

DEVELOPMENT OF ENVIRONMENTAL INSURANCE IN CONDITIONS OF ECONOMIC INSTABILITY

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Abstract. The *objective* of this article is to establish the theoretical and methodological foundations and develop the applied tools for environmental insurance. The research employs a range of methodologies, including dialectical cognition, system and structural analysis, synthesis, integrated approaches, regulatory support, and others. *Problem statement.* The objective of this study is to elucidate the role of environmental insurance in enhancing environmental safety in the event of accidental environmental pollution. In the case of global disasters, it is challenging to discern whether they have a purely natural or anthropogenic origin. The majority of contemporary disasters are a combination of natural and anthropogenic causes, with the resulting damage being significant and difficult to quantify. In light of these considerations, it becomes evident that environmental insurance assumes a pivotal role in periods of economic turbulence. *Methodology.* The research is based on the generalisation of the conceptual framework of environmental insurance, the justification of the causes and consequences of the need for environmental risk insurance, and the development of industrial and agricultural production. A regression analysis was conducted on 30 agricultural enterprises, with the parameters of the regression equation determined using a matrix of initial data for correlation and regression analysis of profitability. The results of the study show that accidental environmental pollution due to accidental circumstances causes significant damage. To reduce environmental risks, it is proposed to create a system of environmental insurance, the main prerequisite of which is the principle of cross-border functioning. *Results.* It has been demonstrated that environmental risk insurance represents a valuable instrument for guaranteeing environmental security. It is evident that in the event of unforeseen circumstances, the potential for significant accidental environmental pollution necessitates the implementation of environmental insurance to ensure the attainment of environmental safety standards for all participants. *Practical implication.* The findings of the study, including its recommendations, are of practical interest and may be recommended for implementation in the practice of insuring agricultural enterprises against environmental risks. *Value / Originality.* The fundamental premise of environmental insurance for agricultural enterprises is to enhance the existing framework and substantiate the operational mechanism for environmental insurance coverage of their land resources. The potential applications of environmental risk insurance in the context of industrial and agricultural production are explored. In order to assess environmental risks, it is proposed that the most serious threats should first be identified and ranked, and then the environmental risk should be assessed, taking into account factors such as economic damage and mortality. It is demonstrated that in order to effectively evaluate the feasibility of a regional environmental insurance system, it is essential to develop an organisational and economic framework for implementing such a system in the region.

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1. Introduction

A micro-level study of management reveals that the state of the natural environment and natural resources can influence the output of final products in two distinct ways: either by reducing their cost or by increasing production costs. It is imperative that the natural environment be subjected to balanced, scientifically based control over the utilisation, reproduction and conservation of natural resources, which is accompanied by a widespread increase in public environmental costs. In the context of agricultural practice, it is crucial to underscore that only those rural areas where agricultural activity is conducted in an environmentally safe manner, utilising optimal combinations of technological, chemical, hydro-reclamation, biotechnical, and agricultural nature management practices, will remain environmentally safe (Brychko, 2018; Mulska, 2022).

At the present time, the key factor determining the country's socio-economic development is scientific and technological advancement, coupled with the accelerated depletion of natural resources and an increase in the release of harmful industrial waste into the environment. In this regard, the issue of enhancing environmental protection measures at enterprises and ensuring the quality of natural resources is of paramount importance (Borisova, 2019).

The necessity for environmental insurance in the context of the prevailing economic conditions is underscored by the exacerbated challenges posed by the critical degree of depreciation of fixed assets a cross a range of economic sectors, including agriculture. This has the effect of intensifying the negative impact on the environment.

Implementation of the basic principles of environmental protection laid down in international treaties and conferences, laws and legislative acts of Ukraine is often impossible due to the extreme limited resources. The task is even more complicated when it comes to catastrophic events, where resources are needed urgently and on a relatively large scale to prevent their development, eliminate the consequences and compensate for the damage caused. Catastrophic and environmental risks for Ukraine are a cruel reality not only because of the Chernobyl accident and the military intervention of the Russian Federation, but also because 15 million people live in areas of possible contamination with highly toxic substances, 11 million in areas of seismic activity, 7.4 million in areas of possible catastrophic flooding, and the level of depreciation of fixed assets is about 36%; a significant part of the population has moved to other, safer places of residence (EU environmental standards for the Ukrainian livestock sector, 2018; National Academy of Agrarian Sciences of Ukraine. Poultry farms in Ukraine should comply with EU standards, 2023; Polyakov, 2021).

Despite the considerable advances made in scientific and technological fields, the global population, along with the organisations and individual territories they inhabit, remain exposed to significant risks associated with natural disasters. Furthermore, the likelihood of being situated within the vicinity of a substantial man-made accident has increased considerably. Furthermore, for a number of reasons, it is no longer possible to distinguish between natural and anthropogenic causes of global disasters. The majority of disasters can be attributed to both natural and anthropogenic causes. The economic impact of these disasters is significant, accounting for up to 4% of the country's GDP.

The *goal of the study* is to provide substantiation for the theoretical, methodological, and applied foundations of environmental insurance in the context of economic relations undergoing transformation.

The achievement of this goal necessitated the following research objectives:

- Generalisation of the conceptual apparatus of the study of environmental insurance of agricultural enterprises;
- substantiation of the causes and consequences of the need to insure environmental risks, environmental risks in the context of industrial and agricultural production;
- development of directions of environmental insurance of natural resources of agricultural enterprises;
- improvement of the mechanism of environmental insurance of enterprises of the processing sector of agro-industrial production.

The research employs a range of methods, including the structural-logical, dialectical method of cognition, system and structural analysis, synthesis, system and integrated approaches, graphic, regulatory and others.

2. Environmental Risk Insurance

The prevailing instability in the economic, social, political, and legal spheres represents a defining feature of the present historical period. In light of this, there is a pressing need to develop a conceptual model of safe and sustainable development that takes into account the state of the natural environment. In the pursuit of environmental safety, particular emphasis is placed on the issue of financial guarantees, including insurance coverage. Insurance represents an effective economic mechanism for the protection of the environment. Ukraine incurs considerable expenditure in order to prevent risks and eliminate consequences. The financial consequences of environmental disasters can be mitigated through the use of insurance, which is a more cost-effective solution than preventive measures implemented by the state. In the current context, environmental insurance assumes a particular significance. However, it has not yet received the requisite attention in

Ukraine (González-Ruiz, 2018; Krasnoperova, 2020; Malolitneva, 2020).

The specifics of emergency situations are such that, due to their probabilistic nature, work in the direction of their prevention requires significant costs. Furthermore, the quantitative assessment of the effectiveness of these works is difficult. In the majority of cases, forces and assets that are in reserve in the event of an emergency remain unused. The enhancement of industrial safety necessitates the formulation of meticulously devised scenarios for the prospective undertaking of measures at potentially perilous facilities in the event of emergencies.

The deterioration of the environment is a consequence of the accelerated growth of the productive forces of society. In order for economic, social and environmental values to prevail in the country, it is necessary to develop and implement a comprehensive economic mechanism with institutional support. In this regard, an important element of this mechanism may be the process of establishing a system of liability for users of natural resources in the event of adverse environmental impacts.

Environmental insurance, i.e., liability insurance for business entities that are sources of increased environmental hazards in the event of accidental environmental pollution, can provide significant support to this system. Environmental insurance can provide compensation to victims of accidents that have already occurred, as well as implement preventive measures to prevent accidents with the involvement of non-governmental sources of funding (Petrunenko, 2021).

There is no single interpretation of the definition of environmental insurance in the literature (Plastun, 2021; Prokopenko, 2020; Reynaud, 2019). Environmental insurance is seen as a means of protecting someone's property from any environmental hazard, as well as liability insurance for damage to third parties.

Environmental insurance can be viewed as:

- 1) Liability insurance of legal entities (as a result of accidents at high-risk facilities, in case of environmental pollution);
- 2) property insurance (risks, property damage, man-made accidents);
- 3) personal insurance of citizens (risks associated with damage to life and health as a result of an accident at a hazardous facility).

3. Environmental Insurance of Land Resources of Agricultural Enterprises

Environmental insurance is a set of economic relations that are particularly important for the agricultural sector. The formation of a mechanism for environmental insurance of land resources of agricultural enterprises is particularly relevant.

In the context of market transformations, the formation of the institution of agricultural land insurance should take place in a certain fundamental sequence (Figure 1).

The proposed insurance system is based on the following: an information database on the number of contracts and sums insured; an information database on the types of risks, frequency of insured events and reported insured events; an information database on the volume and structure of investments in land plots; an information database and relevant land protection, tax and insurance regulations.

In light of the findings derived from the aforementioned data, a determination is made regarding the insurance compensation to be awarded for the actual losses incurred to land resources. The compensation in question should not exceed the level of damage, but must be at least equal to the amount of damage. Otherwise, the reproductive process will fail to fulfil its functional purpose (Baliuk, 2021; Budziak, 2023; Kaletnik, 2020).

There are levels of unsatisfactory quality of agricultural land resources that imply the existence of a risk in the production of environmentally friendly and high-quality agricultural products:

Level I – soil degradation as a result of agricultural intensification and increased anthropogenic pressure on land resources.

Level II – use of chemicals, waterlogging, salinisation, acidification, soil erosion.

Level III – pollution of land resources due to the use of agricultural products (Khromushyna, 2018). The study of soil cover by environmental indicators makes it possible to develop and implement measures for the rational use of agricultural land resources (Figs. 2, 3).

The calculation of insurance coverage costs is contingent upon a number of factors, including the condition of the object in question, the duration of the contract, the anticipated losses resulting from the occurrence of the event, the probability of such an occurrence, and other pertinent considerations (Edward, 2023; State Service of Ukraine on Food Safety Consumer Protection, 2023). In addition, possible ways of such a negative impact should be considered in three possible areas (DEFRA):

- Damage to land resources (if it negatively affects human health);
- damage to water resources as defined in the EU Water Framework Directive (2000/60/EC);
- damage caused to various species of animals and plants.

It is advisable to focus on the legal provision of quality guarantees for agricultural products produced in an environmentally satisfactory condition. Relevant measures should be aimed primarily at forming the institution of positive responsibility, that

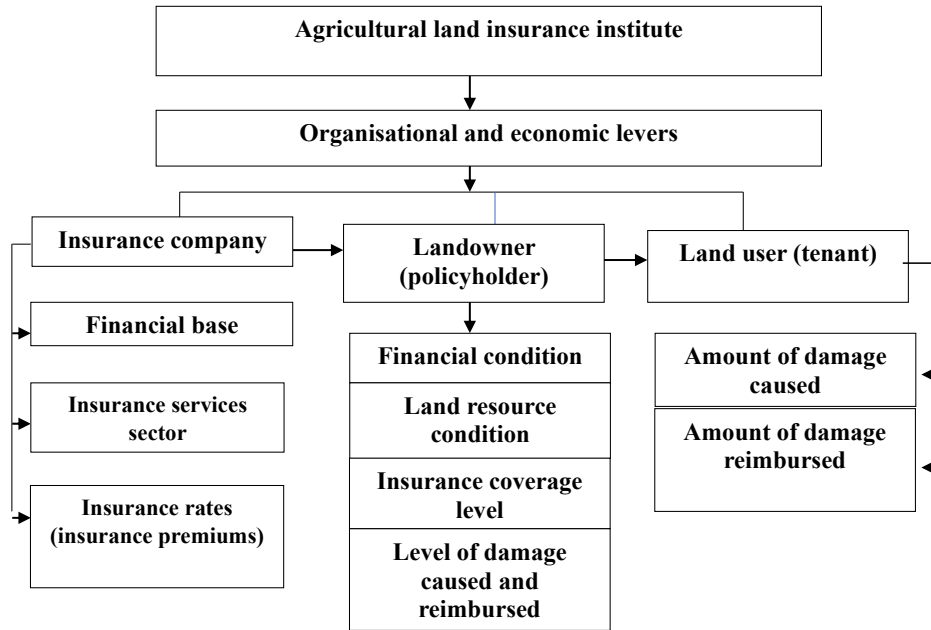


Figure 1. Flowchart of creating a database of environmental insurance of agricultural land
 Source: authors' research

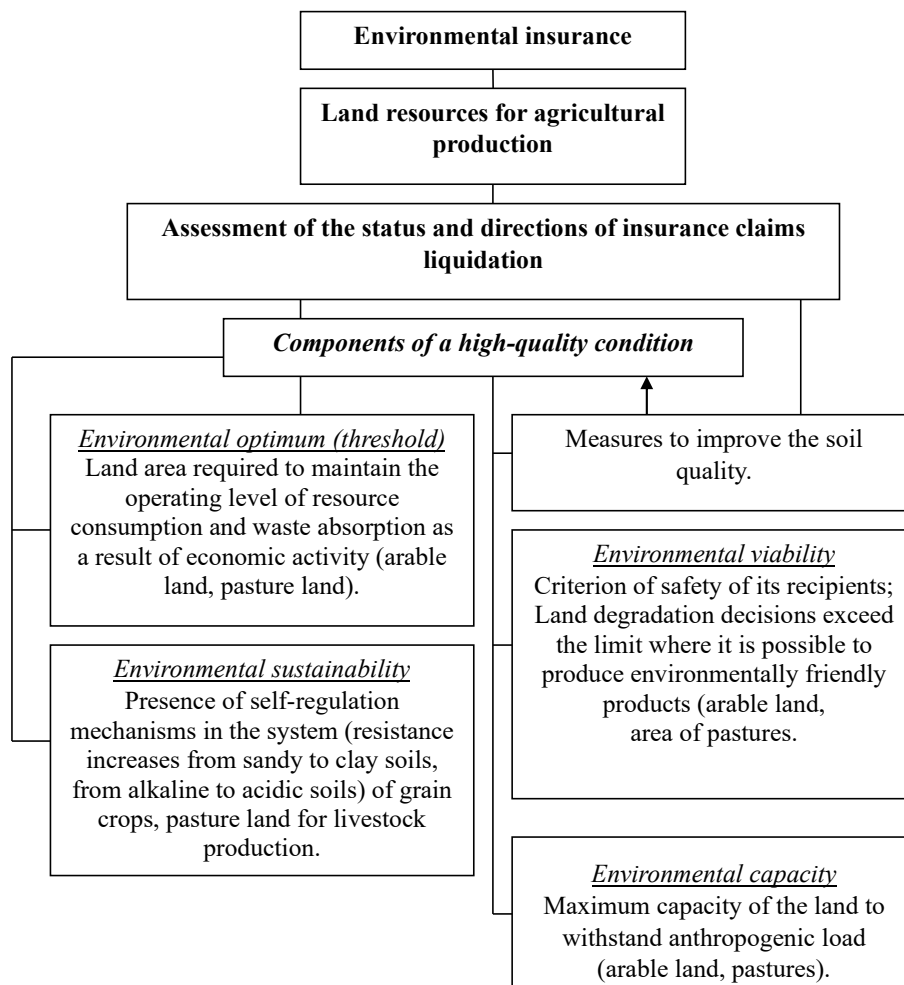


Figure 2. Scheme of environmental tools for land resource insurance
 Source: authors' research

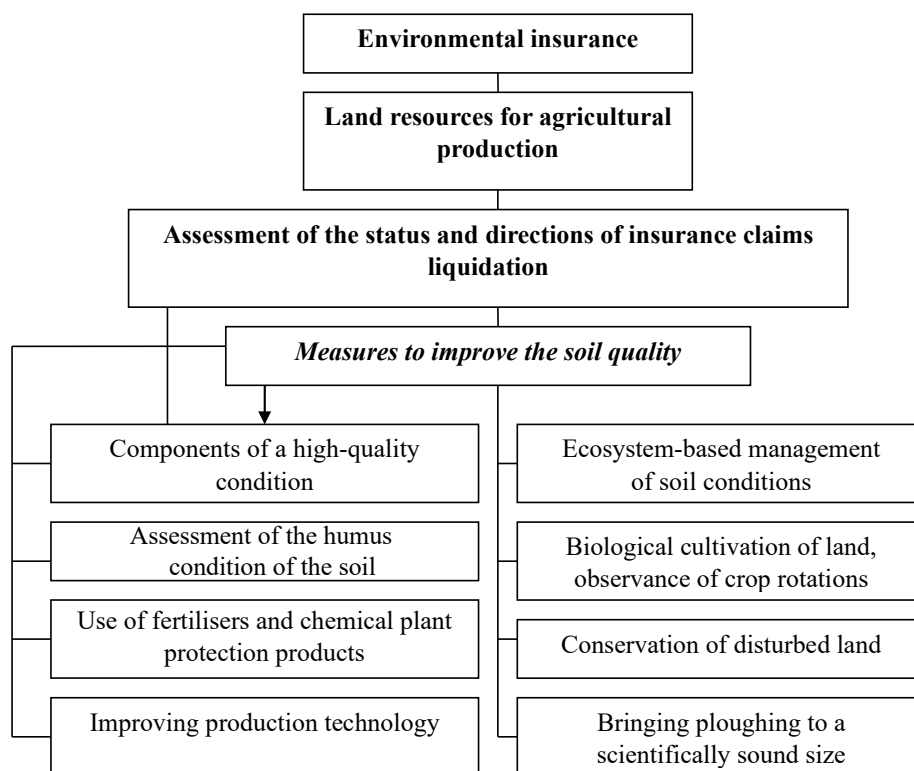


Figure 3. Scheme of organiiational tools for land resource insurance

Source: authors' research

is, responsibility not for offences, but for achieving predictable or desired results, i.e., it is necessary to transfer moral responsibility to the legal plane. At the same time, legislative acts should complement the relevant economic mechanisms developed on the basis of the generally defined nature of legal registration of socio-economic relations in the field of agricultural production.

In the context of environmental insurance, risk is an essential component of the risk assessment process. It is calculated as the product of the potential losses and the probability of occurrence of an insured event (Moskalenko, 2023).

The environmental insurance system serves to advance technological modernisation, motivate business entities to adopt innovative developments, and facilitate the introduction of new technologies that exhibit a diminished level of adverse effects. The aforementioned measures are designed to reduce the tariff rates of insurance premiums to a level that is deemed acceptable for the operation of enterprises, with a particular focus on agricultural enterprises.

4. Environmental Insurance of Agricultural Processing Enterprises

It would be prudent to consider the environmental impact of agricultural production in the context of processing industry enterprises, particularly in their

most concentrated form. This can be explained by the fact that processing enterprises occupy a significant position in the industrial potential of rural areas and exert a considerable influence on the ecological component of life. The main components of the natural environment that are damaged by processing enterprises are as follows:

- Deterioration of air quality due to emissions of gases of different chemical composition and concentration from various sources;
- contamination of groundwater with harmful substances as a result of waste discharge and insufficiently treated water into filtration fields for a long time;
- deterioration of land quality due to uncontrolled expansion of the boundaries of the territories allocated for the production of processing industry products.

It is only possible to achieve complete elimination of air pollution from processing plants if production is completely shut down. In all other cases, compromise options can be used. The limit, which provides for the maximum volume and concentration of emissions that adversely affect human health, is the maximum permissible emission standard (MPE) (Pirozhkov, 2017). They are set for a specific emission source. If the MPEs are exceeded, the company that caused the environmental damage is obliged to compensate for the damage at its own expense. At the same time, the company can insure environmental risks.

It is feasible to address the issue of groundwater contamination resulting from the discharge of waste and inadequately treated water by implementing fundamentally novel wastewater treatment methodologies.

The problems of reducing the irrational use of land by processing enterprises can be solved through the following organisational and economic measures:

- Allocation of new land plots for landfills and treatment facilities on land unsuitable for agricultural use;
- carrying out restoration and reclamation works on the lands that were previously occupied by sedimentation tanks, sludge ponds, filtration fields, and became unnecessary with the transition to new wastewater treatment technologies;
- implementation of a set of measures to restore swampy, saline and acidified soils to their normal state;
- arranging for the removal of waste from enterprises after washing agricultural raw materials, as well as defecation lime to deoxidise acidic soils, etc.

The financial resources required for the implementation of these projects may be sourced from a variety of avenues, including the processing industry enterprises themselves, with subsequent allocation to production costs. Alternatively, the funds may be derived from other sources, such as state capital investments, foreign investors, future owners of the aforementioned plots, local self-government bodies, environmental insurance, and so forth.

One significant challenge in the implementation of environmental insurance mechanisms is the absence of a comprehensive database of statistical data on environmental pollution. This lack of data hinders insurers' ability to accurately assess the probability and scale of potential losses associated with economic activities, which in turn impedes the development of appropriate insurance rates with a differentiated approach. It is reasonable to posit that environmental insurance would be beneficial for those engaged in domestic nature use. It is essential to consider both the intrinsic dangers of production to the environment and the extent of environmental investment by the policyholder in environmental protection measures (Shvets, 2023; Ulko, 2022).

An insured event is defined as damage to third parties caused by fire and/or accident at a high-risk facility during the period of insurance coverage. In such cases,

the insurer is legally obliged to pay the insurance indemnity. The insurance amount and insurance rate should be determined for each specific object of increased danger in accordance with the category of danger as outlined in Table 1.

Insurance indemnity is contingent upon direct damage caused by a fire and/or accident at an object of increased danger to the life, health and property of third parties, which at the time of the insured event is in their possession or use, including natural resources, territories and objects of the nature reserve fund. Insurance payments in Ukraine are made as follows:

- For compensation for damage caused to the life and health of third parties as a result of an insured event
 - 50% of the sum insured, including the insurance payment per person;
 - in case of payment of insurance indemnity to the heirs of the deceased third party – 500 non-taxable citizens' minimum incomes;
 - in the case of disability of groups I, II and III to a third party – 450, 375 and 250 non-taxable citizens' minimum incomes, respectively;
 - for each day of the third party's disability – one non-taxable citizens' minimum incomes, but not more than 250 non-taxable citizens' minimum incomes for the entire period of disability;
 - for compensation for damage caused to natural resources, territories and objects of the nature reserve fund – 30% of the sum insured;
 - for compensation for damage caused to property of third parties – 20% of the sum insured.

The fundamental criterion for the effective operation of a business entity is profit. A multivariate correlation and regressive analysis of the activities of agricultural enterprises was conducted with the objective of assessing the degree of impact on the effective assessment of production reserves (land, labour, capital). The relationship between these factors is expressed by a linear regression equation as follows:

$$y_x = a_0 + a_1x_1 + a_2x_2 + a_3x_3 + a_4x_4,$$

where y_x – estimated value of profit for the year, thousand USD;

x_1 – number of employees, persons;

x_2 – land area, ha;

x_3 – non-current assets, thousand USD;

x_4 – current assets, thousand USD;

a is the coefficient of the i -th regression factor, which shows the degree of average change in the resultant

Table 1

Insurance amount and insurance rate for a high-risk facility

Hazard category	Insured amount	Insurance rate
1	200,000 non-taxable minimum incomes of citizens at the time of calculation of the sum insured	1.5%
2	70,000 non-taxable minimum incomes of citizens at the time of calculation of the sum insured	0.6%
3	45,000 non-taxable minimum incomes of citizens at the time of calculation of the sum insured	0.4%

Source: authors' research

attribute when the corresponding factor attribute changes by one unit, provided that all other factors included in the regression equation remain fixed at the same average level.

The parameters of the regression equation were determined on the basis of the input data matrix for the multivariate correlation and regression analysis of 30 agricultural enterprises (Table 2).

According to the research outcomes, the relationship between the studied factors is as follows:

$$y_x = 87.0910 + 0.6889x_1 + 31.0730x_2 + 0.0024x_3 + 0.0167x_4$$

Checking the significance of the regression coefficients shows that the actual value of the *F*-criterion of the normal distribution of 2.82 exceeds the tabulated value of 2.76 at the specified confidence level of $p = 0.95$, so the above regression equation can be used for further analysis.

The implementation of environmental risk insurance is conducted in accordance with both voluntary and mandatory requirements. The source of formation of insurance funds is the insurance premiums paid by enterprises engaged in environmentally hazardous industries. The insurer's initial capital may be constituted by regional environmental funds, funds from state and commercial insurance systems, and contributions from founders. The initial distribution of insurance indemnities is contingent upon the number of policyholders, the magnitude of the initial capital and corresponding payments, and the availability of reinsurance (Shpak, 2021).

The risk faced by policyholders can be mitigated through the implementation of an effective environmental insurance framework. As the number of policyholders participating in the insurance scheme increases, the financial resilience of environmental insurance operations is enhanced, leading to a reduction in insurance premium rates. In order to ensure the effective functioning of the environmental insurance system, it is essential to identify the regions where its implementation is most appropriate. Furthermore, an inventory of environmental hazard objects must be conducted in order to ascertain the level of environmental risk associated with each of them. Finally, a list of specific insurance events that are subject to mandatory and voluntary environmental insurance must be developed.

The development of compulsory environmental insurance should take place through the following:

- 1) Updating insurance tariffs (which are set based on the class of hazardous facility; insurer statistics on insured events; and data on the probability of occurrence and potential severity of the consequences of an insured event in a particular case at a particular hazardous facility);
- 2) expansion of the list of potentially hazardous objects subject to insurance, insured events, the scope of the insurer's liability and the procedure for determining the amount of damage and losses;
- 3) streamlining the pricing system and application of coefficients to insurance tariffs (classification of hazardous facilities by the level of danger and quality of measures taken to maintain the safety of the hazardous facility) (Demikhov, 2020; Schusser, 2019).

For all types of environmental insurance, it is advisable to entrust the determination of the risk of accidental pollution to an environmental audit service that provides information on the degree of environmental hazard of the facility and the amount of potential environmental damage.

The formation of an environmental insurance market is not yet a guarantee of compensation for losses incurred by an enterprise. On the basis of environmental services and other sources of financing, it is necessary to develop various forms of entrepreneurship focused on environmental protection and the reproduction of natural resource potential; to create a system for eliminating the consequences of various disasters, prepared for effective action in any crisis situation (Semenda, 2018; Skryl, 2019; The State Statistics Service of Ukraine, 2022, 2023).

There are a number of methodological approaches that can be employed in order to assess environmental risks. The initial step is to identify the most significant threats and rank them in order of severity. Subsequently, the environmental risk is assessed, taking into account factors such as economic damage and mortality.

Properly organised environmental insurance reduces the risk of insurers: the more insurers are included in the insurance field, the higher the financial stability of environmental insurance operations and the lower the premium rates. In order to ensure the

Table 2
Parameters of multivariate correlation and regression dependence

Indicator	Regression factor coefficient (a_i)	Indicator	Indicator value
Current assets (x_4)	0.02	Multiple determination coefficient (R^2)	0.3108
Non-current assets (x_3)	0.01	Actual value of <i>F</i> -normal distribution criterion (<i>F distrib.</i>)	2.82
Land plot area (x_2)	31.07	x	x
Number of employees (x_1)	0.69	x	x

Source: authors' research

effective functioning of the environmental insurance system, it is essential to identify the regions where its implementation is most appropriate. Furthermore, an inventory of environmental hazard objects must be conducted in order to ascertain the level of environmental risk associated with each of them. Finally, a list of specific insurance events that are subject to mandatory and voluntary environmental insurance must be developed. It would be advisable to develop an organisational and economic mechanism for implementing the environmental insurance system in the region. In addition, it would be beneficial to determine the rate of insurance premiums and amounts paid to the policyholder in the event of an insured event. Furthermore, it would be advantageous to develop basic regulatory documents and test models of the regional environmental insurance system.

5. Conclusions

Environmental risk insurance should be regarded as a means of guaranteeing environmental safety, fulfilling compensatory and preventive functions, and as a mechanism that enables the technological modernisation of production facilities. It can be reasonably proposed that environmental insurance represents a potential breakthrough area, facilitating the development, implementation and dissemination of innovations.

The findings of the studies indicate that accidental environmental pollution resulting from unintentional causes has a significant adverse impact on the national

economy and the population. In this regard, the reduction of the risk of economic damage due to accidental pollution represents a significant challenge.

In order to mitigate environmental risks, it is recommended that an environmental insurance system be established. This system would be founded upon the principle of cross-border operation, which entails the attainment of environmental hazard standards at the national level by all participating entities.

The research provides evidence that environmental insurance should be incorporated into the insurance system as an economic instrument, thereby facilitating the reduction of the anthropogenic impact on the natural environment. Environmental insurance may be either voluntary, which is regarded as a form of business activity, or mandatory, whereby financial guarantees of minimal compensation for damage are made available. The relationship between insurer and policyholder should be founded upon the principles of mutual benefit and the economic interest of the policyholder in enhancing their own environmental safety.

The implementation of legislation pertaining to the advancement of environmental insurance would serve to regulate the relationships within the domain of civil liability insurance for damages incurred to the state, life, health and property of individuals, legal entities and individual entrepreneurs as a consequence of contraventions of the legislation on environmental protection, a subject which requires further investigation.

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