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APPLICATION OF RKFMEA, FOR ASSESSING THE RISK AND SUSTAINABILITY IN THE BLACK SEA BASIN

Vladimir KANEV[1], Sabina NEDKOVA[2], Plamena ATANASOVA[2], Marusya LYBCHEVA[1], Mariana PANAITESCU[3]& Fanel-Viorel PANAITESCU[3]

[1] Black Sea Institute Association, Burgas, Bulgaria
[2] Burgas State University "Prof. d-r Assen Zlatarov", Yakim Yakimov Blvrd.1, Burgas, Bulgaria
[3] Constanta Maritime University, Faculty of Naval Electro-Mechanics, 104 Mircea cel Batran Street, 900663, Constanta, Romania, e-mail sabina_nedkova@btu.bg

Abstract: The Black Sea basin is a territory that is distributed between countries with different status and level of economic and social development, in which various historical, cultural and social transformations have been and continue to be realized, in which challenges and risks of a different nature are encountered. Nowadays the territory around the Black Sea is identified as the "Black Sea Region". That is the reason for which it is important to create models through which various risks are managed - economic, social, natural, technological. The research is aimed at preventing natural and technological risks in coastal zones and the water area, as a prerequisite for sustainable development, associated with the ever-complicating technical and technological processes. The development proposes the use of specialized software for risk assessment and analysis and prevention management, the application of which creates a prospect for safer socio-economic development and sustainable growth and the assets we assess and seek to improve.
Key words : Black Sea basin, risk assessment, sustainability, FMEA.

1. INTRODUCTION

The Black Sea Basin is a territory that is distributed between countries with different status and level of economic and social development, in which various historical, cultural and social transformations have been and continue to be realized, in which challenges and risks of a different nature are encountered. Focusing on the risk as a starting point, or the possibility of an adverse event with damage occurring, the understanding of sustainable development is the presence and accumulation of knowledge for better management and avoidance or reduction of damage in the event of an adverse event. Or Risk Assessment + Selection and implementation of prevention + Periodic monitoring and renewal, which with good management give Sustainable Development [1].

2. MATERIALS AND METHODS

For the scientific assessment of the risk in the Black Sea basin had been used specifically designed risk assessment method called RkFMEA. The basic principle of RkFMEA, which is a management system, is that it is not based on the prevailing top-down approach, but on the bottom-up approach to data collection, risk assessment and planning of prevention measures and their management. The system takes into account the resources needed for prevention and this is reflected in the acronym. The system works on the basis of the expert opinion of specialists and responsible administrators at the selected lowest administrative level. The system is an extension and modification of FMEA [2] and uses a standardized set of quantitative factors with values from 1 to 10. It has been added to it, and on the same functional principle, more important factors for risk assessment and prevention management - that of the effect of existing protection and prevention measures and their effect (N) and of the proposed new prevention measures and their effect and efficiency (F) [3]. Depending on the selected lowest and basic administrative level that will assess and enter the data, two other factors are added to harmonize the risk levels and compare them under comparable conditions - the factor (L) for the value of possible damages from the GDP of the municipality or mayoralty or settlement, depending on the selected lowest administrative level and the factor (D) for the age dependency coefficient of this administrative level.

RkFMEA provides quantitative indicators and respectively comparable measurements of the risk level (risk priority number, RPN), including the current measures and activities for control and prevention (N) and in addition provides the complex risk factor (RPNF),

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representing the level of risk with the need for investment in prevention, the harmonized (normalized) risk levels according to the wealth of the community (RPNL) and according to its age characteristics (RPND). The system and the developed application are used to assess and plan investments in measures and activities for the prevention of accidents and catastrophes, monitoring their implementation and effect, reports and reporting with various analyses with sections through the collected base and with the most useful tool for management, which is an analysis of trends and changes in risk levels and complex and harmonized risk factors, especially for the need for prevention.

The threat and risk are always spatially localized. The system and application allow this to be the threat and risk zone, determined by direct delineation by the expert or using databases, or described verbally, but localized for a city hall, municipality or other administrative level or directly by selecting a city hall or municipality. Subsequent integration is done for a higher level – municipality, or district and up. The delineation of a zone, while using the risk software RkFMEA is shown in Figure 1.

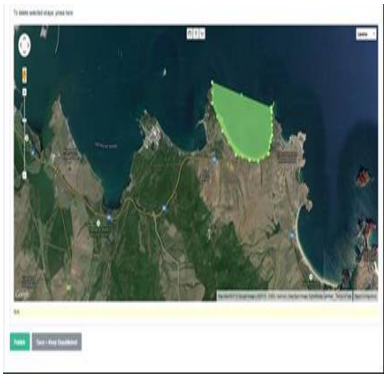

Figure 1 Delineation of a zone, RkFMEA

The RkFMEA system and the application work with a selection of factors from tables, descriptions in text format and an assessment of damage and prevention in an approximate monetary value, term in years or percentage. To derive the value of the factor (F) for the efficiency of a new prevention, which is done automatically, it is necessary to estimate the possible damage for the selected area or municipality, roughly in order. Intangible damage such as that for the environment in the system is estimated in the years needed to restore the affected area. Accordingly, the value of prevention is estimated in monetary means (money) and for the environment in years of recovery in the event of a disaster with implemented prevention. This approach, applied for the first time in the RkFMEA system, makes it possible to derive the efficiency of a given new prevention measure, and the complex risk factor RPNF shows how urgent a given new prevention measure is. The application allows for proposing and comparing several measures and choosing the most appropriate one in terms of its effectiveness, while the RPNF-based maps show where the proposed prevention measures are most urgent, taking into account the level of risk.

The risk levels and depictions, based on RPN are:

- High for a factor above 250 - ;
- Moderate for a factor from 50 to 250 - ;
- Low or negligible for a factor below 50 - .

The risk levels based on RPNF, RPNL and RPND are:

- High for a factor above 1700- ;
- Moderate for a factor from 200 to 1700- ;
- Low or negligible for a factor below 200- .

The system and the application provide reports in tabular format and in GIS. For the purposes of planning and managing risk-based prevention and making investment and priority decisions at the municipal and district levels and above, the three-color maps are most suitable, while for detailing the measures themselves, specialized information for the administration in tabular form is suitable. Access to the summarized GIS information is offered to the public.

After extensive research and testing in administrations, the system and application only need a few hours once a year to fill in the data, which is sufficient to collect data and to output sufficient information for making management decisions. Figure 2 shows the trend of human health risk for all threats in Burgas district (simulated data), with a negative change in red, no change in yellow and a positive change in green, which means that new prevention measures have been implemented compared to the previous year and they are having an effect.

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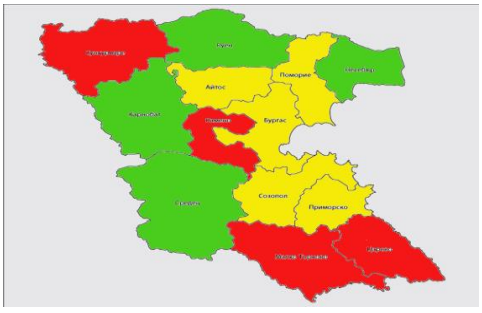

Figure 2 Delineation of risk zones within a municipality, RkFMEA

Figure 2 shows the trend of the risk to human health for all threats in the Burgas district (simulated data), with a negative change in red, no change in yellow and a positive change in green, which means that new prevention measures have been implemented compared to the previous year and they are effective.

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The developed application, accessible from a desktop computer, tablet or smartphone, was experimentally used for the risks of pollution of the Black Sea with petroleum products, with a detailed selection of the area and for the environmental and technological risks to human health for the Burgas district, with a selection of the municipality.

3. EXPERIEMENT

Using the risk assessment tool RkFMEA, the environmental and technological threats and risks to human health for the Burgas region, including the Yambol and Haskovo regions, have been identified based on a review of past events and surveys conducted with interested administrations [4]. The information had been gathered within a project funded within JOP Black Sea basin IUCRISKMAN, 2.2.1.73194.264.[5]

The main threats or "risks", according to our broad linguistic understanding of the meaning of the word risk, indicated by the survey participants focus on the pollution of the Black Sea waters with oil products. They are as follows, and their percentage weights were also derived from the study: Spill of pollutants from shipping – 45%, spill of pollutants from point sources on land – 18%, spill of pollutants brought by rivers – 19%, spill of pollutants from point sources at sea – 2%. The total amount is not 100% because permanent natural sources of hydrocarbon pollution are not included here. The main threats for the purposes of further systematization are detailed in three levels, with a priority given here for those from shipping: Spill from a ship in the open sea in the event of a collision, damage, catastrophe – 29%; Spill from a ship at anchor/in port from an accident or operation (this includes bunkering, bilge water, transhipment operations, waste) – 32%; Permitted and unregulated discharge of bilge water and pollutants from a ship on the high seas – 39%.

Threats from pollution of the Black Sea lead to risks that have been identified and assessed for the coastal environment, with permanent damage on land; the marine environment, with permanent damage at sea; fisheries and aquaculture; public health and tourism/beaches/industry (including agriculture and port industry).

After selecting an area, selecting a threat, sub-threat, risk, the factors and the descriptive part are determined, which are systematically managed by the application. The expert, working with the software selects, based on experience and knowledge, the corresponding value of the RPN factors, and it is important to consider whether the respective factor is in the green zone (value 1 to 3), the yellow zone (value 4 to 6) or the red zone (value 7 to 10).[6], [7], [8] To assist in the selection of the respective threat and risk, auxiliary tables have been developed. In addition, an estimate of the value of the possible damages is given. The example, given in Table 1 is from a sample from the table for selecting the effect of existing prevention - factor N. Even if a preventive measure is available, in the absence of support it is not effective, or will have a value of 8.

Table 1. Effect of the prevention factor N

Effect of the precaution measure or action	Description of its effect	Value
Absolute absence	Absolutely no precaution measure, control or action currently envisaged	10
Extremely low	Extremely ineffective or unproven distant measures or actions to prevent or avoid damage and casualties or unmaintained facilities or other safe measures.	8
Average	Average effect of the measure or action to prevent damage and casualties	6
Very high	Very high degree of certainty that the safeguard or action will prevent damage, damage and losses from occurring	2

The system and the application calculate the corresponding values for RPN, RPNF, RPNL and RPND.

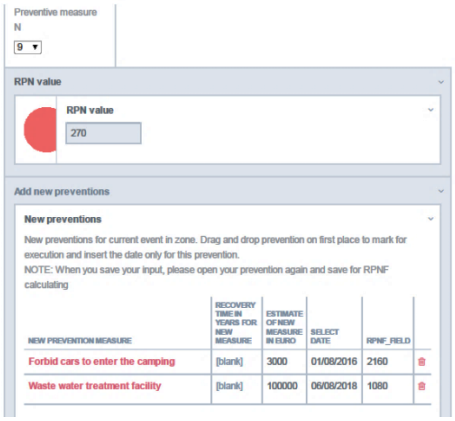

Figure 3 RPN, RPNF and proposed new measures Camping Garden

The value of F is determined by the ratio of the values for the possible damages and the costs of the new prevention measure. In the case of time values, this is again the ratio between the two. The dependence is not linear, with the greater effect of the new preventive measure being given priority.

The most effective one has a factor of 10 or a red zone to show the urgency of its implementation. The

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following Figure 3 is shown a screenshot of the application for the threat of pollution with petroleum products and the risk to tourism for the example of the dumping of car oils in the Gradina campsite (simulated data).

The cheaper measure is more effective and has a higher RPNF value and is in the red zone. The following year it was implemented and the risk level was already in the yellow zone, and with the remaining proposed measure the RPNF is only in the yellow zone with a value of 600, which suggests that it does not need to be implemented yet (Figure 4).

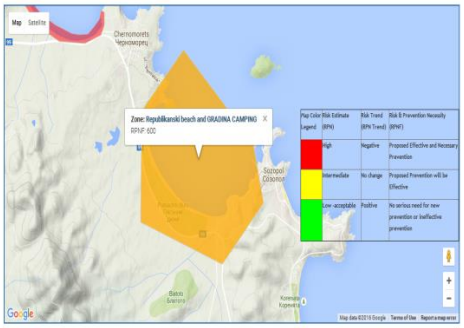

Figure 4 Next (after the risk assessment) year's RPNF Garden Camping Area

The system with the application clearly shows the effect of the implemented prevention, and also provides the opportunity to plan wisely and for preventive measures to be effective. Continuous annual monitoring and updating of data allows for effective planning and monitoring of implementation and to apply preventive measures according to the need and available resources.

3. CONCLUSIONS

The generalization for the entire region, when data is submitted by all interested parties and administrations, allows for comparison and for directing resources and funds to the most urgent places.

Planning preventive measures after risk analysis must also take into account the population's ability to cope with the possible consequences of a natural event or technological crisis. Comparing only the RPN risk levels, for example, for municipalities in one area does not always show where the risk is most significant in relation to the population in a given municipality. With the same damage, but with a different demographic structure, some municipalities will cope more easily than others, or the risk will be different for them.

Research and interviews with representatives of municipalities show the need to consider risk and prevention according to the needs and capabilities of the population in a given administrative unit. The application RkFMEA provides this opportunity for data collection and risk analysis and prevention management at the municipal level, with the territorial boundaries of the municipality conditionally corresponding to the zone indicated above.

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