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ASSESSMENT OF THE INFLUENCE OF MILITARY ACTIVITY ON THE ENVIRONMENT AT THE INTERNATIONAL PEACEKEEPING AND SECURITY CENTER THROUGH THE EVALUATION OF ENVIRONMENTAL RISK

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Abstract. The article provides the estimation of the influence of military activity on the environment at the international peacekeeping and security centre. The assessment was carried out by determining the value of the environmental risk of the military activity impact on the indicator species of animals listed in the Red Data Book of Ukraine - white-tailed bald eagle and small snapper. It has been established that despite the exceeding contents of heavy metals in soils, the risk of deterioration of the health of birds feeding on the territory of the polygon is extremely small.

Key words: military activity, polygon (international peacekeeping and security centre), estimation of environmental risk, indicator species.

1. Introduction

International Peacekeeping and Security Center (IPSC) is located in Yavoriv district of Lviv region. Its purpose is training the Ground Forces of the Armed Forces of Ukraine. The use of tanks, armored personnel carriers, infantry fighting vehicles is practised on the polygon for tactical training of troops. In addition, the polygon accommodates on its grounds signal training fields, artillery training grounds, rocket and artillery units training areas and artillery shooting range. A part of military units stays on the territory of the IPSC only during military trainings and the other part is stationed there permanently. The territory of the IPSC belongs to the western end of the Roztochya ridge - one of the most interesting physical and geographical regions of Western Ukraine, which is the boundary area of the East European platform and the Carpathian Regional deflection [1]. The territory of the polygon is characterized by flat-topped hills up to 350 m above sea level, dissected by a river valley and the system of lakes of after glacial formation. Most of the territory of the polygon is occupied by forest and the rest of it - by a meadow-bog cenosis. The river Vereschitsa flows from the south to the north through the territory of the polygon. In addition, there are 10 lakes, which feed on underground sources. The reservoirs form the flow of the Vereschitsa River and play an essential role in the formation of phyto-and zoocenosis.

The diversity of the plant and animal life of the IPSC is determined by the natural conditions of the Roztochya region, and primarily by its borderline location, which facilitates the exchange of floristic and faunal material with the region of Polissya and the Carpathians. The south-eastern part of the polygon borders the territory of the Yavoriv National Nature Park, which, in its turn, in its southern part borders the “Roztochya” nature reserve.

26 species of vertebrates listed in the Red Data Book of Ukraine were identified on the territory of the polygon and its environs, including 1 species of reptiles, 18 birds and 7 mammals.

Among the permanent species of birds listed in the Red Data Book of Ukraine, the following can be distinguished: Black Stork (Ciconia nigra), Category II (vulnerable species, which in the near future may be classified as “disappearing” if the impact of factors affecting their condition is not stopped [2]); White-tailed Bald Eagle (Haliaeetus albicilla L.), category II, included, in addition, to the European Red List; Small Snapper (Aquila pomarina C. L. Brehm), Category III (rare species whose populations are small and which at the moment do

not belong to the categories of “disappearing” or “vulnerable”, although they are endangered) [2].

Among mammals there is a European mink (M. lutreola L.) and a river otter (Lutra Intra L.). All animals are classified in the second category of the Red Data Book of Ukraine, the river otter is also listed in the European Red List.

Black Stork (Ciconia nigra) settles in old forests near water reservoirs and marshes. It is found on meadows, pastures, fields near water reservoirs. It flies back at the end of March or in April, departing in August – October. It feeds on fish, amphibians, water insects, sometimes catches reptiles and mouse rodents. Body weight of an adult bird is about 3 kg. Black stork lives for 6–8 years.

White-tailed bald eagle (Haliaeetus albicilla L.) is a sedentary bird. It populates floodplain or wet deciduous and coniferous forests. During the breeding season it eats mainly fish, small mammals, in winter – waterbirds, fish and carrion. The adult bird's ration is: 28 % – fish, 44 % – birds, 28 % – mammals. The weight of an adult bird is 3–4.5 kg. Life expectancy is about 30 years.

Small snapper (Aquila pomarina C. L. Brehm) usually nests in wet, sometimes floodplain forests or in forests, near humid valleys, swampy areas or rivers. It also nests in the watershed, relatively drier forests and does not avoid the proximity of large open areas. It flies back at the end of March or in April, departing in September - October. It eats mainly rodents and amphibians, occasionally birds. The adult bird's diet is: 54 % mammals (mostly mice), 3.5 % birds, 0.5 % reptiles and 42 % amphibians. An adult bird’s weight is 1–1.5 kg [3].

European mink (M. lutreola L.). Mink’s food consists of: fish (20–35 %), frogs (25–73 %), crayfish (5–30 %), mollusks, insects, poles, mice and waterfowls. The length of the male body is 30–44 cm, the female is 25–35 cm, the weight is 502–949 and 370–700 grams respectively. The land area is from 12 to 27 hectares. The animal prefers small, heavily clogged running water sources, and leads semi-aquatic life. Minks live for about 10 years.

River otter (Lutra Intra L.). The length of the adult body is approximately 55–95 centimeters and the weight is up to 10 kilograms. Otter get food from water, but partly it is terrestrial. They catch a variety of fish, frogs, crayfish, beetles, small mammals and waterbirds. Otters settle along the banks of small rivers, ponds and lakes, they love forest rivers with rocks and vents, rich in fish. The main food is fish, as well as crayfish, frogs, water rats, muskrat, ducks. Otters live for up to 15 years. An adult animal eats about 1 kg of food per day.

2. Setting the task and its solution

The purpose of the work is to assess the environmental impact of the polygon by assessing the environmental risk of its influence on particularly rare animals.

The scheme of the conceptual model of the military activities impact of IPSC for particularly rare animals is shown in Fig. 1.

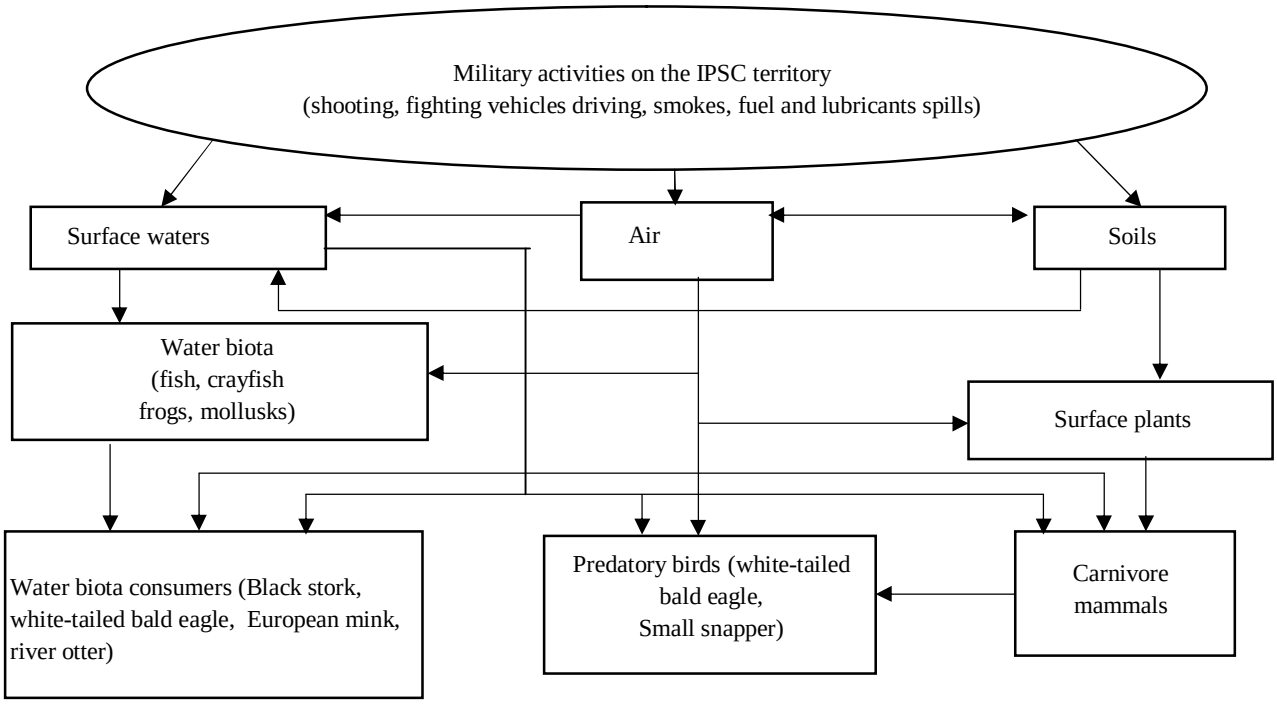

Fig. 1. Scheme of the Conceptual Model of the Impact of Military Activities on IPSC on particularly rare representatives of the biota

During military training, ferrous and nonferrous metals, chemicals used in smoke emition and imitation of fighting poisonous substances, lubricants, etc. pollute the environment. These substances are released into the air, water and soil and, directly or through food chains, end up in the bodies of animals that are objects of concern.

It should be noted that there is no systematic monitoring of the environment condition on the territory of the IPSC. Studies conducted in 1997 [4] found that there is a certain degree of soil contamination by metals with little air pollution during military trainings.

The survey of the polygon conducted in 2009 [5] showed that the degree of soil contamination remained at approximately the same level with some exceeding of the maximum concentrations of copper and nickel, pollution of surface sources is within the limits of the state norms and air pollution is absent. Therefore, further the environmental risk of impact on the biota of polluted soils was evaluated.

It should be noted that animals that consume predominantly aqueous biota may be excluded from consideration due to the unpolluted water sources (with the exception of the white-tailed bald eagle, which, in addition to fish, also consumes poultry and small mammals). Thus, the assessment of the impact of the polygon on the environment will be evaluated by its impact on the two indicator species - white-tailed bald eagle and small snapper.

The impact assessment will be carried out by means of a deterministic assessment of the environmental risk by determining the so-called "risk coefficient" which equals to the ratio of daily concentration or the stressor dose which influences the receptor to the so-called "reference value of toxicity", which means daily concentration or a stressor dose which impacts the receptor throughout life and does not lead to the emergence of an unacceptable effect on it [6], that is,

$$HQ = AD(AC)/ TRV, \quad (1)$$

where *HQ* is risk coefficient; *AD* – average dose, mg/kg; *AC* – average concentration, mg/м^3; *TRV* – the value of the reference value of toxicity in the corresponding dimension.

Characteristics of the risk of the development of harmful effects under combined and complex action of stressors is based on calculation of the hazard index (HI).

The hazard index for the conditions of simultaneous influence of several stressors is conducted in the same way (for example, by inhalation or orally) and is calculated by the formula

$$HI = \Sigma HQi. \quad (2)$$

With the complex influx of stressors in the organism of biota from the environment in several ways simultaneously, as well as under multi-environment and multi-path action, the risk criterion is the total hazard index (THI), which is calculated by the formula

$$THI = \Sigma HIj, \quad (3)$$

where *HIj* is the risk indexs for individual routes of influx or individual routes of action.

For the rough estimation of risk by using *HQ*, Table 1 [7] can be used.

Table 1

Classification of environmental risk levels

HQ	Risk level
<1.0	Minimum – the desired (target) value of risk when carrying out environment preservation measures
1.0–10.0	Minor – acceptable for most biota subjects, but requires in-depth study of the sources and possible consequences of harmful effects to solve the issue of risk management measures
10.0–100.0	Significant – not acceptable for most subjects of biota, requires dynamic control and in-depth study of sources and possible consequences of harmful effects to solve the issue of risk management measures
>100.0	High – not acceptable for biota. It is necessary to implement measures to eliminate or reduce risk

It is obvious that pollutants can enter the body of birds only when eating, as water sources are not contaminated. Consumption of aqueous biota also does not bring hazardous substances into the diet of birds. The danger is only presented with consumption of creatures, which in their turn consumed contaminated soil and plants that grew up on this soil. From literary sources [3] it is known that the white-tailed bald eagle's diet is composed of 44 % of birds and 28 % of small mammals; the diet of small snapper is composed of 3.5 % of birds and 54 % of mammals, respectively. Assuming that consumed birds are predominantly wild ducks, and mammals are mainly field-mise, we can determine the influx of pollutants into the bodies of the objects of concern by the equation (4)

$$I = C_m \times IRf \times F_F \times AUF \times TUF/BW, \quad (4)$$

where *I* is the amount of pollutant inflow, mg/(kg/day); C_m – concentration of contaminants in the meat of prey, mg/kg (dry mass); *IRf* – consumption of food by birds – objects of concern, kg (dry mass) / day (normalized by body weight constitutes: for the eagle – 0.12; for the snapper – 0.1 kg/(kg/day)) [8, 9]; F_F – the share (by weight) of meat consumption in general diet of birds – objects of concern, kg / kg (for the eagle 0.72, for the snapper 0.575 [3]); *AUF* – factor of the use of the area, hectare / hectare (in screening studies we assume *AUF = 1*, meaning that consumed prey is exclusively fed by contaminated food); *TUF* – factor of time, days / days (we assume *TUF = 0.5*), as in the cold period of a year the eagle consumes different food, and the snapper migrates to other regions, i.e., the consumption of contaminated food lasts for about 6 months; *BW* – body weight of birds – objects of concern, kg.

Concentration of pollutant in the prey meat (wild duck and field mouse) C_m can be determined by the equation

$$C_m = C_e \cdot UF_e, \quad (5)$$

Since the wild duck and field mouse accidentally consume soil in addition to plant food, the equation (5) acquires the form of [8, 9]

$$C_m = C_s \cdot UF_p \cdot UF_{ep} \cdot P_F + C_s \cdot UF_{es} \cdot S_F, \quad (6)$$

where C_s is concentration of pollutant in soil, mg/kg; UF_p – factor of bioaccumulation of pollutants from soil by plants, kg/kg [10]; UF_{ep} – factor of bioaccumulation of pollutant from the plant food by prey, kg/kg [10]; P_F – share (by mass) of consumption of plant food in the total ration of prey, kg/kg (0.98 [10]); UF_{es} – factor of bioaccumulation of pollutant from soil by prey, kg / kg [10]; S_F – share (by mass) of random consumption of soil in the general ration of prey, kg/kg (0.02 [10]).

Initial data for the calculation of pollutant influx to the bodies of the objects of concern are given in Table 2. The values of *TRV* for birds [11] are also presented here.

The results of calculating the environmental risk of the impact of military activity at the IPSC on the objects of concern (in the form of the value of the index of hazard *HI*) are presented in Table 3.

Table 2

Initial data for calculating the influx of pollutants into birds' bodies

Characteristic	Pollutants			
	Lead	Nickel	Copper	Zinc
Maximum concentration in soil, mg/kg of soil	35	850	64	40
Background concentration, mg/kg of soil	4.4	1.2	0.26	4.4
The sanitary standard of Ukraine, mg/kg of soil	6.0	4.0	3.0	23.0
Factor of bioaccumulation of pollutants from soil by plants, UF_p, kg/kg	0.045	0.032	0.4	0.123
Factor of bioaccumulation of pollutant from plant food by prey, UF_{ep}, kg/kg	1.56E-04	3.34E -03	2.42E-02	1.58 E-03
The factor of bioaccumulation of the pollutant from soil by prey, UFes, kg/kg	1.50E-06	2.99E -05	4.14E -04	3.96 E-05
Value of TRV, mg / (kg/day)	1.63	6.71	4.05	17.2

Conclusions

Table 3 shows that the presence of metal compounds in the soils of the polygon, contaminated as a result of military activity, does not pose danger to the living of indicator species (the hazard index is much lower than 1), i.e., there is no harmful effect on the growth and reproduction of valuable and rare species of birds – white-tailed bald eagle and small snapper. However, it can be noted that the most dangerous compounds for the birds, out of the investigated compounds, are compounds of copper, notwithstanding the fact that the concentration of nickel far exceeds the sanitary standard of Ukraine. The danger of copper compounds is due to the fact that the factor of their bioaccumulation is significantly higher than the one of nickel.

Table 3

Assessment of the environmental risk of the military activities impact on the objects of concern at the IPSC

Objects of concern	Hazard coefficient *HQ*				Total *HI*
	Lead	Nickel	Copper	Zinc	
White-tailed bald eagle (Haliaeetus albicilla L.)	5.86E-06	5.76E-04	6.48E-03	1.92E-05	7.08E-03
Small snapper (Aquila pomarina C. L. Brehm)	3.90E-06	3.84E-04	4.31E-03	1.28E-05	4.71E-03

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