielce are connected with the aquatic environment, later biosphere, atmosphere, lithosphere and pedosphere.

In addition to surface waters those problems are connected with: heavy load of running waters with non-cleared stormwater and partly industrial and communal sewages; increase of surface runoff as a reason of impermeable areas growth; flooding of lower road segments; very short concentration time of high flood waves causing flood risk, mainly in the Silnica river valley; quality and quantity degradation of groundwater in the area of major groundwater reservoir; lack of hydrometric observations.

Problems and threats to the biosphere are mainly connected with: direct proximity to building infrastructure; pollutants emissions; fragmentation and diversity of land ownership which causes interruptions in ecological corridors and their durability; forests, meadows and peat bogs degradation; reducing of wild animals natural habitats; insufficient revitalization of the green areas in the city.

According to the atmosphere threats in the area of Kielce we can distinguish: air pollution from industries, road traffic and housing emission along with limited ventilation of the city; noise pollution; increase in high rainfalls frequency due to existence of spreading urban heat island.

Diverse terrain lithology determines variable ground bearing capacity which influences building infrastructure. In the areas of some tectonic faults an increased concentration of radionuclides have been registered. Land relief creates natural barriers in the city development, also causing fast surface runoff to flow through the city center.

Table 1 – List of the natural and anthropogenic environment characteristics and their issues in Kielce

Geo-sphere	Component	Environment characteristics	Environmental issues
Lithosphere	geology	Structures and forms of Paleozoic stem of Świętokrzyskie Mts	Migration of dissolves containing elements or compound that could be harmful to health and life
		Dense network of tectonic faults and dislocations	In areas of some faults – raised concentrations of natural radionuclides
Lithosphere	terrain relief	Evidences of neotectonic activity	Earthquakes
		Rock and mineral raw materials existence	Intensive exploitation and processing of rock and mineral raw materials
		Mosaic character of surface geological structures	Spatially variable ground bearing capacity
		Course of mountain ridges surrounding the city	Natural barriers of city spatial development, variability of topoclimate and aerosanitary conditions, river runoff and organisms migration;
Lithosphere	terrain relief	Existence of hollow basins and river gorges	Sediment accumulation (with pollutants) and increased risk of flooding in hollow basins and river valleys; tendency to water level rising, limitations in road infrastructure development, hard building conditions
		Steep terrain slopes	Faster water circulation
		Durable anthropogenic landforms: quarries, mounds, dykes, road embankments	Vast levelled areas, changes in slopes geometry, slopes modelling by mass movements and erosional processes, soilfluction and ground flows which destroys road infrastructure; limitations in ecological bandwidth
Pedosphere	soils	Mosaic character of soil cover in city fringes (including organic soils) and dominance of anthropogenic and downgraded soils in city center	Uncontrolled increase of impermeable surfaces area in the city center (infiltration reduction), covering of soils and removing biologically active ground surfaces, difficulties in soil protection resulting from existing acts of law – important to biodiversity preservation
Atmosphere	topo-climate	Soil contamination	Increased concentrations of heavy metals along roads, alkalization, salinization, changes in species of vascular plants, lichens and degradation of their habitats
	aerosanitary conditions	Rised air temperature and high thermal and moisture contrasts in different areas of the city	Increased convection processes resulting in rised frequency and extreme intensity of rainfall, in the central part of the city, and in consequence increased river runoff.
Atmosphere	aerosanitary conditions	Amphitheater-like relief structure and air stagnation	Difficult ventilation of the city and its susceptibility to air pollution
		Existing emitters of pollutants	Exceeds of acceptable concentrations of 24-hours PM10; repeated dust pollutants floating from terrain surfaces (for example roads)
		Existing sources of noise pollution	Noise exceeding standards (road traffic, mass entertainment events)
Atmosphere	aerosanitary conditions	Sources of electromagnetic radiation of point and line character	Existence of high and medium-voltage lines, transformer stations, transmitting and relay stations, base stations of mobile telephony

Hydrosphere	surface waters	<p>Rising contribution of anthropogenic drainage (roads and drainage systems) in forming of surface runoff</p> <p>High dynamics of Silnica river runoff, which flows through the city center</p> <p>Reduction of river valleys cross-sections areas</p> <p>Existence of numerous Bridges and footbridges</p> <p>Run of transit-like rivers (Bobrza and Lubrzanka) along the city borders</p> <p>Water filling of isolated drainage depressions</p> <p>Low quality of running waters</p> <p>Low quality of stagnant waters</p> <p>Exceeding norms concentration of chlorides and sodium in winter period</p> <p>Expansion of storm sewage pretreatment systems</p> <p>Absence of sufficient rainfall and runoff monitoring systems and insufficient number of running waters quality control points</p>	<p>Periodically intensive and rapid surface runoff on road surfaces and along storm sewer system</p> <p>Very high time and spatial diversity of runoff quantity and unnaturally short concentration times of flood waves (below 1 hour) limits possibilities of emergency services reactions; supply of water through numerous canals, high runoff irregularity and high flow velocity, loss of water in the end part of Silnica river valley due to cone of depression existence</p> <p>Rise of water level and flow velocity in the sections of diminutions increases flood risk</p> <p>Insufficient throughputs of bridges and footbridges that result in rising of water level and flood risk</p> <p>High seasonal fluctuations of water level (2.0-2.5 m)</p> <p>Possibility of pollutants concentrations and their infiltration into the ground</p> <p>Discharges of storm sewages, and partly sanitary and industrial sewages through storm sewer system on which only small number of entities have permission</p> <p>Algae growth and excessive growth of aquatic vegetation due to eutrophication; exceeding the indicator of bacteria (enterococci) and E. Coli, and this limits their use for recreational purposes</p> <p>High contamination of surface waters associated with winter road maintenance</p> <p>Still insufficient number of stormwater treatment plant</p> <p>Lack of flood protection; lack of obtain an accurate spatial distribution of water quality and movement of pollutants</p>
	groundwater	<p>Existence of two Devonian groundwater reservoirs and excavations of the quarries near the city borders</p> <p>II and locally III class of groundwater pumped out for public purposes</p> <p>Existence of objects potentially dangerous to the main groundwater reservoir (petrol stations, stockpiles)</p>	<p>Supply of drinking water from Major Groundwater Reservoir (GZWP-417) 65% of the population of 200 thousand inhabitants of Kielce; formation of depression cones around the water intakes (Bialogon, Dyminy) and dewatering mines (Sitkówka-Nowiny), and consequently the disappearance of springs and periodicity of smaller streams</p> <p>Spatially variable resistance to migration of pollutants into groundwater, which is very small (<25 years) in most parts of Kielce area. The problem is the flow of polluted water Silnica river over Major Groundwater Reservoir (GZWP-417)</p> <p>Location burdensome investments in areas lack of isolation or partial isolation of groundwater</p>

		<p>Exceeding national standards on the concentration of nitrate, manganese, and the presence of bacteria <i>E. Coli</i></p> <p>Disappearance of small water reservoirs, wetlands, meadows, bogs; floristic impoverishment due to changes in land use and disappearance of grazing and meadland – decline in soil fertility</p> <p>Alkalinization of forest soils influences the restriction of the growth pine and development of heathland communities</p> <p>Forest degradation - the impact of low emissions, traffic pollution, increase soil moisture over embankments and road culverts in the valleys; maladjustment tree stands for habitat; habitat restoration; human impact; transformation of the more humid forest habitats in oak-lime-hornbeam forests; introduction of alien habitat tree species, which adversely affects the entire plant community and soil; lack of new afforestation; insufficient revitalization of urban green areas</p> <p>Disappearance and displacement of habitat as a result of the change in land use, soil moisture and vegetation appears</p>
<p>Biosphere</p> <p>flora, fauna and biodiversity</p>	<p>Diverse, but generally low shallow groundwater quality in the areas of strong anthropopression</p> <p>Domination of synanthropic communities, significant share of thermophilous and tall herb communities</p> <p>High Ca content in the soils of forest ecosystems, associated with the deposition of dust cement and lime industry</p> <p>Existence of forests around the city and their direct vicinity to built-up areas</p> <p>29 protected natural habitats (xerothermic grasslands, marshy pine forests, riparians and oak forests)</p> <p>156 flora species: rare, threatened and vanishing, 37 species are listed as vanishing, rare or endangered in the country. Existence of the 75 protected plant species</p> <p>Most valuable natural areas within mountain ranges and river valleys, forming ecological corridors and nodes</p> <p>Large number of certain species of fauna (birds - 221, fish - 20) within nature reserves, hills, river valleys and urban green areas</p>	<p>Protection of species of plants and preservation of the existing state</p> <p>Securing the sustainability and patency of ecological corridors prior to the change of use, interruption of continuity, pollution, changes in water relations; restore the missing sections of ecological corridors and increase their network</p> <p>Remain in good condition existing natural habitats and their revitalization; protection of species of animals</p>

Source: Own work

Existing pedospheric problems in Kielce are similar to those in other big cities: natural soil cover degradation; spreading of impermeable areas (which covers soils and plants); heavy metals, oil derivatives and salt contamination.

Conclusion. The article demonstrates that in the area of Kielce, as a reason of imposition of various natural and anthropogenic conditions a very diverse and complicated geocosystem exists.

Deep and multidirectional analysis of natural environment conditions in Kielce allowed to evaluate its existing and potential contemporary threats. Furthermore it enabled to formulate problematic issues whose solution is important to efficient functioning of the city. In result 38 groups of problems in the scope of 5 natural environment components have been distinguished. Most of them (15, which is 40%) are connected with hydrosphere, where 11 concerns surface waters and 4 groundwater. The analysis shows that aquatic environment problems are the most important to Kielce and are also the most urgent to solve.

Detailed identification of problems concerning natural environment and its threats is necessary to precise formulate tasks, postulates, desiderata and recommendations for the purpose of local environmental protection programs creation. This way of dealing with environmental issues in land management practices could lead to improvements in environment state and its efficiency, and indirectly to improve the quality of citizens life.

Literature

1. *Barbacki A., Bujakowski W., Graczyk S., Hotojuch G., Kasztelewicz A., et al.* 2009, Ocena warunków geologicznych Kielc pod kątem energetycznych i leczniczych zasobów wód podziemnych (termalnych i leczniczych) niezbędnych dla podjęcia decyzji o ewentualnym ich wykorzystaniu i uwzględnieniu w bilansie energetycznym oraz dokumentach rozwoju miasta. Arch. UM Kielce.
2. *Barga-Więclawska J.*, 2006, Ocena dynamiki zmian środowiska przyrodniczego Kielc na podstawie występowania ślimaków i małży z uwzględnieniem charakteru biotopu, liczby gatunków i liczby osobników, jako elementów wskaźnikowych stanu środowiska. Arch. UM Kielce.
3. *Bezak-Mazur E., Widłak M., Ciupa T.*, 2001, A Speciation analysis of aluminium in the river Silnica. Polish Journal of Environmental Studies, 10, 4, 263-267.
4. *Biernat T., Ciupa T., Eliasiewicz R.* 2007. Atlas zasięgu obszarów zalewowych w dolinie rzeki Silnicy wodami o prawdopodobieństwie 0,5%, 1% i 10%. 2006. Geoprojekt Kielce, Arch. UM Kielce.
5. *Biernat T., Ciupa T., Suligowski R.*, 2004, Mapa Hydrograficzna Polski w skali 1:50 000 arkusz M-34-42-A Kielce. GUGiK. Warszawa.
6. *Bróż E., Maciejczak B.*, 1991, Niektóre nowe oraz rzadkie i zagrożone gatunki roślin naczyniowych w florze miasta i strefy podmiejskiej Kielc. *Fragm. Flor. Geobot.*, 36, 171-179.
7. *Chmura U., Kosielski M., Kuczer J., Kuczer M., Lochno A., et al.* 2010, Raport dla miasta Kielce - Inwentaryzacja źródeł emisji do powietrza atmosferycznego w związku z potrzebą aktualizacji baz danych dotyczących stanu i ochrony powietrza atmosferycznego m.in. dla potrzeb integracji systemów gromadzenia i przetwarzania danych o środowisku w Miejskim Systemie Informacji Przestrzennej. Arch. UM Kielce.
8. *Ciupa T.*, 2009a, Wpływ zagospodarowania terenu na odpływ i transport fluwialny w małych zlewniach na przykładzie Sufragańca i Silnicy (Kielce). Wyd. UJK, Kielce.
9. *Ciupa T.*, 2009b, The hydrological effects of urbanization exemplified by the Silnica and Sufraganiec river catchments (Kielce, Poland). *Folia Geogr., Seria Geogr.-Phys.*, XL, 5-25.
10. *Ciupa T., Biernat T.*, 2006, Metale ciężkie w wierzchniej warstwie gleb miasta Kielce. [In:] A. Kostrzewski, J. Czerniawska (eds), *Przemiany środowiska geograficznego Polski Północno-Zachodniej*. Bogucki Wyd. Nauk., Poznań, 195-202.
11. *Ciupa T., Biernat T., Suligowski R., Fogel A., Stolarz P.*, 2011, Opis stanu środowiska miasta Kielce. Instytut Gospodarki Przestrzennej i Mieszkalnictwa, Warszawa-Kielce.
12. *Ciupa T., Suligowski R., Biernat T.*, 2011, Identyfikacja problemów środowiska przyrodniczego miasta Kielce. *Problemy Ekologii Krajobrazu*, XXXI, 5-11.
13. *Ciupa T., Wałek G.*, 2013, Zastosowanie kartografii porównawczej i technik GIS do analizy wpływu rzeźby terenu na przestrzenne przemiany zabudowy Kielc. [In:] B. Medyńska-Gulij, J. Kubiak (eds), *Pragmatyka w kartografii*. Prace i Studia Kartograficzne, 4, 15-36.
14. *Cywicki R.*, 1990, Budowa geologiczna i charakterystyka przydatności gruntów

dla budownictwa. In: Opracowanie fizjograficzne ogólne do miejscowego planu zagospodarowania przestrzennego miasta Kielce, Geoprojekt, Kielce, 12-28. **15.** *Hojny-Kołos M.*, 2002, Trzęsienia ziemi w Polsce w latach 1000-1995, Mapa Inst. Geofizyki PAN, Warszawa. **16.** <http://natura2000.gdos.gov.pl>. **17.** <http://www.stat.gov.pl/bdl>. **18.** Jakość wód podziemnych miasta Kielce, 2011, Arch. Wodociągów Kieleckich, Kielce. **19.** *Janiszewska M.* (ed.), 2010, Wyniki klasyfikacji i oceny stanu wód powierzchniowych w województwie świętokrzyskim w roku 2009. Kielce. **20.** *Jaśkowski B., Kasprzyk A., Olszak I. J.*, 2008, Wykorzystanie anomalii zawartości izotopów ²³⁸U, ²³²Th i ⁴⁰K oraz naturalnego promieniowania elektromagnetycznego do wyznaczania przebiegów uskoków tektonicznych. *Landform Analysis*, 9, 351-356. **21.** *Józwiak M., Ciupa T., Józwiak M., Kiczor P., Kościółek A., et al.* 2010, Raport wskaźnikowy w zakresie zarządzania środowiskiem i zrównoważonym rozwojem miasta Kielce dla potrzeb opracowania programu ochrony środowiska przy wsparciu miejskiego systemu informacji przestrzennej (GIS). Arch. UM Kielce. **22.** Kielecki Obszar Metropolitalny. Statystyczne Vademecum Samorządu, 2010, WUS Kielce. **23.** Koncepcja Przestrzennego Zagospodarowania Kraju 2030 – projekt z 25 stycznia 2011 roku, 2011, Ministerstwo Rozwoju Regionalnego, Warszawa. **24.** *Kwinkowski M., Jankowska-Błaszczuk M., Piwowarczyk R., Kaca W.*, 2007, Analiza zapylenia i występowania aktywnych biologicznie substancji w powietrzu m. Kielce. Arch. UM Kielce. **25.** *Maciejczak B.*, 2008, Resources and distribution of pteridophytes in the area of Kielce (Poland). [In:] E. Szcześniak, E. Gola (eds), Club mosses, horsetails and ferns in Poland-resources and protection. *Pol. Bot. Soc & Inst. of Plant Biol.*, Wrocław, 117-125. **26.** *Olszewski H.*, 2006, Badania akustyczne w obszarach uprzemysłowionych i rejonach obiektów uciążliwych w Kielcach. Arch. UM Kielce. **27.** *Prażak J.*, 1994, Dokumentacja hydrogeologiczna (RE) Kielce, w tym GZWP 417 Kielce. Arch. PIG O/Świętokrzyski, Kielce. **28.** *Prażak J.*, 1997, Mapa hydrogeologiczna Polski 1:50 000. Ark. Kielce (815). Arch. PIG O/Świętokrzyski, Kielce. **29.** *Prażak J., Janecka-Styrcz K.*, 2007, Kielce. [In:] Z. Nowicki (ed.) Wody podziemne miast wojewódzkich Polski. PIG Warszawa. **30.** *Przemyski A., Piwowarski B., Sitarz A., Woźniak I., Przemyski P.*, 2009, Siedliska Kieleckiego Obszaru Chronionego Krajobrazu. Arch. UM Kielce. **31.** *Studencki M.*, 2006, Mapa zaburzeń tektonicznych na terenie Kielc w skali 1:25 000 z uwzględnieniem wpływu dyslokacji nieciągłych na budowę i zdrowie mieszkańców. Arch. PIG O/Świętokrzyski, Kielce. **32.** *Szulczewska B., Cieszevska A., Giedych R.* (eds), 2009, Opracowanie ekofizjograficzne wykonane na potrzeby Studium uwarunkowań i kierunków zagospodarowania przestrzennego miasta Kielce. Arch. UM Kielce. **33.** *Świercz A.*, 2005, Analiza procesów glebowych i przekształceń roślinnych w zakalizowanych siedliskach leśnych regionu świętokrzyskiego. Komitet „Człowiek i Środowisko” przy Prezydium PAN, Zesz. Nauk., 39, Warszawa-Kielce. **34.** Ustawa o ochronie przyrody z dnia 16 kwietnia 2004 r. (Dz.U. 2004 nr 92 poz. 880, z późn. zm.). **35.** Ustawa o udostępnianiu informacji o środowisku i jego ochronie, udziale społeczeństwa w ochronie środowiska oraz o ocenach oddziaływania na środowisko z dnia 3 października 2008 r. (Dz.U. 2008 nr 199 poz. 1227). **36.** *Wałek G.*, 2012, Współczesne przeobrażenia rzeźby terenu Kielc. *Landform Analysis*, 19, 81-90. **37.** *Wałek G.*, 2014a, Rola dróg w kształtowaniu kierunków spływu powierzchniowego w zlewniach miejskich na przykładzie Kielc. [In:] T. Ciupa, R. Suligowski (eds), Woda w mieście. Monografie Komisji Hydrologicznej PTG, t. 2, Kielce, 301-310. **38.** *Wałek G.*, 2014b, Use of digital elevation models and orthophotomaps in identifying anthropogenic mounding of river valleys (Kielce, Poland) // *Fiz. geografia ta geomorfologia. – 2014. – Вип. 2(74). – С. 103-109.* **39.** *Woźniak R., Ziółkowski L., Śliżewski B., Szwagrzyk M., Kramarczyk M.*, 2010, Koncepcja zagospodarowania wód deszczowych dla miasta Kielce. CONECO–BCE. Kraków. **40.** *Wypiórkiewicz J.*, 2005, Dokumentacja dynamiki występowania ssaków w środowisku przyrodniczym Kielc, w tym w dolinach rzek i ich sąsiedztwie. Arch. UM Kielce. **41.** *Zarzycki K., Szelağ Z.*, 2006, Czerwona lista roślin naczyniowych w Polsce. [In:] Z. Mirek, K. Zarzycki, W. Wojewoda, Z. Szelağ (eds). Czerwona lista roślin i grzybów Polski. Inst. Bot. im. W. Szafera PAN, Kraków, 11-20. **42.** *Żarnowiecki G., Szałach G.*, 2001, Zróżnicowanie warunków biotopoklimatycznych w Kielcach. *Dok. Geogr.*, IGiPZ PAN, 23, 119-129.

Ciupa T., Suligowski R. Natural environment of Kielce city (Poland) – state, threats and protection. In this study the identification and analysis of major environmental issues in Kielce with two hundred thousand inhabitants have been made. Simultaneously, the most important and urgent environmental problems of the city have been indicated. For this purpose, the inquiry of the available scientific studies (textual and cartographic), archival elaborations, including implementation ones, as well as acts of law have been performed.

Contemporary natural environment management in Kielce, especially while preserving the rules of sustainable development, requires a profound and multidirectional evaluation of the state of its preservation, defining the real and potential threats, as well as the acquaintance of the forms and ways of its protection. It is particularly important in urbanized areas, which are characterized by extremely wide spatial differentiation of geosystems.

Keywords: natural environment characteristics, threats, urban area.

Цюпа Т., Суліговські Р. Природне середовище міста Кельце (Польща) – стан, загрози і захист. У дослідженні визначені та проаналізовані основні екологічні проблеми в Кельцях з населенням близько двісті тисяч жителів. Також вказані найбільш важливі та нагальні екологічні проблеми міста. Для цього використані існуючі наукові дослідження (текстові та картографічні), архівні розробки, а також законодавчі акти.

Сучасне управління природним середовищем в місті Кельце, особливо при дотриманні законів сталого розвитку, вимагає глибокої і різнобічної оцінки його сучасного стану, визначення реальних і потенційних загроз, а також визначення способів його захисту. Це особливо важливо в урбанізованих районах, які характеризуються надзвичайно широкою просторовою диференціацією геосистем.

Ключові слова: характеристики природного середовища, загрози, міська територія.

Цюпа Т., Сулиговски Р. Окружающая среда города Кельце (Польша) - состояние, угрозы и защита. В исследовании определены и проанализированы основные экологические проблемы в городе Кельце с почти двухсоттысячным населением. Также указаны наиболее важные и актуальные экологические проблемы города. Для этого использованы имеющиеся научные исследования (текстовые и картографические), архивные разработки, а также законодательные акты.

Современное управление окружающей средой в городе Кельце, особенно с учётом законов устойчивого развития, требует глубокой и разносторонней оценке ее современного состояния, определение реальных и потенциальных угроз, а также способов ее защиты. Это особенно важно в урбанизованных районах, которые характеризуются чрезвычайно широкой просторантсвенной дифференциацией геосистем.

Ключевые слова: характеристики окружающей среды, угрозы, городские территории.

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