МІНІСТЕРСТВО ОСВІТИ І НАУКИ УКРАЇНИ
НАЦІОНАЛЬНИЙ АВІАЦІЙНИЙ УНІВЕРСИТЕТ
ФАКУЛЬТЕТ ЕКОЛОГІЧНОЇ БЕЗПЕКИ,
ІНЖЕНЕРІЇ ТА ТЕХНОЛОГІЙ
КАФЕДРА ЕКОЛОГІЇ

ДОПУСТИТИ ДО ЗАХИСТУ
Завідувач випускової кафедри
_____ В.Ф. Фролов
«_____» _____ 2020 р.

ДИПЛОМНА РОБОТА

(ПОЯСНЮВАЛЬНА ЗАПИСКА)

ВИПУСКНИКА ОСВІТНЬОГО СТУПЕНЯ МАГІСТРА

ЗА СПЕЦІАЛЬНОСТЮ 101 «ЕКОЛОГІЯ»
ОПП «ЕКОЛОГІЯ ТА ОХОРОНА НАВКОЛИШНЬОГО СЕРЕДОВИЩА»

Тема: «Екологічні ризики для об'єктів природно-заповідного фонду Українського Полісся в контексті проекту водного шляху Е40»

Виконавець: студентка групи ЕК-202м Яцків Алла Володимирівна
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КИЇВ 2020

MINISTRY OF EDUCATION AND SCIENCE OF
UKRAINE NATIONAL AVIATION UNIVERSITY
FACULTY OF ENVIRONMENTAL SAFETY,
ENGINEERING AND TECHNOLOGIES
DEPARTMENT OF ECOLOGY

APPROVED TO DEFENCE
Head of the Graduate Department
_____ V.F. Frolov
«_____» _____ 2020

MASTER THESIS

(EXPLANATION NOTE)

MAJOR "ECOLOGY AND ENVIRONMENTAL PROTECTION"

Theme: "Environmental risks for the protected areas of the Ukrainian Polissya in the context of the E40 waterway project"

Done by: student of the EC – 202m group, Alla V. Yatskiv
(student, group, name)

Scientific Advisor: Ph. D. in Geology and Mineralology Sc., Associate Professor of the Ecology Department, Tamara V. Dudar
(academic degree, academic rank, surname, name, patronymic)

Consultant of the chapter "Labour Precaution": _____ Viktoria V. Kovalenko
(signature) (S.N.P)

Standards Inspector: _____ Andrian A. Iavniuk
(signature) (S.N.P)

KYIV 2020

НАЦІОНАЛЬНИЙ АВІАЦІЙНИЙ УНІВЕРСИТЕТ

Факультет екологічної безпеки, інженерії та технологій

Кафедра екології

Напрям (спеціальність, спеціалізація): спеціальність 101м «Екологія», спеціалізація «Екологія та охорона навколишнього середовища»

(шифр, найменування)

ЗАТВЕРДЖУЮ

Завідувач кафедри

_____ В.Ф. Фролов

«_____» _____2020 р.

ЗАВДАННЯ

на виконання дипломної роботи

Яцків Алли Володимирівни

1. Тема роботи: «Екологічні ризики для об'єктів природно-заповідного фонду Українського Полісся в контексті проекту водного шляху Е40» затверджена наказом ректора від 11 жовтня 2019 р. № 2364/ст.
2. Термін виконання роботи: з 11.10.19 по 05.02.20.
3. Вихідні дані роботи (проекту): дані дистанційного зондування Землі Геологічної служби США, програмне забезпечення ENVI, багатоспектральні супутникові знімки *Landsat-7/ TM, Sentinel-2*,а також *техніко-економічне обгрунтування проекту Е40*.
4. Зміст пояснювальної записки (перелік питань, що їх належить розробити): Аналітичний огляд літературних джерел за темою диплому. Фізико-географічна характеристика дослідження території, а саме природно-заповідного фонду, що знаходиться на шляху Е40. Застосування даних ДЗЗ для оцінки екологічних загроз для Полісся під час можливого будівництва водного шляху Е40 Гданськ-Херсон.
5. Перелік обов'язкового графічного (ілюстрованого матеріалу): таблиці, рисунки, діаграми, графіки.

6. Календарний план-графік

№ з/п	Завдання	Термін виконання	Відмітка про виконання
1	Отримання завдання, пошук літературних джерел по темі, напрацювання методології роботи	11.10.2019 – 20.10.2019	
2	Підготовка основної частини (Розділ I)	21.10.2019 – 10.11.2019	
3	Підготовка основної частини (Розділ II)	10.11.2019 – 17.11.2019	
4	Підготовка основної частини (Розділ III) та підготовка до першого попереднього захисту	19.11.2019 – 14.12.2019	
5	Перше попереднє представлення роботи на кафедрі	16.12.2019	
6	Підготовка основної частини (Розділ IV)	12.12.2019 – 28.12.2019	
7	Підготовка основної частини (Розділ V)	02.01.2019 – 09.01.2019	
8	Доопрацювання основної частини (Розділ IV) та підготовка до другого попереднього захисту	10.01.2019 – 21.01.2019	
9	Друге попереднє представлення роботи на кафедрі	22.01.2019	
10	Формулювання висновків та рекомендацій, косметичні правки, консультація з нормоконтролером, урахування зауважень	23.01.2019 – 26.01.2019	
11	Дооформлення, отримання підписів, перевірка на плагіат, підготовка до захисту	27.01.2019 – 04.02.2019	
12	Захист готової роботи на кафедрі	05.02.2019	

7. Консультація з окремого(мих) розділу(ів):

Розділ	Консультант (посада, П. І. Б.)	Дата, підпис	
		Завдання видано	Завдання прийнято
Охорона праці	Коваленко В. В, к.б.н., доцент кафедри цивільної та промислової безпеки		

8. Дата видачі завдання «__»_____ 2019 р.

Керівник дипломної роботи (проекту) _____ Дудар Т.В.

(підпис керівника) (ПІБ)

Завдання прийняв до виконання _____ Яцків А.В.

(підпис випускника) (ПІБ)

NATIONAL AVIATION UNIVERSITY

Faculty of Environmental Safety, Engineering, and Technologies

Ecology Department

Direction (specialty, major): specialty 101 "Ecology", major "Ecology and Environmental Protection"

APPROVED

Head of the Department

_____ Frolov V.F.

«_____» _____2020

MASTER THESIS ASSIGNMENT

Alla V. Yatskiv

1. Theme: "Environmental risks for the protected areas of the Ukrainian Polissya in the context of the E40 waterway project" approved by the Rector on October 11, 2019 № 2364/ст.

2. Duration of work: from 11.10.2019 to 05.02.2020.

3. Output work (project): remote sensing data from the United State Geological Service, ENVI software, multispectral images *Landsat-7 TM* and satellite images of high-resolution *Sentinel-2* and also *the feasibility study of the E40 inland waterway*.

4. Contents of explanatory note: (list of issues): Analytical review of the literature on the topic of the diploma. The physical and geographical characteristics of the study, namely the nature reserve fund located on the E40 waterway inland. The use of remote sensing data to assess environmental threats to Polissya during the possible construction of the E40 Gdansk-Kherson waterway.

5. The list of mandatory graphics (illustrated story): tables, figures, charts, graphs.

6. Schedule of master thesis fulfillment

№	Task	Deadline	Evaluation of the performance
1	Receiving of topic assignment, search of the literature and methodology development	11.10.2019 – 20.10.2019	
2	Preparation of the main part (Chapter I)	21.10.2019 – 10.11.2019	
3	Preparation of the main part (Chapter II)	10.11.2019 – 17.11.2019	
4	Preparation of the main part (Chapter III) and drafting explanatory note for the first preliminary presentation	19.11.2019 – 14.12.2019	
5	First preliminary presentation of the diploma work	16.12.2019	
6	Preparation of the main part (Chapter IV)	12.12.2019 – 28.12.2019	
7	Preparation of the main part (Chapter V)	02.01.2019 – 09.01.2019	
8	Finalization of the main part (Chapter IV) and drafting explanatory note for the second preliminary presentation	10.01.2019 – 21.01.2019	
9	Second preliminary presentation of the diploma work	23.01.2019	
10	Formulation of the conclusions and recommendations of the diploma work, editing, consultation with standard's inspector, remarks and recommendations consideration	24.01.2019 – 26.01.2019	
11	Finalizing, signatures receiving, plagiarism verification, preparation to the final protection (presentation)	27.01.2019 – 04.02.2019	
12	Protection (presentation) of the final version of the diploma work at the department	05.02.2019	

7. Consultant(s) of certain chapter(s):

Chapter	Advisor (position, name and surname)	Date, signature	
		Date of task issue	Date of task passing
Labour precaution	Kovalenko V. V., Ph.D. in Biol. Sc., associated professor of civil and industrial safety department	04.12.2019	20.12.2019

8. Date of task issue «_» _____ 2019

Diploma advisor _____ Tamara V. Dudar

(advisor's signature) (name and surname)

Task is taken to perform _____ Alla V. Yatskiv

(graduator's signature) (name and surname)

ABSTRACT

Explanatory note to thesis “Environmental risks for the protected areas of the Ukrainian Polissya in the context of the E40 waterway project”: 86 pages, 13 figures, 5 tables, 59 references.

Object of research – impact assessment of the potential E40 IWW construction on the NRF objects.

Aim of work – to identify the potential threats to the nature reserve fund (NRF) objects as a result of the waterway implementation; to calculate the economic feasibility of the E40 river waterway and its influence on the NRF within the Ukrainian Polissya.

Mehods of research: remote sensing data from the United State Geological Service, ENVI software, multispectral images *Landsat-7 TM* and satellite images of high resolution *Sentinel-2.*

REMOTE SENSING, PROCESSING OF SATELLITE IMAGERY, THE E40 INTERNATIONAL WATERWAY, NATURE RESERVE FUND, ENVIRONMENTAL IMPACT ASSESSMENT, ENVIRONMENTAL RISKS

РЕФЕРАТ

Пояснювальна записка до дипломної роботи на тему «Екологічні ризики для об’єктів природно-заповідного фонду Українського Полісся в контексті проекту водного шляху Е40», 86 сторінок, 13 рис., 5 табл., 59 літературних джерел.

Об’єкт дослідження - оцінка впливу на об’єкти природно-заповідного фонду (ПЗФ), що знаходяться в радіусі потенційного будівництва міжнародного водного шляху Е40.

Метою представленого дослідження є виявити потенційні загрози об’єктам природно-заповідного фонду (ПЗФ) внаслідок впровадження водного шляху; обчислити економічну доцільність проекту водного шляху Е40 та його вплив на ПЗФ в межах Українського Полісся.

Методи дослідження: дані дистанційного зондування від Геологічної служби Сполучених Штатів, програмне забезпечення ENVI, багатоспектральні космічні знімки *Landsat-7 TM*, а також супутникові знімки з високою роздільною здатністю *Sentinel-2*.

ДИСТАНЦІЙНЕ ЗОНДУВАННЯ, ОБРОБКА СУПУТНИКОВИХ ЗНІМКІВ, МІЖНАРОДНИЙ ВОДНИЙ ШЛЯХ Е40, ПРИРОДНО-ЗАПОВІДНИЙ ФОНД, ОЦІНКА ЕКОЛОГІЧНОГО ВПЛИВУ, ЕКОЛОГІЧНІ РИЗИКИ

CONTENT

LIST OF SYMBOLS, ABBREVIATIONS AND DEFINITIONS

ChREBR - The Chornobyl Radiation and Ecological Biosphere Reserve

CEZ – The Chornobyl Exclusion Zone

EIA – Environmental Impact Assessement

EN – Emerald Network

ENVI – Environment for Visualizing Images

GIS – Geographic Information System

IGS – Institute of Geological Sciences

IWRM – Integrated water resources management

IWW – International waterway

NAS – National Academy of Sciences

NECU – National Ecological Centre of Ukraine

NDVI - The Normalized Difference Vegetation Index

NPP – National Nature Park

NRF – Nature Reserve Fund

RS – remote sensing

REI - rules of electrical installations

SDG – Sustainable Development Goals

UN – the United Nations

UNECE - the United Nations Economic Committee for Europe

INTRODUCTION

Relevance of the topic: The E40 International Water Way (IWW) is one of the international inland waterways, which development is supported by the United Nations Economic Committee for Europe (UNECE) through the AGN Agreement. IWW E40) connects the Baltic Sea with the Black Sea. It starts in Gdansk and later in the Polish part runs along the Vistula and the Bug River, to Terespol, the Polish- Belarusian border. In the Belarusian part, it runs across the river Mukhavets, Dnipro-Bug channel, Pina and Prypiat rivers to the Belarusian-Ukrainian border.

In the Ukrainian part of E40 waterway is formed by waters of the Prypiat river threw Chornobyl exclusion zone and the Dnipro river, which leads to Kherson and the Black Sea with length 970 km. The total length is variates between 2220 to 2268 km.

The project involves significant changes in rivers: changes in hydrological and hydroecological regimes, construction and reconstruction of hydraulic structures, increasing the size of the fairway, aligning the river bed, building tanks, dredging works, etc. That's why all activities that are going to be done during realization of this project must undergo the EIA [1] procedure.

***Aim of work*:** to identify the potential threats of the waterway implementation; to calculate the economic feasibility of the E40 river waterway and its influence on the NRF within the Ukrainian Polissya.

To achieve the objective set out the following tasks:

1. To analyze the feasibility study of the E40 IWW.
2. To consider the environmental state of the Prypiat river section within the Ukrainian Polissya and to analyze the possible threats of the E40 IWW realization on the NRF.
3. To map landscape changes within 30km area landscape changes within 30km area around the Chornobyl Radiation and Ecological Biosphere Reserve, for the period 2000-2018, using such space images as *Landsat 7* and space images with high resolution *Sentinel-2*.
4. To calculate the environmental and economic feasibility of the project, based on the feasibility study.

***Object of research*:** is the impact assessment on the nature reserve fund (NRF) within the potential E40 IWW construction

Subject of research: is landscape covers of the Ukrainian Polissya within the E40 IWW construction impact, in particular, territories of NRF

Methods of research: analysis of scientific literature on nature reserve fund, the assessment of potential hazardous impacts of the E40 IWW construction and systematization of obtained data on the definition of feasibility of the project.

Scientific novelty:

1. Got further development analysis of economic inappropriateness of the project.
2. Map development as method of proof that the E40 IWW is unprofitable project with a high level of potential risks.

Practical importance: the E40 IWW construction can be a huge threat to the whole NRF of Ukrainian Polissya. An ill-conceived infrastructure project will bring more harm than good. In order to increase the effectiveness of the advocacy work against the E40, **National Ecological Centre of Ukraine** become a contact side in coordinated approach which covering the 3 countries – Belarus, Poland, Ukraine – **environmental coalition**, the international level (eg. EU and financing institutions)

Personal contribution of the author: the main scientific achievements of the diploma are obtained by the author in person. The existing scientific approaches to the stability of geosystems to technogenic influences are analyzed and generalized. In the process of mastering the thesis, the author has analyzed the changes of landscape complexes within the territories of potential E40 IWW construction.

Approbation of results. The results of the research were reported at the V International scientific and practical conference of students, undergraduates and graduate students «Sectoral Problems Of Environmental Safety» (Kharkiv, 2019), Scientific-technical conference of students, aspirants, doctorants and young scientists "Innovative Technologies" (Kyiv, 2019), All-Ukrainian competition of student's scientific works in the field of "Energy" (Mariupol', 2018).

Publications*:* 3 abstracts have been published on the results of the work.

CHAPTER 1
THEORETICAL ASPECTS OF ENVIRONMENTAL RISKS

Recent theoretical development in environmental sociology has focused on the concept of "risk." Macro- and middle-range theoretical conceptualizations relevant to understanding environmental risk and resource depletion have emerged from Europe and the United States. We review five theoretical approaches to the environment-society relationship and identify convergent characteristics relevant for resource management in the modern world. These characteristics suggest goals for resource management should include expanded discursive systems, a more informed public and building institutional trust. [2]

In classical sociological theory, the biophysical environment was a peripheral rather than a core concept for addressing analytical models of society and human behavior. Because of sociology's competition with biology and psychology, the biophysical environment was relegated to the margins of sociological inquiry (Benton 1994). If sociology were to stand as separate distinctive subject matter, it had to be cordoned off from biology and the natural realm (Durkheim [1897] 1970). Extracting the "social" from its environmental context was reinforced by the technological transformations of the day. Classical theorists witnessed the relative escape of modern societies from ecological constraints and the development of the human capacity to transform an independent biophysical world. (Goldblatt 1996). At the time, it was assumed that the biophysical environment could absorb pollution associated with modernization and provide as inexhaustible supply of natural resources.

The historical context has been radically altered. The emergence and proliferation of human-generated environmental risks and the depletion of natural resources critical for human survival are central problems of the twenty-first century. In other words, "far from transcending ecological constraints, modern societies (are) rapidly acquiring new ones of their own making". [3] Given the growing awareness of problems associated with environmental pollution resource depletion, many researches and practitioners have attempted to understand the impact of environmental risks on individuals, communities

and ecosystems. The modern world has been increasingly sensitized to "risk" as "the organizing concept that gives meaning and direction to environmental regulation" and policy. [4] Theoretical approaches in environmental sociology provide emerging models that are relevant to resource management and policy directives.

Modern industrial and agricultural production processes negatively impact the environment in two ways. First, withdrawals from the environment cause resource depletion when nonrenewable resources are overused and renewable resources are used faster than they are replenished by natural processes (Meadows *et al.* 1992). Second, additions to the environment take the form of pollution when toxic chemicals (typically, the negative by-products of production processes) are released at rates too fast for earth's natural processes to absorb and break them down (Meadows *et al.* 1992). Historically, these impacts on the environment (resource depletion and pollution) have been treated separately. However, examples of their interconnectedness abound.

As such, we contend that theories primarily focusing on natural resource depletion and/or pollution of the environment can be categorized as theories of environmental risk.

Traditional risk assessment focuses on the direct impact of toxic chemicals on human health, not on the health of wildlife species, ecosystems, or ecological services. The process of risk assessment followed a four-step methodology.

The first step, hazard identification, begins with identifying concentrations of chemicals and biological contaminants that may pose human health risks.

Dose-response assessment is **the second step**, which includes an estimation of how much exposure to a contaminant is necessary for adverse health effects and how human response may vary as a function of different contaminant levels.

The third step, exposure assessment, consists of identifying potentially exposed individuals, the medium(s) through which exposure actually and potentially occurred, and an estimate of the duration of exposure.

The fourth step is called risk characterization, which involves integrating the assessments derived from the first three steps. The objective of this final step is to determine whether adverse health effects will result from exposures to specific contaminants. [5]

This methodology provides a statistical determination of the probability of harm to humans from specific natural or human action. Traditional risk assessments are conducted by knowledge experts who operate within a clearly specified domain and utilize a rational actor approach to risk (Clarke 1999; Freudenburg 1988; Jasanoff 1999). The outcome of this process is effective planning for situations of relatively low or moderate uncertainly. However, under conditions of high uncertainly, this non-reflexive realist approach results in an empty promise of control, or more simply, a discourse that says “trust me” (Clarke 1999). Increasingly, the exalted status and truth claims of traditional risk assessment have been a point of contention, as different theoretical approaches have emerged for identifying and constructing risks and managing uncertainly in the modern world.

1.1. Overview of existing information on environmental risk identification

The concept of "environmental risk" is now interpreted differently. Many authors consider it not only a risk to public health, but also other types of risk, such as risks of destruction of natural systems, health of the population, failures of technogenic systems at specific enterprises, management of natural resources, natural disasters, influence of regional military conflicts, risk of environmental terrorism (S. Pyrozhkov).

There is also a lack of understanding of risk assessment within health and environmental studies. Some scientists associate environmental risk with certain environmental factors and examine the risk to the health of the individual (the likelihood of specific adverse environmental effects), while others view risk as a population-defined concept.

Environmental risk - likelihood of negative changes in the environment caused by anthropogenic or other impacts; causing damage to the environment in the form of possible losses in a certain time.

Any economic or other decisions should be made in such a way that they do not exceed the limits of the harmful effects on the environment. Sometimes it is difficult to set them, because the thresholds for the influence of many anthropogenic and natural factors are unknown.

An environmental risk management strategy may be based on the choice of risk level from minimum to maximum. For example, in the Netherlands, when planning industrial activities that affect the environment, along with geographical, economic and political maps, they use risk maps for the territory of the country. Before constructing an industrial enterprise and putting it into operation, designers quantify the risk level of operation of that enterprise and substantiate its acceptability. When licensing a new business, the risk map of the region in which it is located is additionally required. [6]

The basis for the construction of risk maps should be the analysis of joint manifestation in space and time of exo- or endogenous catastrophic processes and mapping of different types of hazards. Natural and anthropogenic risk factors are explored with respect to the resilience of the territories, combining geological and ecological maps. With the accumulation of information, the first characteristics of risk maps are used to turn qualitative characteristics into quantitative ones. [7] The end result of risk mapping is its assessment and indication on the maps of natural potential - the ability of the landscape of a territory to self-recover after anthropogenic or natural disaster.

Several environmental management strategies have been developed:

- prevention of catastrophes up to the refusal of production of dangerous industries, closure of emergency facilities;
- prevention of emergencies when it is impossible to prevent the caused catastrophe (construction of protective structures, dams, creation of underground infrastructure, early evacuation of the population);
- mitigation of the consequences of disasters, implementation of stabilization compensatory measures. [8]

The environmental management strategy should be based on the concept of acceptable (non-zero) risk. According to her, they not only study the factors and sources of increased risk, but also predict the course of events, assess the consequences of natural and man-made disasters. In many cases, this can help you avoid major disasters by finding alternative solutions.

Environmental risk assessment involves:

- study of scenarios of possible accidents and their consequences for the environment and the population;
- analysis of accident prevention and mitigation measures;
- calculation of probable losses caused by the activity of the enterprise;
- detailing the means of loss reduction;
- assessment of the impact on the residual pollution environment;
- a system for informing supervisory organizations and citizens about a possible accident.
-

The following basic approaches are used to assess environmental risk:

1. **Engineering**. Major efforts focus on the collection of accident statistics and associated emissions of toxic substances into the environment in order to calculate the probability of accidents;
2. **Modeling**. Develop mathematical models of processes that lead to human and environmental hazards due to the use of harmful chemicals and compounds;
3. **Expert**. If the statistics are insufficient or some fundamental dependencies are not clarified, they seek the assistance of experts who assess the impact of the risk analysis events;
4. **Sociological**. Determine the level of risk for different populations.

Since risk (*RZ*) is complex, it is possible to estimate the probable adverse effects - results (*NN*) for the management entity and the variable probability of their occurrence (*P*):

$$RZ = NN \bullet P \tag{1.1}$$

Increasing the level of risk is influenced by objective and subjective factors. [9] *Objective factors* include prerequisites that do not depend directly on the characteristics of the project (for example, changes in political, economic, social and environmental states),

and *subjective ones* - features of the project itself (technical equipment, qualification of contractors, production organization, etc.).

Using the methods of probability theory and mathematical statistics, risk can be quantified. The probability of scenario development is determined by an objective method (calculating the frequency with which events occur) or subjective (by peer review).

Environmental safety also depends on which recipients fall into the area of an accident. It is influenced by the location of the object, climatic conditions, pre-emergency environment.

Environmental risk management involves making complex decisions: political, social, technical, economic and risk reduction to an acceptable level. To analyze the risk, set its permissible limits in relation to security requirements and make management decisions [10]:

- an information system that will allow you to quickly control the existing sources of danger and the condition of objects of possible damage;
- reporting on foreseeable economic activities, projects, technical decisions that may affect the level of environmental safety, as well as programs for probable risk assessment;
- expertise of security and preparation of alternative projects and technologies that are a source of risk;
- developing a technical and economic strategy for enhancing security and finding the optimal cost structure for managing the magnitude of risk;
- compilation of risk forecasts and analytical determination of the level of risk at which the number of environmental damage stops;
- influencing public opinion and promoting scientific data on environmental risk levels.

Determining the level of environmental risk, it is also necessary to assess the predicted health status and the possible number of victims, biota by biological integral indicators, the impact of pollutants on humans and the environment.

1.2. Physical and geographical characteristics of the studied object

1.2.1. The current state of Prypiat River

The Prypiat River is a river in Eastern Europe, approximately 761 km (473 mi) long. [11] It flows east through Ukraine, Belarus, and Ukraine again, draining into the Dnipro.

The Prypiat passes through the exclusion zone (fig. 1) established around the site of the Chornobyl nuclear disaster. The city of Prypiat, Ukraine (population 45,000) was completely evacuated after the Chornobyl disaster. [12]

Fig. 1 The state of the Chornobyl Exclusion Zone (June, 2019)

Prypiat has a catchment area of 121,000 km^2 (47,000 sq mi), 50,900 km^2 (19,700 sq mi) of which are in Belarus (Fig.1.1). 495 km (308 mi) of the whole river length lies within Belarus. [3]

Fig. 1.1 Map, displaying the course of the river, flowing eastward through southern Belarus through the cities of Pinsk and Mazyr

The Prypiat Valley at the upper part is poorly defined, at the bottom clearer, 5 - 8 km wide. The float is developed all over, there are two off-flood terraces. Upper floodplain width 2 - 4 km or more; in some years it is flooded for several months. At the bottom the width of the floodplain reaches 10 - 15 km. The upper part of the upper part is channeled; below - winding, forming meanders, many straits (one of them is connected with Lake Nobel) are sandy islands. The width of the river in the upper reaches up to 40 m, in the middle - 50 - 70 m, in the lower part mostly 100 - 250 m, at the confluence with the Kyiv reservoir - 4 - 5 km. The bottom of Prypiat is sandy and sandy silt. River slope 0.08 m / km. The Prypiat Basin has a well-developed hydrographic net (10.5 thousand rivers and streams). Most of the tributaries are fully or partially channeled. Among the right-bank tributaries flowing through the territory of Ukraine - Turia, Stochod, Styr, Gorin, Stviga, Ubort, Slovechna, Solon, Uzh (right). Power is mixed. The water regime is characterized by a prolonged spring flood, a short-term summer barrier, which is disturbed by rain floods and the almost annual autumn rise in water levels. In spring, 60 - 65% of annual runoff occurs, water rises by 1 - 4 m, in areas with narrowed floodplain - by 7 m.

Freezes in early December, shakes at the end of March. The color of water is determined by the predominance in the river basin of peat-bog soils. 577 km navigable, the Dneprovsko-Buz Canal is connected to the Muhavets River (basin of the Zakhidnyi Bug).

In 1986 the river and its basin became contaminated due to the Chornobyl accident; along the banks of the Prypiat, tens of kilometers of dams have been erected to protect the river from radioactive substances. As the catchment areas of the Prypiat River are contaminated with radionuclides, especially within the Chornobyl Exclusion Zone, it is the main source of radionuclide removal into the Kyiv Reservoir. Scientists have proved that the removal of radionuclides from the water of the Prypiat River is the largest compared to other ways of migrating radionuclides from the exclusion zone.

Ichthyofauna is represented by the following species: pike, sabrefish, fisherman, ide, chub, fir, nosar, carp, mustache, podust, tench, golden carp, catfish, and minnow. [4]

The input part of the head balance in the cascade of the Kyiv reservoir is an unregulated flow of the upper Dnipro and Prypiat. In the average water year, these rivers bring in the spring more than 17 km^3 of water (60% of the annual inflow). In low-water years, the share of spring inflow is reduced to 35-36%. For the summer period (June-August), there is a 13.6 to 29.5% annual inflow. The autumn influx here is from 9.8 to 27.1%, winter - from 10 to 26.3% per annum. Since the reservoir performs only weekly-daily regulation, the distribution of the expenditure part of the balance-flow through the Kyiv HPP on a seasonal scale of the year has a similar nature. [14]

1.2.2. The current state of the Ukrainian Polissya and nature reserve fund (NRF) object within it

The Ukrainian Polissya is a flat plain with low heights. In the area of Podilsk height, absolute heights reach 210 meters or more. In the low plains of the south of Polissya there are isolated hills and hills, the most important of which is Ovruch Ridge (316 m). The hills and 10-20 m high trees alternate with river valleys.

The climate is temperate continental, with warm humid summers and mild cloudy winters. [15]

The rivers of the Ukrainian and Belorussian Polissya (with wide valleys and wetlands) belong to the Dnipro basin. The largest ones are Dnipro, Prypiat, Desna, Goryn, Stir, Teteriv, Uzh, Oster, Berezina, Ubort, Pina. Lakes are an integral part of the Polissya landscape.

Forests are also a characteristic feature of the Polissia landscape. Forest types depend on soils and terrain. In the designated area, they cover an area of more than 2.5 million hectares. Polissya is characterized by pine and oak-pine forests. The main tree species are pine (57.4%), oak (20.6%), birch (10.2%), black alder, hornbeam. Spruce forests grow in separate areas in the northeast Polissya. [16]

Polissya is a geographical and historical-ethnographic region that covers the northern regions of Volyn, Rivne, Zhytomyr, Kyiv, Chernihiv and Sumy regions of Ukraine, the southern part of the Brest region of Belarus, the eastern part of Podlasie Poland and the southwest of modern Russia.

Polissya is a special historical and ethnographic area of Ukraine, part of the former Slavic homeland, an ancient ethnocontact area. [17]

Ukrainian Polissya region (Forest zone of Ukraine) for a long time has been characterized by a low level of vegetation adventization, mostly due to its natural and climatic conditions: large percentage of the area covered with forests and wetlands, absence of large urban and industrial centers, relatively poorly developed transportation network, and other factors. Following major land reclamation conducted during the mid-20th century, the situation changed significantly. The urbanization and emergence of industrial centers over the last decades of the 20th century facilitated penetration of many species of alien plants, which currently tend to be spreading actively. The alien fraction flora in the left-bank regions of Polissya is specific; the species composition is more diverse and alien species are generally more widespread. Here, the influence of the Forest-Steppe zone and eastern continental Eurasiatic regions is observed. Alien species prevail in the florogenetic spectrum of the Eastern Mediterranean and Irano-Turanian origin. The right-bank regions of Polissya have species of the Central European origin, including species connected with South European mountain areas, Western Mediterranean species, species from the Balkans and Caucasus region, as well as numerous mesophytes of the

Northern American origin. The distribution of species on the territory of Polissya has been influenced by drainage reclamation with substantial changes caused in the aboriginal species composition and structure of natural ecosystems.

The Ukrainian Polissya is a physiographic province located in the south-west part of mixed forest zone, on the border with the forest-steppe zone. The Polissya region is characterized by a low relief, extensive hydrological system, wide, swampy river valleys, high groundwater level and prevalence of turf-podzol and swamp soils. The highest participation in plant cover of this region have pine and mixed forests, meadows and swamps. The area has also a high share of agricultural lands. It is occupied by different geological structures of Russian Platform. The west part of Ukrainian Polissya is situated on the northern part of Galych-Volyn depression [18], middle part – on the north-west part of the Ukrainian crystalline shield and its slope, and eastern part – in the Dnipro-Donetsk depression. Landscapes of these Polissian areas are characterized by numerous landforms, such as: river valleys and outwash, moraine outwash and moraine plains. These landforms prevail in the modern relief of Polissya. The region has a temperate-continental climate with warm and humid summer and mild, cloudy winter, and it is divided into 5 botanical and geographical regions (Fig. 1.2.).

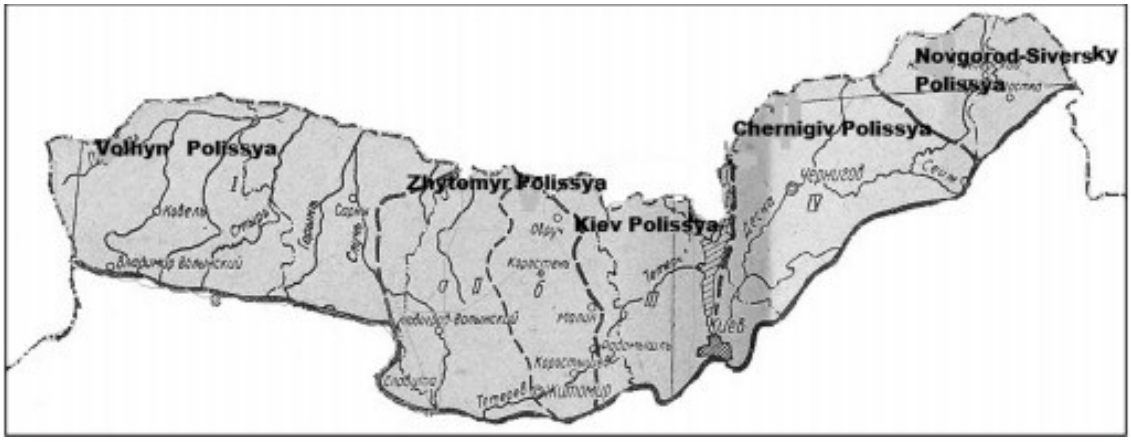

Fig. 1.2. Map of the Ukrainian Polissya

The Volynian Polissya [19] is a flat undulating plain, located to the north of the Prypiat River valley. This region is characterized by numerous swamps, deposits of marl and chalk, turf-podzol soils and lakes of karst origin. Vegetation is dominated by broad-leaved pine forests.

Zhytomyr Polissya [20] is located on the Ukrainian crystalline shield. It is distinguished by the significant development of denudation forms of relief, well-developed topographic features and small waterlogged areas. Its southern and central parts are located at the altitude of 200–250 m a.s.l., northern part – 150–200 m a.s.l., and Slovenchan - Ovruch ridge – 315 m a.s.l. The region has numerous outputs of crystalline rocks and sand-dominated clay-sandy and sod-podzolic soils. In vegetation prevail oak-pine, birch-pine, pine, horn beam oak and oak forests with high species diversity.

Kyiv Polissya [21] occupies an area of the Middle Dnipro region, located on the Ukrainian crystalline shield in the Dnipro-Donetsk depression. Its topographic features are poorly developed and a high groundwater level promotes waterlogging. Among soils prevail turf podzol soils, while vegetation is dominated by oak-pine and pine forests, as well as pine plantations. Meadows, swamps and shrubby vegetation are distributed along the region's river valley.

Chenigiv Polissya [22] occupies an area located in the Dnipro-Donetsk depression. It is a low relief area – a moraine-outwash, slightly undulating plain with small loess islands, dissected by the Dnipro, Desna and Snow River valleys. The region is dominated by poor and medium turf-podzolic soils, occupied by mixed forests.

Novgorod-Siverskyi Polissya [23] is an extreme eastern part of the Ukrainian Polissya. It occupies the northern part of south-western slope of the Voronezh crystalline massif. The climate is more continental than in other parts of the Ukrainian Polissya and the region has the lowest percentage of waterlogged areas. The specific features of this region are numerous chalk outputs and development of karst phenomena. The main types of forests are pine-mixed and oak-hornbeam forests. They are characterized by high species diversity.

The Polissya region of Ukraine occupies the southern part of Polissyan Lowland of the East European Plain. The land area is approximately 113 thousand km² (19% of the territory of Ukraine). It is divided by the Dnipro River into the Right-bank Polissya (western part) and the Left-bank Polissya (eastern part). The Right-bank Polissya (Volyn Polissya, Zhytomyr Polissya and Kyiv Polissya) differs from the Left-bank Polissya (Chernigiv and Novgorod-Sivers'k Polissya) (Popov et al. 1968).

1.2.2.1. The Chornobyl Radiation and Ecological Biosphere Reserve

The Chornobyl Radiation and Ecological Biosphere Reserve was created according to the Decree of the President of Ukraine No. 174-2016 dated 26 April 2016 [24] at the territory of Ivankiv and Polissia districts of Kyiv region within the Exclusion Zone and Zone of the Unconditional (Obligatory) Resettlement (EZ and ZU(O)R).

This reserve appeared as a result of the anthropogenic catastrophe and demonstrates a post-apocalyptic period, i.e. the disappearance of man with absolute domination of animals and plants.

Founded in 2016, this biosphere reserve is the youngest and biggest in Ukraine. Its territory was named after the atomic plant in the town of Prypiat destroyed in 1986 by the explosion at the nuclear power plant there.

In the Chornobyl reserve, which is situated in Kyiv Region and occupies 2/3 of the Chornobyl nuclear power plant's exclusion zone, nature itself has created the perfect conditions for animals and plants as soon as man deserted the area in 1986. At that time, the radiation levels rose by several thousand times there. In 2019, radioactivity still poses a serious threat to human beings, especially in the 10-km area around the nuclear plant. But it has little effect on the development of animals and plant populations. (Fig. 1.3)

The objective of establishment of the Reserve is to conserve the most typical natural complexes of the Polissia in the natural state, to support and enhance the barrier function of the Chornobyl EZ and ZU(O)R, to stabilize the hydrological regime and to rehabilitate areas contaminated with radionuclides, to facilitate the organization and carrying out of the international scientific research.

The main tasks of the Reserve are as follows:

- Minimization of the environmental hazards and conservation of the natural resources of the EZ and ZU(O)R, prevention of the radionuclide emission outside the territory of the radioactive contamination zones;
- Recovery and conservation of the natural diversity of landscapes, the gene pool of flora and fauna of the Reserve, maintenance of the overall ecological balance;
- Periodic inventory of the natural resources, research of the phenomena and processes occurring in the ecosystems of the Reserve;

- Implementation of the ecological, medical and biological and radiation monitoring of the territory;
- Scientific research in the field of the environmental protection;
- Protection of the territory of the Reserve with all-natural objects;
- Maintenance of the territory in the proper sanitary and fire-safe condition; organization of fire protection of the natural complexes;
- Ecological and educational work, etc.

The area of the Reserve is 226,964.7 ha.

The territory of the Reserve is characterized by eight types of landscapes, a large number of wetlands and meadow lands, about 30 types of forest vegetation, 23 upland and 7 aquatic phytocomplexes, 12 upland and 8 aquatic zoocomplexes.

Flora: 1228 species of higher vascular plants, of which: 5 species of club moss, 6 species of horsetails, 13 species of funguses, 7 species of clavaria, 269 species of monocotyledonous, and 928 of dicotyledonous. The Red Data Book of Ukraine includes 60 species of vascular plants, and the Red List of the International Union of Conservation of Nature includes 21 species of them. Among the rare species is pasqueflower, snowdrop, hazel grouse, club moss, aconite, spring snowflake, Siberian iris, pussy willow, etc.

Fauna: the total number of the registered vertebrate animals is 339 species, 60 species of them are fish, 12 species are amphibians, 7 species are reptiles, 202 species are birds, and 58 species are mammals. 58 species are listed in the Red Data Book of Ukraine, among the rare species are Ukrainian lamprey, smooth snake, scapula, dove-hawk, blackcock, stork black, white-tailed eagle, barbastelle European, brown bear, lynx, otter, Przewalski horse, bison, etc.

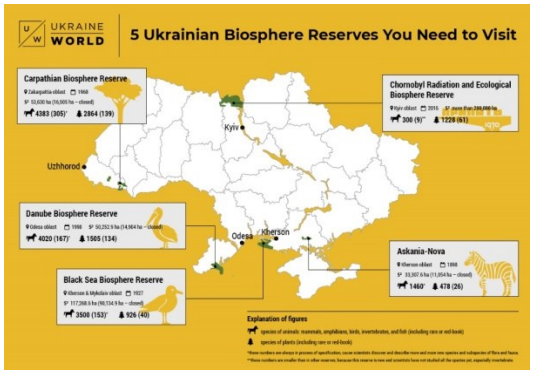

Fig. 1.3. The top 5 Ukrainian Biosphere Reserve

1.2.2.2. National Nature Park "Prypiat-Stokhid"

National Nature Park (NNP) "Prypiat-Stokhid" is one of the most picturesque places of Ukrainian Polissya, the land of woods, swamps, lakes and rivers. This ecological tour [25] is an opportunity to have an active rest and feel the spirit of Polissya land floating along the Stokhid and Prypiat rivers.

NNP was created in 2007 to protect and unify a series of natural complexes of the Prypiat River and Stokhid River valleys in northwestern Ukraine. The park provides protection, research areas, and recreation representative of the meadows and wetlands of the Polissia biosphere region. The park supports two RAMSAR wetlands [26] of international importance, and are joined in a cross-boundary RAMSAR wetland in Belarus. The park is in the administrative district of Liubeshiv in Volyn Oblast.

Prypiat-Stokhid NNP is located in the Central European mixed forests ecoregion, a temperate hardwood forest covering much of northeastern Europe, from Germany to Russia.

Bogs cover 43% of the park, forests and bottom-land 35%, shrub-land 16%, and 6% water. Because of the rich diversity of habitats – swamps, bogs, peatlands, riverine islands, etc. – the park exhibits great biodiversity, including over 800 species of higher plants and 220 vertebrate species, including 60 species of mammals and 220 species of birds.[15][16] Over 150,000 waterfowl are recorded during the annual migration.

1.3. Conclusions to Chapter

In this chapter, we have discussed traditional risk assessment and the need for a revised theoretical framework. We have described two macro-level theories which framed global environmental political discourse over the last decade. Then we have reviewed three middle-range theories that focus on the local biophysical environment as a sociocultural variable. Finally, we have identified several trends likely to inform future efforts to manage environmental risks.

We have found how to assess ecological risks, using the methods of probability theory and mathematical statistics and how to predict impact on human health.

In the context of studied object, the main attention should be put on the Chornobyl Exclusion Zone. In 2016 the Ukrainian part of the exclusion zone was declared a radiological and environmental biosphere reserve by the national government.

Over the years, Chornobyl has also become an excellent natural laboratory for the study of evolutionary processes in extreme environments, something that could prove valuable given the rapid environmental changes experienced worldwide.

At present, several projects are trying to resume human activities in the area. Tourism has flourished in Chornobyl, with more than 70,000 visitors in 2018. There also plans for developing solar power plants in the area, and for expanding forestry work. Last year, there was even an art installation and techno party inside the abandoned city of Prypiat.

CHAPTER 2
RESEARCH METHODOLOGY AND BASELINE DATA

2.1. Peculiarities of the E40 International Waterway feasibility study

The International Water Way (IWW) E40 is one of the international inland waterway, which development is supported by the United Nations Economic Committee for Europe (UNECE) through the AGN Agreement. [27] IWW E40 connects the Baltic Sea with the Black Sea. It starts in Gdansk and later in the Polish part runs along the Vistula and the Bug River, to Terespol, the Polish- Belarusian border. In the Belarusian part, it runs across the river Mukhavets, Dnipro-Bug channel, Pina and Prypiat rivers to the Belarusian-Ukrainian border.

The matter of shipping restoration on the entire length of the route was often undertaken at the Inland Transport Committee of the United Nations Economic Commission for Europe, national transport ministries, border regions and research institutions in Poland, Belarus, Ukraine and Germany. As a result of joint discussions, a concept to work on possibilities of revitalization of IWW E40 was created. [28]

The presented report, [28] whose primary goal was to select the optimal variant of E40 route in its existing bottleneck between the Vistula River and Mukhavets, was made by an international consortium of institutions from Poland, Belarus and Ukraine under the leadership of Maritime Institute in Gdansk.

The document was elaborated accordingly with requirements of Terms of Reference and it consists of four parts:

I. Analysis of Transport and Market Economics
II. Assessment of social and environmental effects
III. Technical and navigational issues
IV. Financial, legal and institutional aspects

It should be emphasized that the realization of the idea of restoration of the waterway connecting the Baltic Sea with the Black Sea through the Vistula and the Dnipro requires a serious revitalization and modernization works, mainly on the Polish section between the

Vistula and the Dnipro, but also to building and modernizing hydrotechnical infrastructure on the Vistula River to ensure a continuous and smooth transport of freight. The Vistula River also plays a key role in other water transport connections passing through Polish territory. The report elaborates in detail issues of costs, environmental safety and the possibility of using European best practices in creating favorable conditions for navigation on the Vistula River and along the E40 route.

It should be noted that along the missing link of E40 on the Bug River, between Warsaw and Brest, there can be found valuable landscape and protected areas that belong to the European network of protected areas "Natura 2000". Therefore, planning and construction of hydrotechnical and engineering infrastructure in these areas and development of shipping will require a more thorough study. Also a prescribed by law durations of research should be considered. A detailed analysis of the environmental conditions is included in a report developed for the assessment of environmental impact. In principle, this report should be used at national and regional level to generate strategies for revitalization of inland waterways.

In addition, the report may constitute a material supporting policies and development of companies conducting their activities based on the logistics infrastructure located along the IWW E40. [28]

2.2. Economic aspect. Calculations of the economic feasibility of the E40 river waterway

According to the estimates of the Gdansk Maritime Institute [29], the project on the arrangement of the water route E40 (hereinafter E40) is associated with increased investment risks, while its long-term influence on the Ukrainian economy may be negative.

The E40 project on the creation of the water way joining the Baltic and the Black Sea on the route Gdańsk—Warsaw—Brest—Pinsk—Kyiv—Kherson has reached its final pre-investment stage. The governments of Poland, Belarus and Ukraine are looking into the possibility of investing significant funds into this project with Mobilization of state resources as well the financing of international donors. The biggest part of the capital

investments (around EUR 12 billion) is directed to the Polish section of the route Visla—Brest. The arrangement of the Ukrainian section of the E40 has been preliminarily estimated up to EUR 30 million, that's the smallest investment costs among three countries. [30]

The mobilization of investments in the Ukrainian section will have a positive effect on the stage of their utilization because it will provide construction work for organizations and will create a number of jobs. The flow of foreign capital will improve the country's payment balance.

Nevertheless, there are grounds to doubt that E40 will have a long-lasting positive effect on the development of the country's transport system and will foster the sustainable development of the Ukrainian Polissya regions that cover the water route, as well as the Ukrainian economy on the whole.

The Dnipro-Bug Canal is the largest hydrotechnical facility in Belarus with a length of 196 km from Brest to Pinsk, including 94 km of an artificially laid canal and straightened sections of the Pina and Mukhavets rivers connecting the Western Bug with Prypiat.

We have to state that internal water transport is inferior to the automobile and railway transport by the key parameters of competitive power in terms of the delivery speed, the possibility to operate low-volume cargoes, the use of flexible logistic schemes, and also the seasonal restrictions. Moreover, the inland water route transportation, as a part of the delivery chain, generally involves an additional transshipment section which decelerates the transporting and increase the cost of delivery.

It's obvious that Ukraine cannot be guided by the average specific weight of the cargo inland water transportation in EU28 at the level of 6.7% which is referred to by the E40 project's feasibility study prepared by the Gdansk Maritime Institute. [29] The common European statistics are influenced by the indices of such countries as the Netherlands (38.9%), Belgium (20.4%) and some others, having a ramified system of canals which are the coastal extension of marine water routes. Those canals are used for short advancement of cargoes inland towards large logistic hubs for further transhipment onto automobile and railway transport. This means that in this case there is a distortion of

statistics as in fact because the marine cargo transportation is considered as part of inland water cargo transportation.

As another proof of the economic feasibility of the Project in Ukraine is official data of the State Statistics Service of Ukraine [31] that shows distribution of average freight turnover in January-April, 2018 (fig. 2). Over the total volume of water freight transportations abroad made up 56.3%. Compared to January - April 2018, the volume of foreign cargo transportation decreased by 3.1%, which proves again insufficient level of interest from the governmental side in water inland transportation improvement.

	Freight turnover		Freight transported	
	million t-km	in% to January-April, 2018	million tons	in% to January-April, 2018
Transport	**110163,7**	**102,8**	**218,7**	**109,1**
railway	61835,4	98,7	104,6	98,7
automotive	14950,9	113,9	72,8	133,6
inland water	903,4	98,9	1,3	128,7
pipeline	32374,6	106,6	40,0	102,6
aviation	99,4	111,9	0,03	108,4

Fig. 2 The total volume of freight transportation by different transport modes

Moreover, according to the estimates of the Gdansk Maritime Institute, the fees on inland water cargo transportation become competitive as compared to the automobile and railway transportation if the volume of the transported cargoes is at least 1000 tons for over 500 km. But the possibility of saving money by transportation via inland water routes is zeroed by the fact that the route usually offers the longest distance in comparison with the automobile and railway transportation. For example, the length of E40 between its two ends, Gdansk and Kherson, is more than 2,000 km whereas the automobile roads between the two ones are shorter.

The E40 transportation will be at a material disadvantage in terms of time. For instance, according to the estimates made by the Gdansk Maritime Institute, the transportation of forty 40-feet containers by a barge from Gdansk to Kherson without stopping in the ports on the route will take around 14 days, or around 290 hours.

The same amount of cargoes can be delivered by the railway—for 66 hours, which is 4.4 times faster, and by automobile transport—for 31 hours (9.3 times faster).

In case of stops and operations in the inland ports of E40 (Warsaw, Brest, Kyiv, Mozyr, Dnepropetrovsk, etc.), the delivery term will increase to 18 days, and the difference against railway and automobile transportation will increase up to 6.5 times and 14 times respectively. (Table 1)

Table 1. Comparison of different transport modes on the E40 route

A transport mode	Inland water	Railway	Automotive
Cargo weight	Forty 40-feet containers by a barge		
Length of the route	Approximately 2000 km		
Time without stopping	14 days (290 h)	-	-
Time with stopping	18 days (432 h)	3 days (66 h)	2 days (31 h)

Such a long water delivery will lead to a 'freeze' of the freight owners' funds, since it will be impossible to involve the goods into the economical turnover (sales) for the duration of such a period. Modern business is extremely time-sensitive because it aims at accelerating the capital turnover; thus, significant time expenditure will strongly undermine the interest in E40.

There is also some estimated constructional works, connected with channels on the Ukrainian-Belarussian section. The canal consists of 11 sections separated by shipping locks. The canal watershed is located on the Kobrin – Liakhovychi section. In the west, on the territory of Belarus, it flows into the Zakhidnyi Bug, which is a tributary of the Vistula River located in Poland. From the east watershed, the canal flows into the Prypiat River.

The channel is located in the Brest region, runs from west to east on the lands of Brest, Zhabinkovsky, Kobrin, Drogichinsky, Ivanovo, Pinsk, Luninets regions.

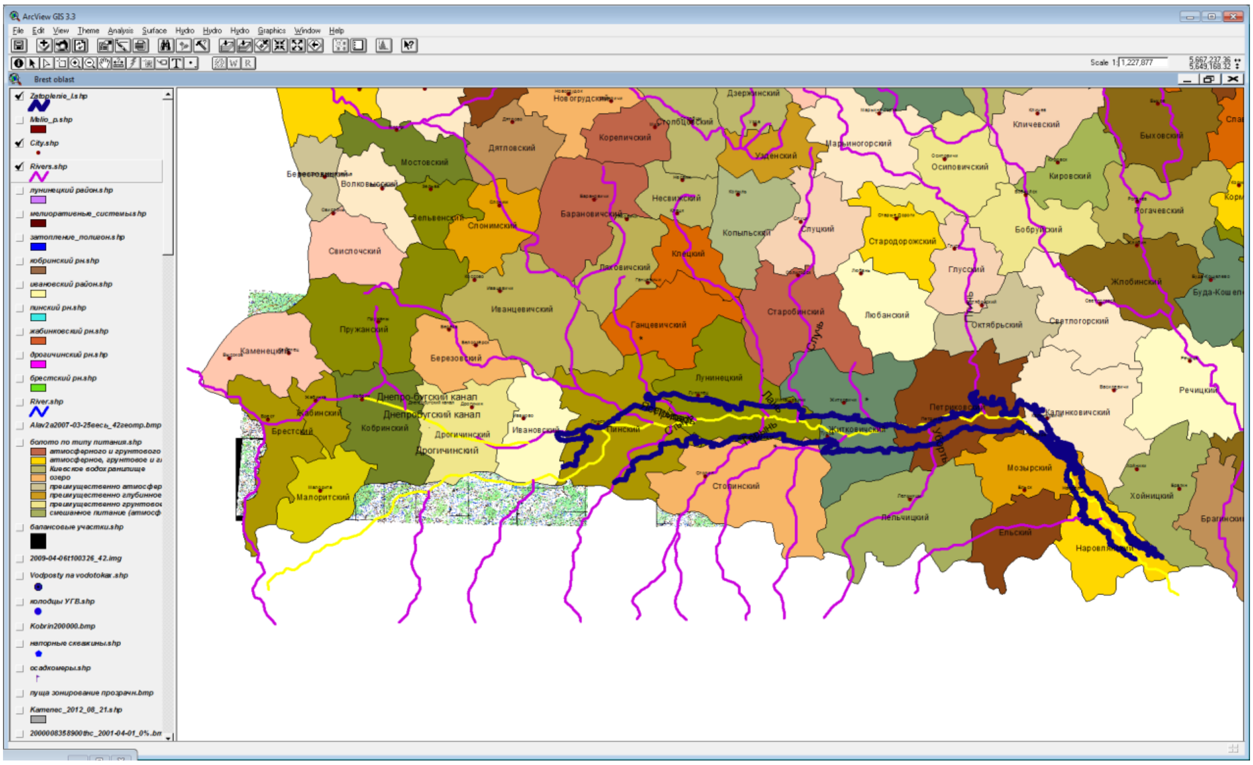

Fig. 2.1. Calculation of the E40 within the Belarus

The Polissya region has highly developed agricultural production, which largely determines the economy of the regions.

The 12 waterworks implemented along the canal along the canal with shipping locks provide the possibility of navigation between the basins of the Baltic and Black Seas with overcoming the watershed section with a water level exceeding 11.5-14.5 m, including the largest drop of 4.5 m at the Kobrin hydroelectric complex.

The catchment area of the canal exceeds 8.5 thousand km^2.

The most elevated watershed part of the canal is fed by the Biloozersk water supply system, which is a cascade of channel lakes on the border with Ukraine, providing water from the upper Prypiat. From the territory of Ukraine, the supply of water through canals also occurs from Orekhovske and Lukove lakes. In Belarus, the main tributaries are the rivers Mukhavets, Nesluha, Filipovka. Downstream, immediately after the confluence with the Prypiat, a large left-bank tributary, the Yaselda River, flows into it.

Thus, the Dnipro-Bug Canal, in addition to shipping, plays a water-regulating role in a hydraulically connected system of watercourses, in particular, bypassing flood expenses from elevated territories of Ukraine and Belarus.

At the same time, three small hydroelectric power stations confined to the sluice waterworks were built on the canal, the most powerful of which is Kobrinska - 710 thousand kWh / year.

Within Belarussian-Ukrainian section, from the Belarussian side, the E-40 waterway includes three rivers: Mukhavets (basin of the Baltic Sea), Pina and Prypiat (basin of the Black Sea), as well as Dnipro-Bug Canal (Fig. 2.2).

2.3. Legal aspect. National policy of Ukraine in the sphere of infrastructure and international agreements that will be violated

The IWW E40 construction plans are only being discussed at the moment, with an intern-governmental commission formed to assess the feasibility. Hence it is very timely now to take actions to counteract this development. The construction works will include deepening, straightening, damming and flood prevention at Prypiat with the development of at least 7 dams, flood prevention dykes and regulation of water intake and discharge, in order to controlling the flooding regime of Prypiat. The proposed waterway will likely affect several protected areas, including those having Ramsar status.

After the round tables during II Forum of Belarus and Ukraine in Zhytomyr, Ukrainian government started preparation for the reconstruction of the E40 IWW in legal aspect. As of September 6, 2019, Committee of the Verkhovna Rada of Ukraine on Transport and Infrastructure submitted amendments to the Law of Ukraine "On Inland Water Transport" [32], in which it tried to expand definition of "inland water transport". However, even without it, the Project is full of flaws – for example, there is written a possibility to discharge without any restrictions all sewage and sewage from toilets from vessels to the river while moving vessels along the Pivdennyi Bug and Dnipro rivers.

Moreover, the biggest threat, especially within the realization of E40 IWW Project, is that this draft law (Part 5, article 12) [32] gives the right to uncontrollably conduct dredging works of any water area without the consent of local authorities, without any expert opinions and public discussion, i.e. in a completely closed regime, which is contrary to the law "On Environmental Impact Assessment".

Despite the fact that the draft law was sent for revision, the USPA announced tender for the bottom dredging works from km 64.5 to km 46.5 with a total length of 18.0 km, on the section of the Prypiat river from the border of Ukraine with the Republic of Belarus to the mouth.

Guaranteed dimensions of the ship on this section: depth - 160 cm; width - 35 m; radius of curvature - 300 m.

To maintain the guaranteed dimensions of the waterways on the Prypiat river from the border with the Republic of Belarus - km 64.5 to km 46.5, a repair draft of 100 thousand m^3 must be carried out. [33]

It means that these works will grossly violate environmental legislation. The general technical requirements of the tender do not include the requirements for carrying out an environmental impact assessment, as the planned activity is defined as an "operational repair drawdown". However, this classification does not take into account the potential threats to the destruction of the river ecosystem, the spread of radiation contamination from disturbed sediments, and the peculiarities of such works in the territory of the Chornobyl Radiation and Ecological Biosphere Reserve. [34]

Dredging operations in the specified area of the Prypiat River cannot be classified as "operational repair drawdown" because no one has performed regular navigation over the Prypiat River for 33 years after the Chornobyl disaster.

According to sub-paragraph 10, paragraph 3, Article 3 of the Law of Ukraine “On Environmental Impact Assessment”: “construction of deep-water vessels, including in natural river beds, special canals on land and in shallow sea waters suitable for passage of vessels, and as well as channels for flood control purposes and hydraulic structures» are subject to environmental impact

Extremely important studies of such an assessment should be to study the radionuclide content of the Prypiat River bottom sediments, as well as to influence the water quality of the dredging works on the river bank, the radionuclide migration, and the change in hydrological regime.

The Prypiat River is a transboundary watercourse and dredging works, and especially the channeling, must be carried out in accordance with the provisions of the

Convention on the Protection and Use of Transboundary Watercourses and International Lakes.

In accordance with the requirements of the current Ukrainian legislation, European directives and the provisions of the Aarhus Convention, such projects are subject to mandatory public consultation.

Ukraine is a Part to the Berne Convention, which protects the wildlife and its inhabitants, and the entire mountain range of the Ukrainian Prypiat belongs to the Emerald Network (Chornobyl Radiation and Ecological Biosphere Reserve, UA0000046).

The deepening of the river will change the hydrology of the area, in particular the river beds and floodplains. And this site contains important populations of 66 species and locates 25 special living creatures.

Separately, the operation of the E40 river path will require a considerable amount of additional surface water. According to preliminary estimates, the water demand of the Dnipro-Bug channel will increase several times. At the same time, Ukraine will not be able to provide any additional cubic meter of water to the volume already supplied through the Vizhiv water intake. On the contrary, the supply of water through this water intake should be reduced to a minimum and increase the flow of water into the main channel of the Prypiat River, since its upper channel is already overgrown with coastal plants and degraded.

The European Commission did not include the E40 project in the EU's priority infrastructure projects precisely because of the high environmental threats of the project, so the implementation of the dredging of the Prypiat River is a waste of public funds.

2.4. Environmental aspect. Environmental threats of E40 IWW implementation

In the **Ukrainian part of E40 waterway** is formed by waters of the Prypiat river threw Chornobyl exclusion zone and the Dnipro river, which leads to Kherson and the Black Sea with length 970 km. The total length is variates from 2220 to 2268 km.

The developers of this project assume that the E40 will become a new trade route between the ports of the Baltic and Black seas to attract investments in the region and create new jobs.

The total area of the regions through which runs E40 route is 392 949.08 km^2 (Fig. 2.2.) and it is inhabited by 28 690 834 people.

Fig. 2.2. The course of the E40 inland waterway and its effected area due to the E40 feasibility study

The weak link of the Dnipro-Bug water system is the uneven distribution of water resources over the course of the year in the watershed section: abundance of spring and shortage in the low flow period. Most of the water during the year comes from the upper reaches of Prypiat and the cascades of the Sviate Lake, Volians'ke Lake and Bile Lake located along Upper Prypiat on the territory of Ukraine. Transboundary problem of Dnipro-Bug water system could cause degradation of the Prypiat riverbed (below water intake), Sviate Lake, Volyans'ke Lake and Bile Lake due to the work of the water supply system. [34]

For instance, a section of the new navigable route will pass through the territories affected by the 1986 Chornobyl disaster. The E40 will likely cause washing the radioactive silt away from the riverbed and thereby affect the water reservoir of Kyiv. Nobody knows which global consequences on national scale will cause radioactive

deposits disturbance on the Prypiat River, the Upper Dnipro River and Kyiv Reservoir during the implementation of foreseen dredging works.

The **Exclusion Zone today is a superficial open radioactive source**.

The base of the whole post-Chornobyl observation system is the Prypiat – Chornobyl facility, as it is located at the mouth of the river, on the catchment area of which there is the largest number of emergency radioactive fallout and the radiation regime which determines the radiation state of the Dnipro water system from Chornobyl. Within the radioactively contaminated territories, a number of works are carried out to prevent the spread of radioactive contamination outside the exclusion zone and the flow of radionuclides into the main reservoirs of Ukraine.

As a result of surface flushing (slope runoff, soil erosion), radionuclides enter the river network and are transported by the waters of Prypiat and Upper Dnipro to the Kyiv reservoir, where their long migration through the cascade of reservoirs to the Black Sea begins. The Prypiat River, receiving its tributaries in Belarus and Ukraine, as well as receiving radionuclides from various sources of contaminated water (contaminated floodplain, Chornobyl reservoir, etc.), is a major pollutant of the Dnipro waters. [35]

The calculations show that in the total carrying capacity ^{90}Sr to Kyiv's water reservoir accounts for about 70% of the Prypiat River, and much of this drainage (65-75%) is formed directly in the exclusion zone. On the contrary, more than 90% of the ^{137}Cs removal to the Kyiv reservoir is formed outside the boundary. Observation data in the post-accident period under the regime of radioactive contamination of the Prypiat River, as well as most small rivers of EZ, show a gradual decrease of the annual amount of radionuclides carried out beyond the EZ (Fig. 2.3) and, accordingly, a decrease in their average annual concentrations (Fig. 2.4). This tendency is the result of the combined action of 2 natural processes:

- reducing the content of radionuclides in the upper contact layer of soils in catchments due to their deepening due to vertical migration [36] and leaching of slope runoff by water;
- reduction of the total amount of radionuclides capable of water migration due to physical decay.

The rapid decrease in the concentrations of dissolved ^{137}Cs in river water in the period 1986–1990 was caused by a decrease in the exchange forms of ^{137}Cs in the contact layer of the soil due to the fixation of this radionuclide by soil particles. [37]

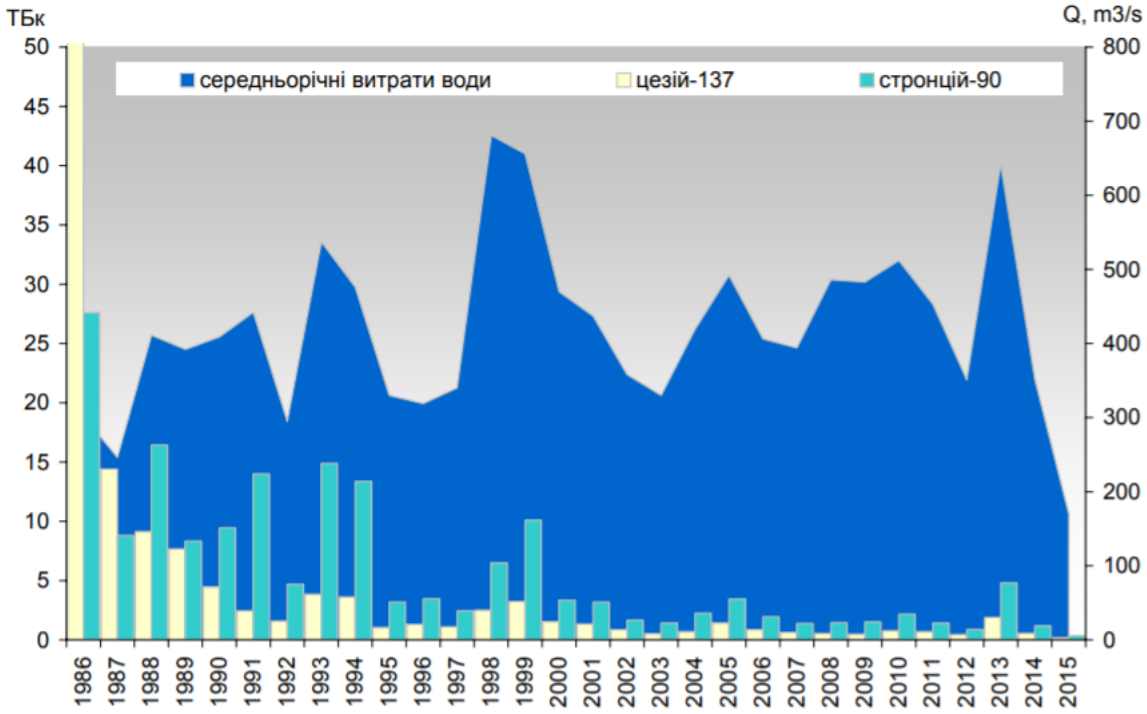

Fig. 2.3 Average annual costs of species and annual removal of ^{137}Cs and ^{90}Sr by the Prypiat River (1986-2015)

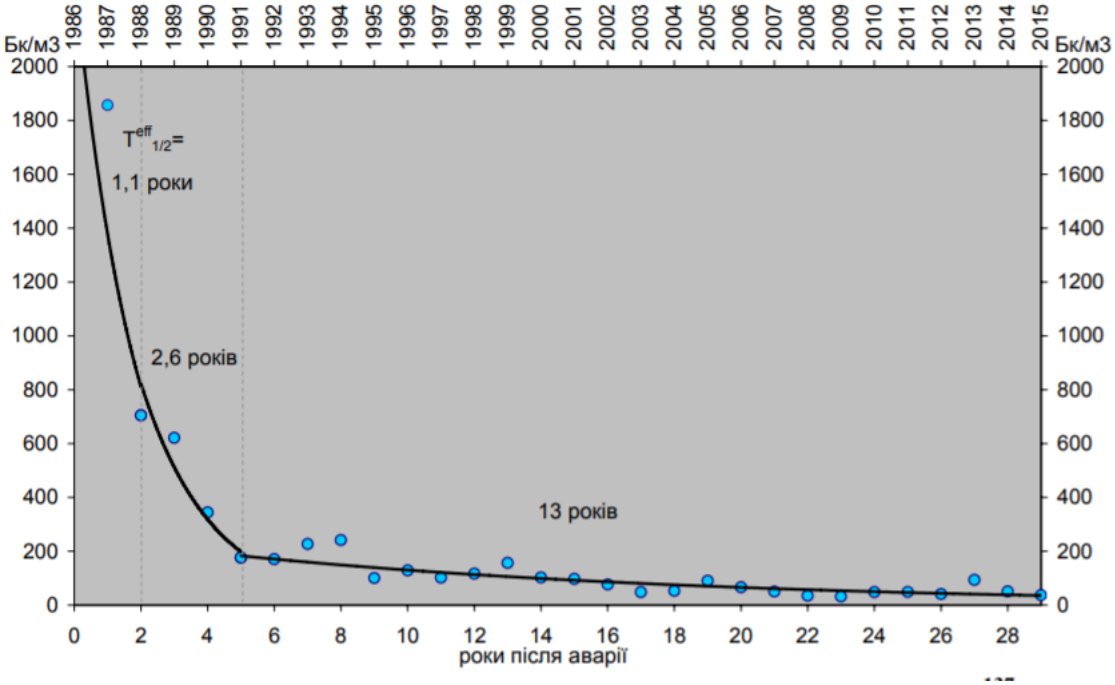

Fig. 2.4 Trends in changes in average annual concentrations of ^{137}Cs in water, Prypiat - Chornobyl, 1986–2015

The estuary section of the Prypiat river suffered significant pollution after Chornobyl accident. Much of the radioactive substances settled both at the bottom of the Prypiat river and at the bottom of the Kyiv reservoir. During dredging works in the river bed within the territory of the exclusion zone and zone of unconditional (mandatory) resettlement and in the upper reaches of the Kyiv reservoir, there will probably be a deterioration in water quality, radioactive thread for millions of Ukrainian citizens due to the clogging of radioactive sedimentation. **The single *transport chemical accident on the water could destroy the supply system of drinking water not only in Kyiv.***

Environmental threats of E40 IWW implementation

Climate break down & drought. An exceptionally dry summer in 2018 has caused havoc across Europe. The year was the fourth-driest and by far the hottest year since records began in 1881. According to the research conducted by the Potsdam Institute for Climate Impact Research, there will be an increasing instability in relation to weather conditions, and extremes will occur more frequently. According to the German Weather Service (DWD), climate change means not only an increase in average temperatures, but also an increase in the frequency of weather anomalies. The summer of 2018 was exceptional with its intensive drought and prolonged heat, but the likeliness of such extreme periods is expected to increase in the future.

Over time, more frequent low water events. Due to low water levels inland shipping was partially discontinued on the majority of European rivers in 2018. Rivers such as the Elbe, Rhine, Oder and Danube carried so little water that navigation was restricted or discontinued. The increasing frequency of weather anomalies will make inland water navigation increasingly unstable and unsustainable, so developing new inland waterways, such as the E40 is unreasonable and uneconomic. [38]

Loss of Biodiversity. All over the world, it is recognized that biodiversity conservation is very important. Therefore, various international agreements, including the Bern Convention and the Convention on Biological Diversity (known as CBD) have been

developed. Poland, Belarus and Ukraine, which are directly impacted by the planned E40 inland waterway, are signatories to the CBD and committed themselves to the so-called Aichi Biodiversity Targets. One of the components of this Aichi Targets aims at conserving at least 17% of terrestrial and inland water areas. The E40 inland waterway would impact nationally designated protected areas, Ramsar sites, Natura 2000 sites and areas which form part of the Emerald Network (Fig. 2.5) protected through the Bern Convention.

The planned E40 poses a threat to:

- 4,558 km^2 of Poland's Natura 2000 sites (equivalent to over 7%)
- 5,342 km^2 of Belarusian Emerald Network sites (equivalent to over 25%)
- 15,501 km^2 of Ukrainian Emerald Network sites (equivalent to 9%)

Fig. 2.5 The E40 waterway image on the Emerald Network map

Habitat destruction is not the only negative impact of the E40 inland waterway on biodiversity. Moreover, the spread of invasive species may be harmful to the environment, the economy or even human health. Invasive species have the potential to outcompete native species by exploiting a resource which natives cannot use, or by directly consuming resources relied on by native species allowing them to take hold in the new environment. Thus, invasive or alien species alter natural habitats and thereby create a direct threat to

native biodiversity.

Of course, E40 will impact life in the waters as well. Through the locks and dams built, fish stocks in the rivers will be affected. This will not only reduce the quantity of fish, but also the recreational opportunities for anglers.

Flood & Climate mitigation. The Prypiat river serves as a natural solution to flood mitigation. Evidence from past modifications to rivers such as the Danube shows that optimisation of the river bed for navigation results in an increased river flow rate. This causes river bed deepening and impacts flooding through increased average flood levels. The increasing water level eventually leads to more investment in artificial flood protection measures, which in turn increases the cost of the project on society.

The transition mires and bog also serve as natural climate mitigation tools as they absorb large quantities of carbon. This capacity of the habitats will decrease with the change of water regime and the E40 inland waterway would have a negative impact on reaching the emissions targets set in the Paris Agreement.

2.5. GIS-technologies as the basis of the cartographic part of the study

GIS applications are tools that allow users to create interactive queries (user-created searches), analyze spatial information, edit data in maps, and present the results of all these operations. [39][40]

GIS can relate unrelated information by using location as the key index variable. Locations or extents in the Earth space–time may be recorded as dates/times of occurrence, and *x, y,* and *z* coordinates representing, longitude, latitude, and elevation, respectively. All Earth-based spatial–temporal location and extent references should be relatable to one another and ultimately to a "real" physical location or extent. This key characteristic of GIS has begun to open new avenues of scientific inquiry.

Dana Tomlin probably coined the term "cartographic modeling" in his PhD dissertation (1983); he later used it in the title of his book, Geographic Information Systems and Cartographic Modeling (1990). [41] Cartographic modeling refers to a process where several thematic layers of the same area are produced, processed, and

analyzed. Tomlin used raster layers, but the overlay method (see below) can be used more generally. Operations on map layers can be combined into algorithms, and eventually into simulation or optimization models.

The combination of several spatial datasets (points, lines, or polygons) creates a new output vector dataset, visually similar to stacking several maps of the same region. These overlays are similar to mathematical Venn diagram overlays. A union overlay combines the geographic features and attribute tables of both inputs into a single new output. An intersect overlay defines the area where both inputs overlap and retains a set of attribute fields for each. A symmetric difference overlay defines an output area that includes the total area of both inputs except for the overlapping area.

Data extraction is a GIS process similar to vector overlay, though it can be used in either vector or raster data analysis. Rather than combining the properties and features of both datasets, data extraction involves using a "clip" or "mask" to extract the features of one data set that fall within the spatial extent of another dataset.

In raster data analysis, the overlay of datasets is accomplished through a process known as "local operation on multiple rasters" or "map algebra", through a function that combines the values of each raster's matrix. This function may weigh some inputs more than others through use of an "index model" that reflects the influence of various factors upon a geographic phenomenon.

In the process of Master thesis writing, remote sensing data from the United State Geological Service, ENVI software, multispectral images *Landsat-7 TM* and satellite images of high resolution *Sentinel-2* were used.

The normalized difference vegetation index (NDVI) is a simple graphical indicator that can be used to analyze remote sensing measurements, typically, but not necessarily, from a space platform, and assess whether the target being observed contains live green vegetation or not. [42]

NDVI was one of the most successful of many attempts to simply and quickly identify vegetated areas and their "condition," and it remains the most well-known and used index to detect live green plant canopies in multispectral remote sensing data. Once

the feasibility to detect vegetation had been demonstrated, users tended to also use the NDVI to quantify the photosynthetic capacity of plant canopies.

The NDVI is calculated from these individual measurements as follows:

$$NDVI = (NIR - RED)/(NIR + RED) \quad (2)$$

where red and NIR stand for the spectral reflectance measurements acquired in the red (visible) and near-infrared regions, respectively. [43]

The calculated NDVI index for chosen object - the Chornobyl Exclusion Zone, is shown in the CHAPTER 4.

2.6. Conclusions to Chapter

Thus, one of the key risks of the E40 Project is the lack of possibility to attract such cargo volumes which would be enough to ensure the recoupment of at least current expenses on the river fleet and the infrastructure maintenance.

E40 does not have any obvious advantages for transporting transit cargoes, so the plans for their mobilization run the risk of not being implemented.

We would like to emphasize that the division of the E40 International River Route project into individual fragments is inadmissible.

In the face of global climate change, the conservation of fresh water and its pollution is a direct responsibility of the Government of Ukraine.

The draining of wetlands, the disruption of habitats through various infrastructure projects (e.g. forest roads) and the continuing logging activities have already destroyed parts of Polissya's beauty, but the proposed E40 navigation waterway would have devastating consequences for this natural paradise. At current state, there is no existed suggestion for the route of the E40 waterway, which would affect four countries.

The rivers impacted by the E40 inland waterway include the Vistula and Bug in Poland, Prypiat of Polissya, and Dnipro in Ukraine. These rivers hold numerous natural values such as freshwater habitats, high biodiversity, protected areas and ecosystem

services, which will be threatened by the construction of the E40 navigation route.

The E40 would not only damage natural resources through hydrological changes such as increasing the water flow rate, deepening the river bed and likely decreasing the groundwater level, but its proponents fail to prove its economic soundness and overall social benefits.

CHAPTER 3
RESULTS OF COOPERATION WITHIN THE UKRAINIAN-BELARUSIAN-POLISH COALITION

3.1. Goal setting by the international expert group

To protect Polissya, Europe's blue treasure, a strong partnership of five civil society organizations from four countries was created as coalition against the planned E40 navigation waterway. The aim of the international expert group is to preserve Polissya's pristine wetland habitats - for nature and for future generations. [44]

In this group are:

- **APB–BirdLife Belarus** - partner organization from Belarus, whose mission is the conservation of biological diversity for the benefit of present and future generations and involvement of people in active nature protection activities. The organization's key activities include research and conservation of wild birds and their habitats.
- **Bahna, Belarus** - The aim of Bahna is to prevent further degradation of the environment and to preserve natural habitats and biodiversity of Belarus. Bahna coordinates the Belarusian environmental alliance with runs the Stop E40 campaign in Belarus. Thereby it links our campaign to a coalition of 20 Belarusian, 13 Ukrainian and 9 EU-based organizations;
- **Frankfurt Zoological Society, Germany** - Frankfurt Zoological Society (FZS) invests in wilderness areas of global significance, in what is called "legacy landscapes" – areas of aesthetic and natural values, with pristine landscapes, important ecosystem processes (e.g. migrations) or ecosystem **values and harbouring endemic and endangered species.**
- **National Ecological Centre of Ukraine** - National Ecological Centre of Ukraine (NECU) consolidates individuals for common action to protect the environment. Among NECU members are scientists, journalists, artists,

students and other people who are committing themselves to protect the environment. The organization has branches in a dozen of Ukrainian cities. NECU aims to bring environmental consideration into the core of any decision making. [45]

- **Polish Society for the Protection of Birds, Poland (OTOP)** - OTOP is the BirdLife partner organization from Poland, whose mission is to protect birds and their habitats and establish and manage new bird reserves. The organization has strong educational work in order to increase public support for nature conservation. OTOP is a member of the Polish Save the Rivers coalition, so it links our campaign to over 60 organisations, scientists and environmental activists.

The partnership aims to preserve the rivers in this region, not turning them into navigation channels.

2/3 of Europe's freshwater habitats have already lost their natural status. They believe that the governments involved in the planning of the E40 waterway as well as potential investors should fully review the economy of the planned project. Currently, there is no evidence provided that E40 is economically competitive with existing alternative transportation routes. From the perspective the focus should primarily lie on further improving already existing road and rail logistics – thus conserving Europe's largest natural floodplain!

3.2. Analysis of ecological-economic ratio and estimated investment costs for the restoration of E40

According to **the feasibility study [28]** of the E40 IWW project, all EU investments should be directed to the Polish section of the way. (Fig. 3)

Poland will undoubtedly remain in the win, not only will it clear its river and make it bankable, but it will also win in ecological terms, because these actions will breathe a second life into a muddy, shallow river.

The Belarussian side [46] proposes the construction of several dams, floodgates, the collapse of the Prypiat River and its straightening. Changing the river's hydrotechnical regime and halting floods will have a significant impact on local flora and fauna. When assessing the Belarussian site, one should start from the fact that it passes through the territory of Prypiat Polissya, where the national park "Prypiatsky" [47], ten national parks and 13 local reserves, 30 natural monuments are located. There are about 60 species of animals, 260 species of birds, 20 species of amphibians and reptiles, 54 species of fish. About 70 species are included in the Red Book and are protected under international obligations.

Many environmentalists believe that the E-40 Waterway is a death for the Polesie! They ask the question: "How much will Belarus cost to reach the sea?" and since damages from the construction of the dams will be irreversible and the project implementers have not yet properly assessed the environmental impact.

But undoubtedly, the Belarussian government will purge and deepen the Prypiat to achieve the strategic goal of reaching the Baltic Sea. We can support it or condemn it, but this is the business of Belarus.

It is worth mentioning that the water area and the coastal part of the Prypiat River were seriously affected by the Chornobyl disaster. [12] And this applies to both sides - both Belarusian and Ukrainian. Over the years since the disaster, the deposits at the bottom have been closed by radioactive sludges. But if dredging works begin in these polluted territories, then everything that settles down and lies at the bottom of a 60-80 cm sludge will turn into a radioactive cocktail in an instant, which can lead to serious consequences, up to the second Chornobyl.

There are several components to this project - economical, environmental and extremely important, related to health care. If radioactive mules are disturbed and move down the Dnipro, it could threaten the loss of the country's main waterway as a source of drinking water, and it will not be possible to use the Dnipro water to irrigate land and irrigate fields. There are currently no treatment facilities in the world that can purify water from radioactive contamination. Today, 2/3 of the population of Ukraine drinks from the Dnipro Basin. [48]

Critics of the project have warned that the E40 Project in terms of freight turnover is now unpromising and will not pay off, and that cargo turnover, which today (Belarus-Ukraine), can be easily transported by rail. This route is much better served by rail. It makes no sense to invest if there is already a ready-built structure that can deliver a turnover from North to South 20 times bigger than the current one ”(for 2017).

Ukraine is a low-water country on the map of Europe, because most of our water resources are not suitable for drinking water intake due to pollution. Over the past 25 years, 10,000 small rivers have disappeared from the map of the country

In any case, Belarus will deepen and clear the rivers, since it needs access to the Baltic Sea, so the radioactive sludge that can rise from the bottom during such work will in any case fall into Ukraine. Therefore, it would be more profitable for Kyiv to take advantage of the situation - to clean the fairway of the Dnipro and the reservoir, and to reconstruct the treatment facilities of Kyiv and other cities along the Dnipro.

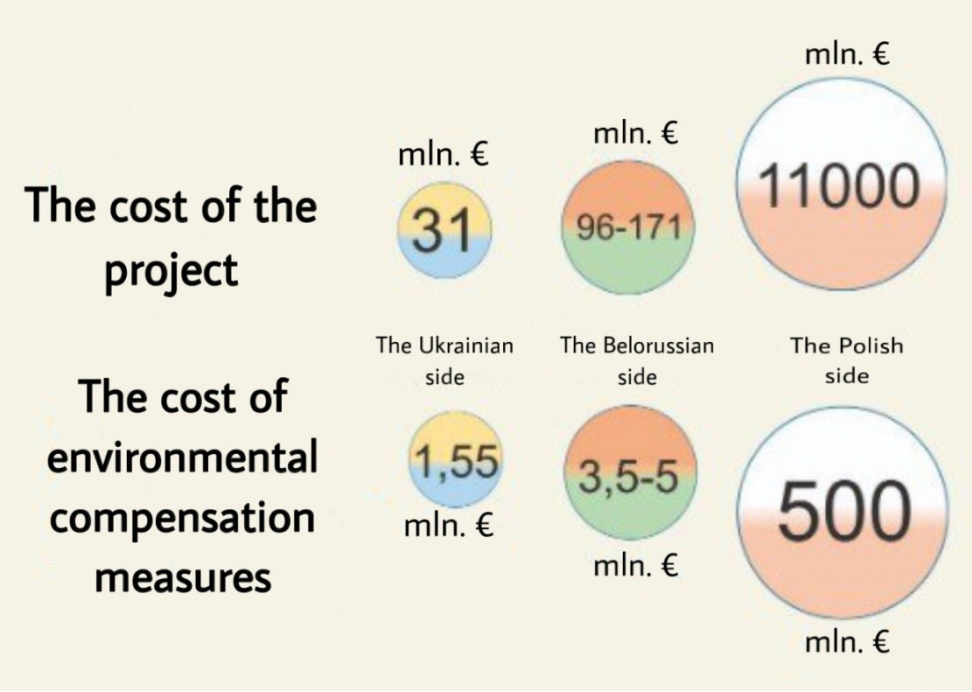

Fig. 3 Comparison of the project’s cost and the cost of environmental compensation measures

The main disadvantages of the project:

1. The environmental impact of an investment project is not quantified, measured or justified.

2. The statement that the implementation of the project may lead to the creation of new attractive jobs is not substantiated.

3. The bulk of E40's economic analysis is based on the erroneous assumption: if cost provided from public sources (e.g. from the state budget or from EU funds), then, when evaluating investment performance from a public perspective, these costs need not be taken into account when calculating overall costs.

4. Even if construction costs are ignored, the analysis shows that the infrastructure created within the project is difficult to maintain only at the expense of revenues generated during its ongoing operation.

5. While the benefits of reducing transport costs for carriers are created mainly for individuals, most of the investment costs (as well as the possible additional costs associated with, for example, river ecosystem degradation) will be borne by society in the whole of the three countries. (Belarus, Poland, Ukraine). This approach is not consistent the user-pays principle stated in the project materials.

6. The documents do not contain enough details about the freight flow forecast used. Although a number of other assumptions are mentioned in the model description, it remains unclear, for example, how many months per year are taken as the navigation period for different waterway options, as this assumption is consistent with the model adjusted for the Netherlands conditions.

7. An analysis of the model's sensitivity to assumptions is not presented in this document. This is a particularly significant drawback given the large uncertainty associated with such projections. This uncertainty has not only not been evaluated in terms of the sensitivity of the assumptions made, but for the assumptions themselves (for example, by defining standard errors in the estimates).

8. A common mistake inherent in the whole report is the lack of a proper understanding by the developers of the concept of socio-economic well-being in which the

benefit-cost analysis is applied (i.e., the comparison of total costs, both public and private, with the general benefits, again private and additional).

9. Investment costs should be fully considered in the analysis. Otherwise, the Internal Rate of Return (IRR) and Network Cost (NPV) estimates presented in the report are not economically meaningful.

10. The average cost of maintaining and repairing hydrological infrastructure, expressed as a percentage of the investment cost of the project (0.01%) in the first phase of activity, seems undervalued. In the light of experience, it could be expected that these costs represent 3-5% of investment costs each year, especially in later periods.

11. The work also does not take into account the existence of numerous protected natural areas of particular value for the conservation of biodiversity in Belarus and Ukraine. These sites may also be harmed by hydrological work. At the same time, the work does not take into account relevant additional costs as part of the project costs (including in the context of possible compensation payments or measures).

12. A more detailed economic assessment of the Document is futile because it will not change the misconception of evaluating the idea of the E40 project for its usefulness.

Due to the fact that the E40 waterway is a cross-border project, it is subject to international conventions ratified by Ukraine (in particular the Espoo Convention, the Aarhus Convention), according to which the Environmental Impact Assessment (EIA) should be carried out in a single package in all three countries.

The transboundary problem of filling the Dnipro-Bug water system can cause degradation of the Prypiat River, Sviate, Volianskyi and Bile riverbeds through the operation of the water supply system.

Many parts of the Polissya are of international importance as exceptional nature monuments that have been granted UNESCO Biosphere Reserves, sites under the protection of the Ramsar Convention.

The authors of the project believe that the Belarusian and Ukrainian sections of the waterway are almost ready to navigate the E40, which is not true.

Costs for mitigating of the E40 IWW environmental impact in the territory of Belarus and Ukraine are not included in the project budget. [49]

In the absence of a developed E-40 project (there is only the feasibility study), international agreements are concluded both at the government level and at the regional level, as well as at the level of companies for the development of fragments of the E-40 river track infrastructure, as if the project was already approved by all interested parties and supported by the public. At the same time, the Ministry of Infrastructure and the Ministry of Natural Resources of Ukraine confirmed that the E-40 project has not yet been developed.

If implemented, the E-40 continental waterway project will have, as experts noted, devastating consequences for the ecosystems of the Republic of Belarus, Ukraine and the Republic of Poland.

According to estimates compiled by Save Polessia – a project initiated by five civil society organizations from Belarus, Ukraine, Poland and Germany – the planned E-40 poses a threat to 4,558 sq km of Natura2000 Polish sites (more than 7%), 5,342 sq km of sites Belarusian Emerald Network (more than 25%) and 15 501 sq. km of sections of the Ukrainian Emerald Network (9%).

3.3. Conclusions to Chapter

The EU Water Initiative aims to implement the EU Water Framework Directive in six neighboring countries, including Belarus and Ukraine.

This project creates a platform to consider the E40 project in accordance with the requirements of the aforementioned EU Directive with wide involvement of the public in its discussion and assessment of all risks associated with it.

The area which is impacted by the E40 inland waterway must clearly and transparently be defined. The process to delineate the territory should consider hydro-morphological connections as well as the migration routes of various species.

Whenever there is a lack of data in terms of environmental impacts, the precautionary principle must be applied to shift the burden of proof to the proponents of the E40 inland waterway.

The EU Water Framework Directive (WFD) requires a strong stakeholder involvement in the development and implementation of River Basin Management Plans (RBMP). The WFD is adopted in Polish legislation and currently implemented in Belarus and Ukraine through the development of the Prypiat and Dnipro RBMPs within the framework of EUWI+East project. Based on the rules of the WFD, citizens and civil society organizations must be able to actively participate in the stakeholder consultation of RBMPs and thereby expressing their opinion about the development of the E40 waterway.

The implementation of the E40 waterway would require significant financial commitment from the three countries involved. As the E40 would mean a heavy burden on tax payer, the financial transparency about planning is critically important. Therefore, our partnership calls the governments and private and public financial institutions to be fully transparent about any financial commitment in relation to this infrastructure development.

One of the environmental risks is dredging above Kyiv along the Dnipro River and the radiation contaminated territory in Belarus. For 30 years, there is no fairway in the Kyiv Sea, so disturbed bottom sediments will inevitably move down the restored fairway to Kyiv and a radioactive suspension will emerge at the HPP dam, which will create threats to the operation of the drinking water supply system.

The construction and operation of the waterway implies a change in the hydromorphological conditions of the entire Polissya region, which will lead to the degradation of valuable wetlands, which are under national and international protection as habitats of valuable species, and a number of vulnerable natural areas of Ukraine.

The transboundary problem of filling the Dnipro-Bug water system can cause degradation of the Prypiat River, Svyaty, Volyanskiy and Bile riverbeds through the operation of the water supply system. Many parts of the Polissya are of international importance as exceptional nature monuments that have been granted UNESCO Biosphere Reserves, sites under the protection of the Ramsar Convention.

The EU Water Initiative is aimed at implementing the EU Water Framework Directive in six neighboring countries, including Belarus and Ukraine.

This project creates a platform to consider the E40 project in accordance with the requirements of the aforementioned EU Directive with wide involvement of the public in its discussion and assessment of all risks associated with it.

In particular, Chapter 6 of the Environment Agreement is important, namely Articles 360-363, 365, 366. According to the Agreement, Ukraine undertakes to gradually approximate its legislation to that of the EU, within the deadlines set out in Annex XX to the Agreement. In particular, the formation of the Emerald Network should be completed by 1 September 2021 and security and management measures should be implemented in all these territories.

Analyzing the composition of the Emerald network, we understand that a significant part of its area is made up of the Dnipro cascade reservoirs, the Chornobyl Biosphere Reserve and the adjacent territories, which are important components of the Dnipro Ecological Corridor, which is a unique migratory pathway of our part of the planet. Even more alarming is the situation in Belarus, where more than a third of the Emerald network is centered around the Prypiat River.

CHAPTER 4
THE CARTOGRAPHICAL MODELING OF ENVIRONMENTAL RISKS

Environmental (synonymous - environmental-geographical) mapping is one of the most relevant areas of scientific research in thematic mapping, characterized by a variety of theoretical positions and specific content. Environmental mapping has traditionally been mostly focused on providing governmental and departmental structures for the implementation of state, regional and local environmental programs and projects. Any environmental activity is carried out within specific territories and is therefore impossible without the use of a cartographic form of information submission. The purpose of the article is to outline the theoretical and methodological foundations of cartographic modeling of the PTB of Ukraine, which provide the compilation of cartographic works that are directly intended for use in the practice of environmental protection, at a high scientific level and taking into account the specificity of the practical use of information presented in cartographic form.

Usually ecological includes maps whose thematic content reflects the relationship between society and nature, estimated from biocentric, anthropocentric or geosystemic positions. [50] The main objects of ecological (ecological-geographical) mapping are: biota; the relationship between organisms and the environment; adverse and dangerous natural processes and phenomena, environmental risks and ecological networks; ecological systems of different territorial level; anthropogenic impact on the environment; complex environmental problems, assessment of natural conditions and resources for human life and activity; nature protection, nature conservation measures and environmental problems; medical-geographical, recreational, complex ecological (ecological-geographical, geo-ecological, etc.) issues. The above list of ecological mapping objects is incomplete, given the breadth of views on its nature.

Environmental problems, including problems of PTB, are integral because they are formed as a result of the whole sum of social-natural relations that develop in a certain territory and are the result of synergetic effect from the interaction of all types of technogenic load on the natural-territorial complexes. The solution of the actual problems

of the state-owned PTB, the assessment of the man-made hazards and risks, determination of the security level of specific objects, justification and support of administrative, administrative and technological solutions are impossible without generalization and visualization of various information about the current ecological state of the natural environment and its dynamics, individual components of the natural and man-made environment, their impact on humans, etc. It is possible to structure, visualize and evaluate such information by means of cartographic studies of the spatial features of the distribution of various threats and risks, their temporal variability.

The object of cartographic modeling is called that part of objective reality known by the method of cartographic modeling; those processes that the researcher imagines as a specific set of independent phenomena that are subject to study. The object of cartographic modeling of the PTB of Ukraine is a set of dangerous phenomena and processes of natural and man-made character, emergencies and events, as well as the spatial organization and functioning of defense resources and response forces within the territory of Ukraine. Such objects may characterize Ukraine's natural and man-made hazards and risks that arise in a particular area (territories), the SSU governing bodies with the NA, forces and means of preventing and eliminating, monitoring, evaluating and forecasting the NA, etc.; they collect and process raw materials for mapping.

Environmental and construction safety is one of the pressing issues. With new construction, reconstruction of the old building, intensive exploration of the underground space, the man-made load on the geological environment increases many times, and hydrogeological conditions change radically. The natural regime of groundwater (level, temperature and hydrogeochemical) is disturbed, which often leads to the emergence or intensification of negative engineering-geological processes and emergencies.

The economic damage from the manifestation of dangerous processes is enormous. Such circumstances are the result of long-term neglect of interdependent issues of hydrogeological and ecological substantiation of economic and construction activity in modern metropolitan areas. However, the assessment of the existing natural-technogenic

situation and the prediction of changes in hydrogeological conditions is almost impossible without detailed hydrogeological study of the territories.

The problem of selection, justification and ranking of the criteria for assessing the ecological and geological state of the geological environment is quite complex and there are no generally accepted solutions for a number of positions, even at the conceptual level. Analyzing publications on this issue allows us to identify several conceptual approaches that are used to solve the problem. [51]

The first approach is based on direct quantitative estimates of the ecological-geological state of the components of the lithospheric space (the lithosphere itself, groundwater, engineering-geological processes and phenomena that develop in the lithosphere). The main disadvantages of this approach are: the inability to assess the overall compositional impact of all the factors under consideration; rather relative correctness and objectivity of the established MPC, MPD, as evidenced by their constant correction and noticeable differences from foreign analogues; lack of a regulatory framework for assessing the resource potential of the lithosphere.

The second approach is based on the assessment of the favorable surface area of the lithosphere for its economic use. The geological environment is considered as a natural or man-made system of a certain ecological status. The latter requires the ranking of the state of the lithosphere or the selection of certain classes of this state.

This approach broadens the set of assessment criteria involved and opens opportunities for the use of indicative assessment criteria for related, lithosphere-related environments. However, it does not provide scientifically sound gradations of environmental status. In addition, most gradations are inherently “contractual” and can be transformed in both number and quantitative characteristics in relation to different natural areas.

The third approach largely eliminates or eliminates the shortcomings of the previous two. Its initial position is the rejection of a separate assessment of the state of the natural environment, including the lithosphere, and their mechanical summation on the basis of point estimates. The defining, conceptual position of this approach is to treat natural and technogenic systems as high-level ecosystems of an organization,

characterized by the functional unity of all components (natural geospheres) that are part of it. This gives the scientifically substantiated right to assess the ecological and geological state of the lithosphere from the beginning through the assessment of the general state of the ecosystem, which generates the state of all the environments and spheres that belong to it, and only then, in the second stage, its detailing by direct evaluation criteria. natural environments.

This approach to ecosystem status detection is based on a limited number of criteria that ensure a joint assessment (qualification) of its ecosystem status. The proposed concept avoids not only the explicit subjectivism of scoring, but also reveals the causes of the current state of the ecosystem and develop specific recommendations for its normal functioning.

The fourth approach is proposed by EO Yakovlev. To increase the likelihood of complex assessments of the ecological status of the regions of Ukraine, the method of averaged assessments of major life-sustaining natural resources (land, water, mineral, biotic) and engineering systems was used, which involves calculating the level of change of individual indicators and converting the values obtained within the regions.

It is advisable to allocate classes of ecological status of a territory on the basis of a small number of the most representative indicators, but it is obligatory with use and mutual consideration of thematic, spatial and dynamic criteria of assessment. It is important to emphasize that there is currently no single integrated ecosystem status indicator, but the number of most representative indicators can be kept to an optimum minimum. The assessment of the ecological status of the territory must consist of an integral morphological assessment of the state of the ecosystem with its decipherment through the characterization of the state of the geospheres (in particular the geological environment). Only such a comprehensive assessment will answer questions not only about the current state of the ecosystem, but also the reasons for its condition, taking into account the impact of natural anomalies and technogenesis. [53]

Assessment of changes in the hydrogeological environment is fundamentally important because the economic damage from the hazardous processes caused by this change is enormous. Assessment of the existing natural-technogenic situation and forecast

of changes in hydrogeological conditions is practically impossible without detailed hydrogeological study of the territory.

The most reliable estimation of groundwater resources is possible on the basis of numerous permanent mathematical deterministic geofiltration models. Creating mathematical models of hazardous objects and adjacent areas allows us to take into account all natural and man-made factors that affect the object, and on the other hand to evaluate the impact of the object on the adjacent area.

The simulation results do not always clearly reflect the existing hydrogeological situation (sometimes catastrophic).

The development of quantitative methods in the earth sciences has very quickly shown that the main limitation of many mathematical models is due to their lack of spatial differentiation. Any metric or equation that is obtained for a given area (area, area) does not yet give an idea of changing that metric or equation from one place to another within that area or area. However, this is precisely the essence of the spatial analysis of the object. It is necessary not only to obtain a mathematical model, but also to learn to map it, reflecting changes in mathematical dependencies between objects from one place to another, tying them to elementary (or characteristic) units of territorial division.

An important factor that largely determines the detail of the study and the method of solving the problem is the idea of the purpose of the analysis results. The assessment of the raw data is the most important step in the analytical process. It is at this point that the fundamental possibility of implementing the selected methods of analysis and the obtained results of the declared quality is determined. The type of data and parameters available for the study largely determines both the achievable accuracy and the specificity of the method to be used.

Pre-cartographic modeling should be more deeply embedded in geoinformation modeling, the primary task of which is to create an information base for cartographic modeling. [56]

The use of general scientific principles of modeling has made it possible to introduce the map to a wide class of models, to extend, supplement and adjust the cartographic methods, comparing them with the general scientific methods of modeling. In

the general flow of modeling, it becomes possible to form new varieties of it, combined with others, for example, cartographic and mathematical based on the borrowing of the methodology of mathematical modeling, etc.

In the context Master theme "Environmental risks for the protected areas of the Ukrainian Polissya in the context of the E40 waterway project", Multispectral images *Landsat-7 EM* and satellite images of high resolution *Sentinel-2* were used to investigate the landscapes changes of the territory of the NRF. The types of terrestrial covers prevailing on the territory of the NRF are analyzed. [52].

The first step was to identify the main types of earth's surface for the most accurate interpretation of the results. The next step was to extract statistical data: 1) the distribution of areas occupied by classes for each research date; 2) changes in the cover types with each other for the specified periods to access the information of the interaction of the classes among themselves for the periods indicated below.

To determine changes in landscape covers and to calculate NDVI index, images were taken for June of 2000 and 2018 respectively (Fig. 4 and Fig.4.1).

Fig. 4 Map of the landscape cover changes as for June, 2000 (Landsat-7 ETM)

Fig. 4.1 Map of the landscape cover changes as for June, 2019 (Sentinel-2)

Satellite images were taken for the same vegetation period but with a difference of 19, to see significant changes, namely:

- significant biomass development, especially within the water areas;
- increasing in wetland vegetation;
- reduction of Prypiat river branching;
- decreasing of Prypiat river water level.

To prove environmental instability, the vegetation index, NDVI was calculated.

Average NDVI index for Lamdsat-7 ETM is **0,122.**

Average NDVI index for Sentinel – 2 is **0,576.**

It means that average NDVI index changed in 19 years in almost 5 times.

At the same period of time, the quantity of water objects decreased, as a consequence of climate changes and overtime use of Prypiat river in agricultural and industrial purposes.

All surfaces (whether natural or man-made) reflect light differently in different directions, and this form of anisotropy is generally spectrally dependent, even if the

general tendency may be similar in these two spectral bands. As a result, the value of NDVI may depend on the particular anisotropy of the target and on the angular geometry of illumination and observation at the time of the measurements, and hence on the position of the target of interest within the swath of the instrument or the time of passage of the satellite over the site. This is particularly crucial in analyzing AVHRR data since the orbit of the NOAA platforms tended to drift in time. At the same time, the use of composite NDVI images minimizes these considerations and has led to global time series NDVI data sets spanning more than 25 years.

4.1 Conclusions to Chapter

The application of cartographic modeling in the practice of environmental monitoring and environmental management allows you to really look at the problem in a new way, to comprehensively analyze it and make highly qualified conclusions and forecasts, to prevent emergencies of anthropogenic origin.

According to the results of studies on the alteration of landscape complexes, the area of the Chornobyl exclusion zone was analyzed. The increase of area, covering a surface by aquatic vegetation and dense vegetation, due to the non-use of the territory for agricultural and industrial purposes. Positive is the fact of increasing the area of tree-shrub group and tall-growing grass vegetation.

The level of possible environmental threats, especially radioactive were considered and next steps to avoid contamination of main water body of Ukraine in the context of E40 should be taken.

To avoid radioactive contamination of the Dnipro:

- The first is to create an overflow dam on the Prypiat River at the border with Belarus. That is, a half-meter wall from the bottom. However, it does not substantially save the passage of contaminated radioactive water mixture.
- The second, if the contaminated sludge still leaves the Belarusian territory in the Prypiat, you may need to use the experience of the Chornobyl disaster to create artificial catchers at the bottom of the Kyiv reservoir, to dig the original

ditches, furrows in which this polluted sludge will be collected, in the hope which would later be delayed by sediments. This will help localize the pollution to some extent, preventing it from spreading to the entire water area of the reservoir. But these are all necessary, but ineffective, obviously side steps.

- And the third way out - the most effective, but also the most costly - is not to move the contaminated parts of the Prypiat water area (and possibly the Kyiv reservoir) at all, and to bypass them by building a navigable canal near the river. Fortunately, there is a wealth of foreign experience in building such canals. After all, for example, the whole of Holland in such artificially created shipping channels. This path is much better than straightening the Prypyat river bed while killing the river. [53]

The consequences of ignoring the problem can be catastrophic. If radioactive mules go down the Dnipro, we will permanently lose our main waterway as a source of drinking water. Fields irrigated with radioactive water will be contaminated, and with them agricultural products: grain, pastures. Winds will carry radioactive dust from the fields. The whole country can turn into one large radioactive area, closed to the rest of the world. The idea of turning our country into a European breadbasket will disappear, as wheat is contaminated, as well as "radioactive" sunflower oil will not be needed by anyone in the world.

The Dnipro urgently needs dredging. But, not as it is today. Dredgers have fallen into the hands of a messy business and are tearing the river apart. They produce sand for commercial purposes, but do not engage in dredging and clearing where the river itself needs it. Only a comprehensive program will help to avoid the death of the Dnipro. One must understand that to speak only of navigation, forgetting that the river is the only aquatic organism is a utopia. To dig a "navigable" ditch in the middle of the Dnipro - money thrown into the wind, because nature will immediately tighten these pits. It takes a comprehensive approach to the rehabilitation of the entire river, which includes clearing and dredging, and not only the navigable part, but the entire water area.

One of the major environmental consequences of the Chernobyl accident is the contamination of radioactive substances with the water and catchment areas of the Prypiat and Dnipro rivers. Part of the Kyiv reservoir is within the exclusion zone. The area of the reservoir in the Zone is 2700 hectares. However, radioactive sludges are distributed not only within the Zone, but also on a much larger area, due to the removal along the fairway. Thus, there is a tendency. At present, in the sludge deposits of the Kyiv reservoir, a considerable part of the radioactive substances that have come to the environment from the destroyed reactor is concentrated. Thus, according to experts, today at the bottom of the Kyiv reservoir was collected about 7200 Curie-137 Curie. The average depth of the Kyiv reservoir is 4.1 m. The maximum depth is 15 meters (below the dam). [54]

CHAPTER 5
LABOR PRECAUTION

Any enterprise is obliged to develop guidelines and measures of occupational safety as required by and in accordance with the Regulations on the Development of Guidelines for Labor Precaution approved by the Order of Labor Precaution Supervisory Committee of Ministry of Labor and Social Policy of Ukraine as of January 29, 1998, No. 9 (НПАОП 0.00-4.15-98). As such, the subject of the given chapter is a specialist – scientist, who works in the field of climate change, environmental and conservation studies (in our case – expert of Non-Governmental Organization National Ecological Center of Ukraine NGO NECU). Such specialist's work combines a unique set of working conditions as his workplace is often comprised of both office and field (working directly in natural sites with animals).

5.1. Organization of the working place of NGO NECU junior expert on climate change

As it was mentioned, working place of a junior expert on climate change is composed of two constituting sites – standardized office and natural field site. The second part is impossible to regulate and normalize be any standards, the only way to control work in the field is the rules of personal safety that should be met by the worker.

In its turn, organization of the work in the office is regulated by the LU «On Labour Precaution», the Order of Ministry of Social Policy of Ukraine «On Approval of Requirements for the Safety and Health of Workers during Work with On-Screen Devices» and the accompanying set of requirements [55], as well as Regulation of the Cabinet of Ministers of Ukraine «Hygienic Classification of Labor (by Indicators of Hazard and Danger of Factors of the Production Environment, Severity and Intensity of the Labor Process)» and the accompanying Sanitary and Hygienic Norms [56].

According to those documents, the office should meet the following set of requirements:

1. Requirements to premises with computing devices:
   - at least 6 m^2 of space allocated for each computer;
   - at least 20 m^3 per each user of space volume;
   - at least 1 m between the computer and the wall with a window;
   - at least 1.2 m between the sides of the monitors;
   - at least 2.5 m between the back of the monitor and another computer or working place;
   - passages should be at least 1 m wide.
2. Furniture and arrangement requirements:
   - all working places' seats should have backs;
   - at least 0.6 m distance from the display to the eyes;
   - nonflammable floor;
   - finishing materials and furniture should have quality certificates that indicate that toxic and poisonous substances (gases) are not released during burning in case of combustion;
   - all grounded metal objects, such as radiators, plumbing and gas pipelines, must be covered with a dielectric shield.
3. Sanitary rules and requirements:
   - daily wet cleaning;
   - standardized first aid kit in easily accessible place;
   - automatic fire alarm system with smoke detector installed;
   - one CO_2 fire extinguisher per every 20 m^2 of area, in an easily accessible place.

Powering and wiring requirements – individual, grouped three-conductor wiring with wires of phase, working zero and protective zero; the protective zero is used for grounding, using a working zero as a protective zero is prohibited; only three-pin connectors are allowed; when the plug is plugged in, the protective zero must be connected first, otherwise a spark will occur; only use of specially designed extension cords is allowed; the cross section of the working zero and protective zero should be not less than the phase conductor (cord); in a room where five or more computers work, a switch is needed for all electrical equipment except lighting, in an accessible place; sockets should be mounted on a non-flammable substrate, 3-6 pieces per unit, wires in

metal sleeves, along walls or under the floor; wires should be connected only by soldering, joints carefully isolated.

4. It is forbidden to:
   - use wires, switches, sockets and extension cords, that are damaged or not designed to connect computers;
   - use homemade extension cords;
   - use non-standard electrical equipment and infrared lamps for space heating.

5.2. Analysis of hazard factors at the working place

The classification and outlining of harmful and dangerous factors affecting junior expert on climate change of NGO NECU at his working places are carried out on the basis of two regulations: Order of the Ministry of Social Policy № 207 of 02/14/2018 "On Approval of the Requirements for the Safety and Health of Workers in Working with Display Devices" and State Sanitary Norms and Rules “Hygienic classification of labor on the indicators of harmfulness and danger factors of the production environment, the severity and intensity of the labor process” [56]. Consequently, the main factors having influence on junior expert on climate change of NGO NECU are:

1. In office working place:
   - Physical – the parameters of microclimate and ventilation in the working area, which deviate from the permissible and optimal ones (including pressure, temperature, humidity and air circulation);
   - Physical – non-ionizing electromagnetic fields and radiation;
   - Physical – inefficient natural and artificial illumination.
2. At natural site:
   - Biological (risk of exposure to pathogenic organisms and their lifecycle products).

5.2.1. The microclimate and ventilation

Microclimate is a complex of meteorological conditions in the room: temperature, relative humidity, number of air ions, air exchange, air movement rate, the content of particulate matter (dust) in the air, the presence of pleasant odors (aromatherapy), etc. Microclimate is highly important for office premises, as workers spend much of their time in them and require comfortable conditions to be the most productive, the specifications are given in Table 5.1 [57].

Table 5.1

Optimal and permissible microclimate parameters values for category Ib premises

Season	Microclimate parameters	Optimal value	Permissible value	Actual value
Cold	Room temperature	21-23 ^{o}C	20-24 ^{o}C	15-22 ^{o}C
	Relative humidity	60-40 %	Up to 75 %	55%
	Room's air velocity	0.1 m/s	<0.1 m/s	–
Warm	Room temperature	22-24 ^{o}C	21-28 ^{o}C	22-27 ^{o}C
	Relative humidity	60-40 %	60 if t=27 ^{o}C	60%
	Room's air velocity	0.2 m/s	0.1-0.3 m/s	–

For the case of our office, in warm seasons all microclimatic values are contained within permissible values, as general exchange ventilation system is installed in the premises in accordance with the state building standards [58] and the room has access to the natural air and cooling sources through two windows.

The situation with the heating in cold season is more complicated, as the general heating system and radiators were installed in accordance with older standards and are significantly outdated causing temperature drop up to five degrees below permissible level.

5.2.2. Non-ionizing electromagnetic fields and radiation

Among sources of electromagnetic radiation and fields in the office room the most essential are: personal computers, personal devices (mobile phones, chargers, powerbanks etc.), transformer boxes, Wi-Fi routers and all sorts of cables and cords and other.

Non-ionizing electromagnetic fields and radiation at the working place are regulated by a range of documents in the field: State Sanitary Norms and Rules of the Work with Sources of Electromagnetic Fields, of Population Protection from the Influence of Electromagnetic Radiation and most importantly ДСН 3.3.6.042-99 State Sanitary Norms and Rules of the Work with Visual Display Terminals of Electronic Computing Machines, summarized in table 5.2.

Table 5.2

Admissible parameters of electromagnetic non-ionizing radiation and electrostatic field for the office working place

Types of field	Admissible field parameters		Allowable surface density of energy flow (intensity of energy flow), W/m
	for an electrical component (E), V/m	for a magnetic component (H), A/m	
Electromagnetic field intensity: 60 kHz – 3 mHz 3 kHz – 30 mHz 30 kHz – 50 mHz 30 kHz – 300 mHz 300 kHz – 300 hHz	 50 20 10 5 –	 5 – 0.3 – –	 10
Electromagnetic field In visible spectrum 400-760 mm In infrared spectrum: 0.76-10.0 mkm	–	–	 10.0 35.0-70.0
Intensity of electric field of visual display terminal			20

The above-mentioned regulations set requirements to protect employees and prevent harmful visual, emotional and psycho-physical tension, which accompanies sedentary works with only upper limbs involved and with increased sight pressure and generation of EM fields.

5.2.3. Natural and artificial illumination

Illumination of the working place in the office in case of exploitation of electronic computing devices is managed by a range of legislative documents, summarized in table 5.3. [55, 56] According to the ДБН В.2.5-28-2006 «Engineering Equipment of Buildings and Structures. Natural and Artificial Illumination», office work with personal computing devices is classified as category VII of visual works – work with glowing material or in hot workshops.

Table 5.3

Comparison of standard and actual values of illumination for the NGO NECU junior expert on climate change office working place

Factor, indicator		Standard value	Actual value
Natural illumination			
Coefficient of natural illumination (КПО), %	Upper or combined illumination	3	–
	Side lighting	1	2
Coefficient of combined illumination, %	Upper or combined illumination	1.8	2.2
	Side lighting	0.6	–
Artificial illumination			
Working surface illumination by the visual work category (defined for category VII with general lighting system), lx		200	320
Direct reflection		Absent	Present
Pulsation coefficient $К_п$, %		20	19

In the considered office room 3 swing-out glass pack windows are installed with sizes of 1300x1400 mm, providing a good natural illumination and optimal combined natural and artificial lighting mix. The room has a general artificial lighting system and an auxiliary local lighting per each individual working place. General illumination is provided by the luminescent lamps of a series ЛПО34-4х58-002 in accordance with ДСН

3.3.6.042-99 [56], and auxiliary lighting is lateral, provided by individual luminescent oblong lamps.

Nevertheless, there were detected certain issues with glittering and reflection as well as pulsation of lighting. This is due to old-fashioned screens of computing devices without anti-glare protection, installed in the office, which also provide pulsing light and need to be replaced with modern technology.

5.2.4. Biological hazards and safety

Risk of biological exposure of NGO NECU junior expert on climate change is possible exclusively in the field and in office through contact with infected and diseased animals. This is also the reason of difficulties with control over and normalization of this hazardous factor.

Regulation in the field of biosafety in labor precaution is provided by the State Sanitary Norms and Rules «Hygienic Classification of Labor by Hazard and Danger of Factors of the Production Environment, the Severity and Intensity of the Labor Process» and by Law of Ukraine «On the Provision of Sanitary and Epidemiological Welfare of the Population» [58]. According to those documents, working conditions are differentiated into classes by the value of hazardous biological factors (Table 5.4).

According to this classification, field work of NGO NECU junior expert on climate change may be deemed harmful of the 3.3 category due to the possible contact with infected organisms. Unfortunately, currently there is no legislation accessible that would allow adding more precision to the point.

Table 5.4

Hazard classes of working conditions by biological factors in the air

Harmful (hazardous) factor	Working conditions class					
	Permissible	Harmful				Hazardous
	2	3.1	3.2	3.3	3.4	4
	Excess over MPC, times					

Pathogenic microorganisms	Highly dangerous infections	–	–	–	–	–	+
	Pathogens of other infectious diseases	–	–	+	+	–	–

Still, in case of adherence to the set of working place biosafety rules, the working conditions may be improved to the permissible level. Those include: accounting information about possible epizootics among animals, avoidance of close work with suspiciously looking specimens if possible or work with the special protective equipment (e.g. masks and respirators) and clothing items (e.g. rubber gloves and boots), if absolutely necessary.

5.3. Organizational and technical measures of harmful and dangerous factors mitigation

Major issues of occupational safety in our case come from the location of the office inside of an old building of an old-fashioned model. Therefore first and foremost measure to be undertaken for both microclimate and lighting issues – is a full modern rennovation of an office with purchase and replacement of an old equipment and technical means (wires, transformer device, personal computers and illumination system, etc.).

As microclimate goes below standards only during cold seasons, main arrangements for normalization of situation and protection of workers include:

1. Allocation of special heating places and spaces inside an office with installment of specific local heating devices for quick and effective heating of general space and upper/lower limbs (but without intensive infrared directed beam heating systems);
2. Sealing of cracks and gaps as well as spaces behind radiators with special insulation and/or heat reflecting materials;
3. Establishment an interchangeable mode of work/rest and breaks, which provides the possibility of breaks for heating;

4. Provision workers with personal protective equipment (clothing, footwear, gloves) in accordance with the requirements.

Basic means for reducing namely reflection and glowing/glittering of light with glares, and increased lighting pulsation are:

1. Replacement of old screens with new, equipped with anti-glare coatings and without pulsing effect, or coating of old ones with special films or liquids;
2. Installation of protective shutters around screens, which will prevent reflection of nearby light from surfaces and decrease distant light glares;
3. Replacement of old luminiscent general and local illumination systems with new energy-saving and opaque LED lamps.

5.4. Fire safety

The category of the office room with computing devices is D "Low fire hazard" in accordance with State Standard ДСТУ Б В.1.1-36:2016 "Definition of Category of Premices, Buildings and External Facilities According to Explosion and Fire Hazard".

Main fire hazardous and explosive materials and facilities include wiring system and cords, various electric devices (personal computers, copier and scaner devices, mobile phones, chargers, power banks etc.), main power supplying station. Among the most obvious potential fire causes are short circuit, wiring and equipment failure, human factor.

In accordance with the determined category, each floor of the office is equipped with fire shield, which includes: 1 standard fire extinguisher (powder, water-foam or water) with charge weight 5 kg per and 1 auxilliary fire extinguisher with charge weight 3 kg per each room (in general, 3 of each per floor), 1 box with sand, 1 fire cover (blanket), 2 swabs or scraps and a hook, 2 shovels, 2 axes.

A fire alarm system includes the following elements: light and sound alarm, "exit" signs above evacuation outs, smoke sensors (CO_2 type), sprinkler systems and central managing panel. Each room is equipped with one light and sound alarm above main exit and smoke detectors near the main transformer box (power supplying system). The system of fire safety also envisages the constructional decisions, providing emergency exit system

composed of two emergency pathways, two emergency doors at a maximum distance of 50 m form the furthest workshop and 40 m from one another and evacuation plans available in each room and in corridors. Other preventive and protective actions include: quaternary personnel briefings on fire safety with evacuation training, daily check of personal electric equipment and monthly check of whole electric provisioning and security, awareness material on fire safety in form of posters in each room.

5.5. Conclusions to Chapter

Therefore, after the completion of labor precaution chapter of diploma, we can conclude that the working place of the NGO NECU junior expert on climate change is in sufficient satisfactory condition, though some adjustments are necessary.

After the analysis of workplace conditions certain minor drawbacks of occupational safety system were detected on the part of microclimate provision during cold seasons and illumination spreading across the room in form of glares and pulsing light.

Considering mainly non-profit character of NGO NECU work as well as big and costly scale of full-on repairs of the whole office, I would suggest the following solutions:

- Purchase new screens, renovate technical equipment of working places and replace old luminescent lams with economically and power efficient LED to normalize office lighting;
- Use organizational measures to come with microclimate flaws during cold seasons: cover gaps and cracks in windows and doors with styrofoam and tape, introduce increased breaks working mode and use local heating devices allowed by standards.

Hopefully, those relatively simple and cheap measures will allow adjustment of the situation. As for other factors and fire safety the considered working place was complacent with legislation and current standards and standards.

CONCLUSIONS

As a results of this diploma work "Environmental risks for the protected areas of the Ukrainian Polissya in the context of the E40 waterway project" were:

1. The results of research on environmental risks of the E40 IWW implementation and possible influence on the protected areas within the Ukrainian Polissya in the form of maps, charts and tables were constructed. The obtained data demonstrate the effect of long-term environmental changes.

2. According to the results of studies on the alteration of landscape complexes, the area of the Chornobyl exclusion zone was analyzed. The increase of area, covering a surface by aquatic vegetation and dense vegetation, due to the non-use of the territory for agricultural and industrial purposes. Positive is the fact of increasing the area of tree-shrub group and tall-growing grass vegetation.

3. The feasibility study doesn't cover costs for mitigating of the E40 IWW environmental impact in the territory of Belarus and Ukraine and does not imply additional costs for the repair of hydrological structures within the E40 IWW.

4. For a more detailed cartographic modeling to predict possible environmental risks of the E40 IWW implementation, it is planned to perform the task by mathematical or engineering approaches.

5. Implementation of the E40 IWW is a flagrant violation of national and international law.

6. Due to the fact that the E40 waterway is a cross-border project, it is subject to international conventions ratified by Ukraine (in particular the Espoo Convention, the Aarhus Convention), according to which the Environmental Impact Assessment (AIA) should be carried out in a single package in all three countries.

7. A common misconception inherent in the whole report is the lack of a proper understanding by the developers of the concept of socio-economic well-being in which the benefit-cost analysis is applied (ie, the comparison of total costs, both public and private, with the general benefits, again private and additional).

8. It should be noted that along the missing link of E40 on the Bug River, between Warsaw and Brest, there can be found valuable landscape and protected areas that belong to the European network of protected areas "Natura 2000". Therefore, planning and construction of hydrotechnical and engineering infrastructure in these areas and development of shipping will require a more thorough study. Also a prescribed by law durations of research should be considered. A detailed analysis of the environmental conditions is included in a report developed for the assessment of environmental impact.

The main disadvantages of the project:

1. The environmental impact of an investment project is not quantified, measured or justified.

2. The statement that the implementation of the project may lead to the creation of new attractive jobs is not substantiated.

3. The bulk of E40's economic analysis is based on the erroneous assumption: if cost provided from public sources (e.g. from the state budget or from EU funds), then, when evaluating investment performance from a public perspective, these costs need not be taken into account when calculating overall costs.

4. Even if construction costs are ignored, the analysis shows that the infrastructure created within the project is difficult to maintain only at the expense of revenues generated during its ongoing operation.

5. While the benefits of reducing transport costs for carriers are created mainly for individuals, most of the investment costs (as well as the possible additional costs associated with, for example, river ecosystem degradation) will be borne by society in the whole of the three countries. (Belarus, Poland, Ukraine). This approach is not consistent the user-pays principle stated in the project materials.

6. The documents do not contain enough details about the freight flow forecast used. Although a number of other assumptions are mentioned in the model description, it remains unclear, for example, how many months per year are taken as the navigation period for different waterway options, as this assumption is consistent with the model adjusted for the Netherlands conditions.

7. An analysis of the model's sensitivity to assumptions is not presented in this document. This is a particularly significant drawback given the large uncertainty associated with such projections. This uncertainty has not only not been evaluated in terms of the sensitivity of the assumptions made, but for the assumptions themselves (for example, by defining standard errors in the estimates).

8. A common mistake inherent in the whole report is the lack of a proper understanding by the developers of the concept of socio-economic well-being in which the benefit-cost analysis is applied (i.e., the comparison of total costs, both public and private, with the general benefits, again private and additional).

9. Investment costs should be fully considered in the analysis. Otherwise, the Internal Rate of Return (IRR) and Network Cost (NPV) estimates presented in the report are not economically meaningful.

10. The average cost of maintaining and repairing hydrological infrastructure, expressed as a percentage of the investment cost of the project (0.01%) in the first phase of activity, seems undervalued. In the light of experience, it could be expected that these costs represent 3-5% of investment costs each year, especially in later periods.

11. The work also does not take into account the existence of numerous protected natural areas of particular value for the conservation of biodiversity in Belarus and Ukraine. These sites may also be harmed by hydrological work. At the same time, the work does not take into account relevant additional costs as part of the project costs (including in the context of possible compensation payments or measures).

12. A more detailed economic assessment of the Document is futile because it will not change the misconception of evaluating the idea of the E40 project for its usefulness.

13. The work also does not take into account the existence of numerous protected natural areas of particular value for the conservation of biodiversity in Belarus and Ukraine. These sites may also be harmed by hydrological work. At the same time, the work does not take into account relevant additional costs as part of the project costs (including in the context of possible compensation payments or measures).

14. A more detailed economic assessment of the Document is futile because it will not alter the misconception of evaluating the idea of the E40 project for its usefulness.

The transboundary problem of filling the Dnipro-Bug water system can cause degradation of the Prypiat River, Sviate, Volianskyi and Bile riverbeds through the operation of the water supply system.

Many parts of the Polissya are of international importance as exceptional nature monuments that have been granted UNESCO Biosphere Reserves, sites under the protection of the Ramsar Convention.

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