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Methods and perspectives of combined ecological and economic regulation by an example of the Kalush-Golinsky potassium salt deposit

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SUMMARY

The imbalance of economic and environmental indicators is one of the most pressing problems for the sustainable development of Ukraine. The decrease in foreign sales of potash mineral fertilizers with a simultaneous increase in its negative balance testifies a number of shortcomings of a systemic and organizational nature. Its reflects on the volumes and quality of domestic commodity products and significantly affects their competitiveness at the world market. At the same time regular monitoring of the environment in the west of Ukraine permanently reveals the problems associated with the technogenesis zone influence of the salt-mining complex in the Carpathian region. And primarily this affects the condition of water bodies. Based on the performed analysis of monitoring data for the last seven years and the basic characteristics of the proposed, but not implemented, proposals concerning brine management at the study area, an experiment was conducted. Within it, a combination of quantitative and financial limiting parameters with modern technological approaches to the extraction of useful components from brines was envisaged. Profitability index - one of the main financial indicators in conditions of annual discount rate fluctuating, was determined. And the conclusion about the high efficiency of such approach realization, aimed to solve a set of environmental and economic tasks, such as stabilizin g the level of environmental security and increasing the macroeconomic performance of the country was made.

Introduction

The Carpathian region's territory, is the one by the example of which it is advisable to consider the possibilities of implementing comprehensive solutions aimed at improving the environmental and economic indicators of sustainable development of the country. The objective necessity of forming the conceptually new approaches to their management is due to Ukraine's integration into the world economic space and changes in the international obligations of our country regarding natural environment protection with ensuring the environmental safety.

The actualization of the environmental and economic problematique is caused by the dominant trend of exceeding the rate of natural resources' use over the rate of production growth *(Shvidanenko et al., 2017)*, outdated technologies and the accumulation of a significant amount of waste. This creates a threatening situation of an environmental nature (the intensification of the dangerous exogenous geological processes might take place) and doesn't contribute to the growth of country's macroeconomic indicators.

Theory

Within the study a dynamic of international trade of Ukraine was analyzed. According to received results the situation on Ukrainian export market has been steadily deteriorating in recent years due to a decrease in sales abroad of commodity products number. Among other things, this included potash mineral fertilizers (*data from SFS of Ukraine*) (fig. 1). At the same time, tracing the changes in the import volumes of the same product, it is noted an inverse proportionality to the previous indicator and its significant increase (fig. 2). Thereafter, the logical outcome of this was the growth of the negative balance (fig. 3).

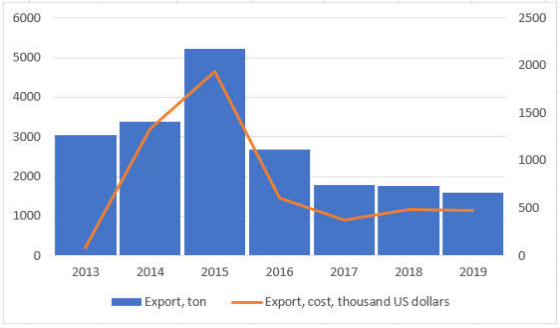

Figure 1 *Export of potash mineral fertilizers.*

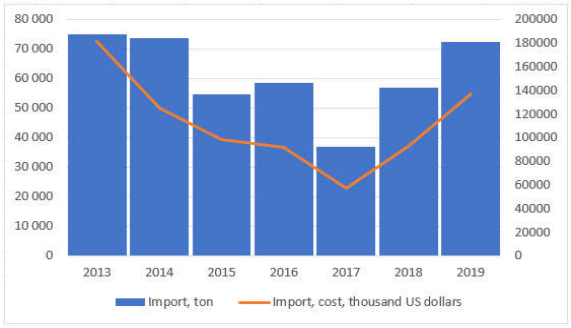

Figure 2 *Import of potash mineral fertilizers.*

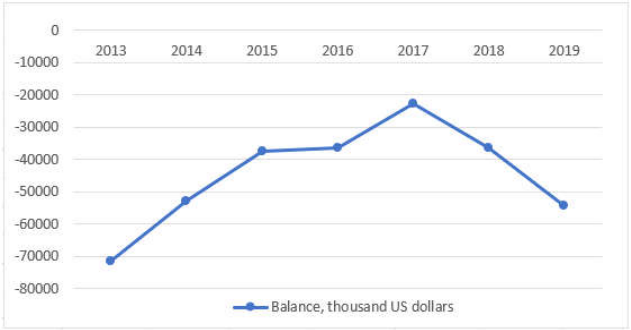

Figure 3 *Potash mineral fertilizer export-import balance.*

Consideration of this market segment not only demonstrates inability to cover domestic demand at the expense of national production capacities, but also highlights the shortcomings of systemic and organizational nature. And precisely the lack of widespread introduction of modern, technically advanced production methods is taking an important place among them. The latter has a significant impact on the volume and quality of commercial products, which accordingly affects the competitiveness of Ukrainian potash mineral fertilizers in the global market.

The problems of the study concerns not only the economic but also the environmental aspect, so it have also been analyzed the data of regular environmental monitoring in western Ukraine, which permanently identifies problems related to karst processes, activation of subsidence phenomena, underflooding of residential areas and the general state of surface and ground waters of the Lviv, Ivano-Frankivsk, Chernivtsi and Transcarpathian regions. And partially all of it is caused by the influence of technogenesis zone of the salt-mining complex of the Carpathian region. The lack of qualitative management of drainage water runoff with increased salinity from the drain pits and sludge ponds of potassium salts deposits, including those that are currently inactive, is a real threat to the water sources used for local water supply. This applies settlements with coastal water intakes located on the banks of the Limnita, Dniester, Tisa and other rivers.

A striking example of such objects posing a real threat in the Carpathian region is Dombrovsky quarry of Kalush-Golinsky potassium salt deposit, which has transformed from the exploitation zone to the one of quasi-stable equilibrium *(Malkova et al., 2021)*. That is, at the moment this is an object of constant long-term regional pollution of ground and surface waters, which proves in an illustrative way the topicality of brines' accumulation problem and the necessity of their processing.

But with all the threatening situation, which is associated with the negative impact of the technogenesis zone on environment, it should be noted the following. The brines are very promising (on the assumption of appropriate processing technologies and methodologies) and rich source of raw materials, the extraction of which might change the balance of macroeconomic indicators, reduce the pressure on environment and improve sanitary and social conditions for the region's residents. Among the useful components contained in the brines and which are of primary interest to the manufacturer are potassium-magnesium salts used for the production of potassium-magnesium. Having traced the trends of changes in the volumes of its global consumption within agricultural sector over the past 10 years, a statistical forecast for the next 5 years was made (Fig. 4). According to it, even in the case of low probabilities the values will grow, and consequently the need of the country to provide itself with this product, reduced the import costs as much as possible will not lose its relevance.

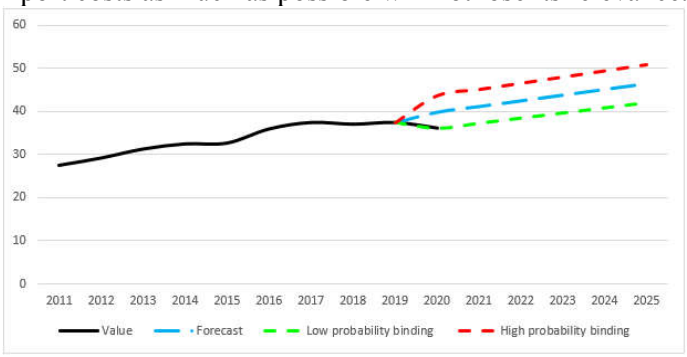

Figure 4 *Forecast of the dynamics of consumption of potash fertilizers in the world.*

Taking the above into account, the reasonability to invest in the projects aimed to increase the country's raw material potential within considered area *(Brine Treatment, 2020; Pramanik et al., 2017)*, is justified not only by the environmental aspect, which includes the ability to make significant affect to the salinity of the adjacent to facilities' territories, thereby reducing the risk of environmental disaster, but also by economical aspect.

Among the other aspects, the above-mentioned Dombrovsky quarry and adjacent tailing dumps present the considerable perspectives for the mentioned activity. This object is a long-standing center of ecological tension in Ivano-Frankivsk region and the probability of its reduction due to the implementation of the brines' useful components extraction concept and their processing into a marketable product looks very promising. In particular, a wide range of far-reaching products of such activity includes the obtaining of mineral fertilizers potassium-magnesium. During past 10 years,

several attempts have been made to put into practice the ideas of brine processing at this object. These initiatives came from completely unrelated organizations of both national and European origin. However, in each case, the proposals faced a number of legal and economic obstacles, thereby they never have been implemented, although the perspectives were indisputable. Within this study, stated in rejected projects goals and declared for their successful implementation needs were analyzed. It was also noted the obvious contrast between the planned effectiveness and economic efficiency under conditions of using traditional methods and more technological ways of the brines' management. This gave grounds for making conclusion about the existence of an urgent need to review the effectiveness of native approaches and methods of processing the brines, which were formed within salt extraction areas and are based on technologies of its demineralization.

Results

Based on the results of a preliminary analysis of diverse variations of modern technological approaches to extraction from complex brines solutions a whole set of various useful components that can be converted into commercial product *(Kosharna, 2020)*, an *experiment* regarding the Dombrovsky quarry *was carried out*. Within this tentative for the studied object, the conditions were simulated, including the following: the use of electrodialysis as one of the most advance technological method of brine processing in the world, the cost of which reaches 10.05 $/m³ or 8.28 €/m³ (according to the currency rate as of 11.06.2021), the proposed in 2018 volume of investments (€ 100 mln), as well as the annual restriction of immediate brine processing by 1 million m³, that was also envisaged in the previous project, but under condition of the traditional technologies use. In addition, for better clarification of possible changes regarding one of the key financial indicators - profitability index (PI) *(USAID, 2012),* that illustrate the level of project efficiency, three options of the annual discount rate have been considered, taking into account its fluctuation during past three years. Considering all mentioned above, the current world prices on technical salt and mineral fertilizers, in particular potassium ones, as well as the volumes of their possible extraction from the Dombrovsky quarry brines (115kg of sulfate potassium-magnesium fertilizer, 210kg of technical salt from 1m³), via the calculation of profitability index (PI) indicator (1) the values presented in table 1, have been established.

$$PI = \frac{\sum_{k=1}^{n} \frac{NCF_k}{(1+r_k)}}{\sum_{j=1}^{m} \frac{I_j}{(1+r_j)^j}} \qquad (1)$$

where n is the forecast period, years; k - year in the forecast period; NCFk - net operating cash flow (income) per year k, mln €/year; r_k - annual discount rate per year k,%; m - number of the years for which the investment is being planned, years; j – the year during which the investment is being made; I_1 - investments (expenses) per year j, mln €; r_1 - annual discount rate per year j, %.

Table 1 *The value of the project profitability index*

Annual discount rate	PI
8%	4,28
14%	4,67
19%	4,94

Guided by the indicated in the Public-Private Partnership Development Program in Ukraine and the Practical Guide to Feasibility Study Preparation dependence: PI > 1, it is possible to draw a conclusion on high efficiency of the represented strategic approach, even under conditions of fluctuations in the country's economic development. The introduction of the latest brine processing technologies significantly affects the general profitability of the project, significantly reducing the payback term (5 years - in the proposed in 2018 project, 3 years under condition of the electrodialysis use), and increasing the volume of total revenue for the project period.

It is reasonable to consider the established indicator as an acceptable not only for the private entrepreneur, but also for the state partner, given the fact that such project will allow to achieve a number of social and economic goals *(Dykha, 2013)*. Among which the following ones could be indicated: creation of the conditions for innovative development of internal market, improvement of investment climate and achievement of the environmental safety level.

Despite the proved above approach efficiency, and the background of successful realization of the projects in this area by European countries, there's a dominating persuasion in Ukraine about the need of using irrelevant, from our point of view, methodology regarding working with salt water. It is also presumed that the inheritance of foreign experience without taking into account the specifics of our country, as well as the instantaneous transition to the new technologies and the revision of the operating system of current infrastructure of the districts with appropriate environmental and economic perspectives, is not possible. For these reasons, at the moment, the merger of technologies into hybrid systems might be defined as the best option to optimize the operations with highly mineralized water in the study region. Gradual combination of traditional operational methods with the advanced ones, accompanied with assiduous monitoring of all key indicators of projects' efficiency in a short time would allow to obtain statistical confirmation of the rationality of approach and ensure a smooth transition of national industry to the new technical and economic level.

Conclusions

Providing that an impartial selection is made, implementation of projects with the indicated trend is a complex solutions of economic and ecological problems. Since the result of such implementation might be expressed by simultaneous increase of extraction volumes of raw materials from brines and thus decreasing the pressure on the environment. It also gives a push to the development of innovation activities of enterprises and promotes the increase of competitiveness of products at the world market. Under such conditions, finding partners abroad will be easier, and the sale of Ukrainian exports (the same potassium-magnesium) will start having a positive impact on the country's economy, as the growth of foreign currency resources will curb inflation.

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