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TRANSBOUNDARY PROBLEMS OF CASPIAN ECOLOGY: ICT-BASED SOLUTIONS

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Introduction. Applications of new information and communication technologies (ICT) for solving one of the important regional problems of the XXI century – the problem of «Estimations of influence on an environment in transboundary context for the region of Caspian sea» [1, 2] are considered.

The Estimation of the Influence on Environment (EIE) is a national procedure of the estimation of the possible influence of planned activity on the environment. According to the recommendations of SCOPE (Scientific Committee on Problems of the Environment at the United Nations) the procedure of EIE was included as the integral and legislatively fixed element in practice of economic planning in many countries of the world, including Caspian countries.

Planned activity (PA) is understood as any activity or essential change of this or that activity, demanding decision making by competent organizations according to the used national procedure of EIE.

Transboundary influence means any influence (not only global character) in the area, which is under the jurisdiction of one country, but this influence is caused by planned activity the physical source of which is located within the limits of the area which is under the jurisdiction of other country [1, 2].

Presently there is a set of projects with possible transboundary influence on the environment of the region of the Caspian Sea, including projects of oil-gas extraction, as well as projects of neighbouring countries connected with rivers, running into the sea. In this connection the necessity of uniform and coordinated normative-methodical documents which would estimate the influence on an environment in transboundary context (EIET) has come into importance. The absence of such documents creates problems not only in protecting natural ecosystems, but also for developers of projects who would like to be sure in observance of all legislative requirements by them, including in the field of national and international relations.

Today there exist four basic documents concerning an essence of the question [1, 2, 3, 4]. In these documents, however, as well as in other documents on EIE, *the rules of organizational interaction* is normalized, but there are no tools *of scientific - methodical support* of the procedure of EIET. Methods of EIE offered in [4] and [5], reflect a condition of an ecological science back 30-years. The methods used in projects of oil-and-gas consortia, solve the local problems connected with EIE of concrete contract areas. Defects and difficulties of application of these methods are well-known [6]. However till now all of them have not been overcome yet though today there are methodological and technological preconditions for this. Transboundary EIE pursues other purposes and solves another much more complicated problem. For many areas of the Caspian sea it is aggravated with two circumstances. First, it is a wide spectrum of accompanying anthropogenic and natural factors of the influence (tab. 1). Second, it is the growing interference of natural and anthropogenic sources of pollution in

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the process of decreasing cleaning ability and ecological capacity of the sea itself (Fig1).

Tab. 1. Anthropogenic and natural factors of transboundary pollution [6, 7, 8].

1. Growing scales of oil-gas extraction on the shelf of the sea.

2. Developing the salt structures in the East part of the Northern Caspian sea. These structures, which are the largest in the region, contain the extremely aggressive, poisonous sulphurous compounds: Tengis, Kashagan (the beginning of the development - 2012, capital investments above 130 billion dollars), Kayran, Aktoty (seam pressure = 850 - 1200 Atm, the capacity of a collector = up to 1000 m, t Grad. = 120-149 Grad. C., the contents of sulfur = up to 25 %). Practically all water areas of the sea are hostages of emergencies occurring in developing these deposits.

3. The geodynamic instability of the sea which has increased in the last years (data given by the Ministry of Defence of the Russian Federation and the Institute of Dynamics of Geospheres of the Russian Academy of Sciences, KaspNIRkH).

4. Pollutions (chemical, petroleum, nuclear, heavy metals), coming from the drained system of the pool (rivers the Volga, Kura, Ural, Sulak, Terek, Sefidrud, etc.), as well as the pollution connected with transgression of the sea and invasion of alien kinds such as ctenophora.

5. Coastal industrial, agricultural, municipal dumps.

6. Natural factors: griffins, mud volcanoes, hydrovolcanism, volley emissions of gas jets, "seaquakes", change of the sea level, global warming.

7. Historical pollution.

8. Transcaspian Tengis-Turkmenbashi-Baku-Tbilici-Erzrum gas pipe line.
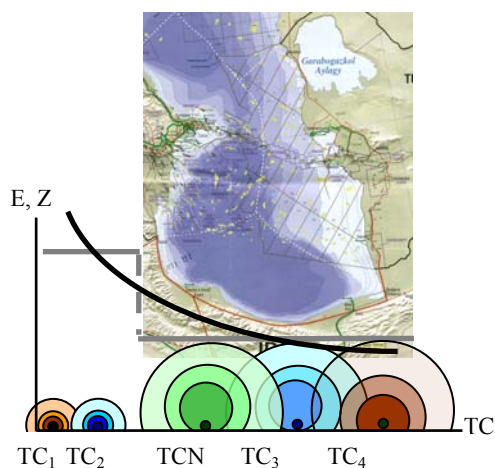

Fig.1. Dynamics of the interference of toxic complexes of natural and anthropogenic sources in process of decreasing the ecological capacity of the sea (the Middle and Southern Caspian Sea)
Symbols:
E - ecological capacity of the sea, Z - zones of distribution of toxic materials, TC_i - toxic complexes of projects of planned activity, TCN- toxic complex of a natural source of pollution.
The figure reflects the qualitative interference picture of growing interference of natural and anthropogenic sources of pollution in process of decreasing ecological capacity of the sea.

The absence of tools of scientific - methodical support of the procedure of EIET leaves wide opportunities for subjective interpretations, as well as for every possible misunderstanding in interethnic ecological conflicts.

In the report the analysis of transboundary problems of the Caspian ecology is submitted. Opportunities and defects of the existing practice of EIE using an operational experience in open reservoirs (the Northern sea, the Alyaska gulf, Mexico gulf, Persian gulf) are discussed. Suggested is a *new approach* to the decision of problems; this approach takes into account ecological features of concrete areas of the Caspian Sea. Consideration is given to the general *statement of the problem of* EIET and to the description *of the support system* of the EIET procedure realized on the basis of new *information and communication technologies. The* feature of these technologies is, that they allow carrying out fast gathering and processing of big

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files of geographically distributed data. But the main thing is that, they open a unique opportunity for reliable forecasting transboundary influences on the basis of integrated use of all last achievements in the field of sea ecotoxicology, cinecology (ecologies of communities and biogeocenoses), modeling of petroleum floods, emissions and dumps, local, regional and space monitoring, as well as a wide experience of the Caspian ecology.

1. The brief characteristic of the approach.

Problems of EIE including a problem of EIET, concern to a class of problems of ecological forecasting under the conditions of high uncertainty and risk. These problems have extremely complex interdisciplinary character. Till now there is no advanced uniform theory of EIE. In their practical activities developers of the Caspian projects are mainly guided by « the best international practice » [8] using « the system of estimated indices / indicators » of the condition of an environment (water, ground, ground depositions, flora and fauna, air) and methods of modeling of emergency of petroleum floods, emissions in the atmosphere and operational dumps. Using these tools in conditions of the Caspian sea (the closed reservoir, falling ability to autopurification, historical pollution) is not enough for solving the problem of EIET. Indices of the condition and results of modeling give estimations of separate elements of the environment, but do not give complete (holistic) picture necessary for *the long-term* analytical forecast and decision making. Attempts to use generalized estimations by formal aggregation result in "loss" of the information and the subjective interpretations frequently connected with personal, group or corporate interests of experts [9].

The decision of the question gives the new approach which takes into account the features of the Caspian Sea, as well as the experience of system, situational and script analysis and a number of principles caused by them. *The fundamental principle of "incompatibility"* **developed by L. Zade** [13] changes a research paradigm of ecological science radically.

The estimation system constructed on this basis is executed as fuzzy situational models (FSM-MODELS) of frame design [7, 9, 10, 11, 12] and is grouped in the form of a uniform system frame. The system frame can be adjusted on separate areas of the sea and for concrete periods of time. The prototypes of FSM-MODELS developed at the present time are constructed on the basis of all accessible sources of problem knowledge (books, articles, materials of conferences, reports of the Caspian Ecological Program, the published data of offshore projects of EIE, results of ecological monitoring of the contract areas of the Southern, Middle and Northern Caspian sea, opinions of experts).

As distinct from EIE-methods common in the international practice FSM-models take into account structural features of concrete Caspian biogeocenosis, laws of their reorganization (ordination, divergence, degradation seral), a degree of their "pathology", as well as the stability to additional anthropogenic loadings.

Using FSM-MODELS in procedures of EIET solves one more important practical question. It helps to proceed from a frame format of inquiries to constructive one. In the new format the general parameters of planned activity recommended by Manuals are not indicated but the concrete parameters which are necessary and sufficient for model forecasting of expected influences on a concrete touched area are pointed out.

The new approach and the FSM-MODELS realized on the basis of ICT, create methodological preconditions for realizing a uniform ecological politics in the Caspian region and more reliable estimations of transboundary consequences of planned activity.

2. Statement of the problem of EIE.

The statement of the problem of EIET determines completeness and reliability of estimations of transboundary influences substantially, as well as all further relations between the Country of an origin and the Azerbaijani Republic. Important points of this stage are, first, the account of

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specific conditions of the Caspian Sea where alongside with influences from planned activity, influences from accompanying natural and anthropogenic sources of pollution take place and, second, the account of the whole cycle of planned projects. So, for example, in case of offshore oil-and-gas projects ecological consequences of works connected with removing and liquidating designs, constructions and pipeline communications should also be taken into account.

In general the statement of the problem of EIE can be represented as follows:

$$\Delta_0(I,S) \overset{D(P,R,t_0,t_n)}{\rightarrow} \Delta_n(I,S),$$

where $\Delta_0(I,S)$ is the estimation (FSM-MODEL) of the initial condition of the environment of a touched area; $\Delta_n(I,S)$ is the forecast (FSM-MODEL) of expected influence of planned activity for the environment of touched area; P is the information about the planned activity and expected transboundary influences on the environment of the touched area; R is the information about accompanying sources of pollution (tab. 1); I are objects and indicators of influence on the environment of the touched area; S are scales of the estimation of the influence on the environment of the touched area; $D(P,R,t_o,t_n)$ is an operator of the estimation and an operator of decision making according to the results of EIE, carried out by competent organizations and community, t_0, t_n are the time of the beginning and the end of the project.

3. The system of the support of the problem of EIE.

Operator *D* is realized with the help of intellectual system of the support having branchy communications with systems of local and regional ecological monitoring, with satellite systems of remote sounding of the Earth, with the nature protection organizations of the Caspian countries, research and project institutes, services of hydrometeorological supervision, ecological departments of the petroleum companies.

On fig. 2 the PC-directed structure of the central block of the system developed for the Azerbaijan sector (shelf) of the sea is given. Physical accommodation of the block is carried out according to the established organizational rules.

4. The purposes of the development of methods of support

1. Providing ecological safety of the Azerbaijan sea sector by developing scientific fundamentals and perfecting methods of the estimation of transboundary influence of planned activity on the sector environment, as well as methods of the post project analysis and ecological monitoring of planned activity.

2. Providing scientifically - methodical support by arbitration consideration of disputes between the Country of an origin and the Azerbaijan Republic, as well as in case of interethnic ecological conflicts, inevitable in conditions of large-scale extraction and growing geopolitic tension in the region.

3. Providing governmental organizations such as MEPR and the Ministry of Emergency Measures with objective and timely information about possible extreme situations, current and potential transboundary influences of PD for taking some preventive precautions and precautions

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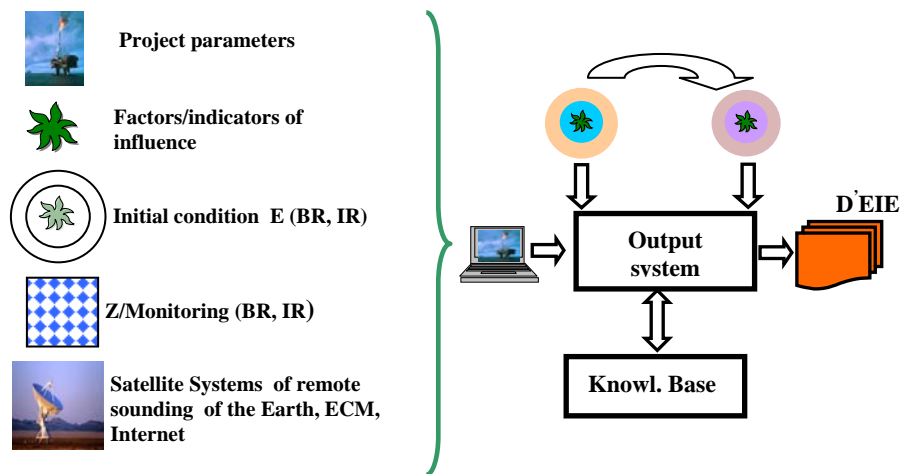www.pci2008.science.az/3/05.pdf

Fig. 2. Structure of the central block of the system of EIE.

Symbols: BR - background range, IR – influence range, A - an initial condition of an environment of a touched area, B - an expected condition of an environment of a touched area.
Knowledgebase:
1. Problem-oriented information retrieval system «Environment of the Caspian sea» (orography, topography, currents, a wind mode, thermodynamic mode, atmospheric circulation, hydrochemical fields, etc.).
2. An ecologic landscape map of an Azerbaijan sector of the sea (areas - coastal, a shelf, deep-water): <Parameters of the environment>; <Objects and indicators of the influence>;<Criteria of EIE>; <Parameters of quality of the environment>, <Scales of EIE>.
3. Ecological Passports of potential sources of pollution (including bank of «prints of fingers» and the qualifier of toxic materials in the format of HOCNF OSPARCOM (CEFAS, Great Britain).
4. Archive of projects of EIE (Internet, Public libraries).
5. Normative-methodical base of the procedure of EIE. Laws. Standards. Tools (methods, models, technologies): <Technologies of bioindication, biodiagnostics, biotesting>; <Methods of an estimation and forecasting of potentials of pollution and autopurification of areas of the sea>; <Methods of an estimation, forecasting and normalization of anthropogenic loadings on separate areas of the sea>; <Scales of an estimation of influences for separate areas of the sea>; <Technologies of identification (taking of "finger-prints") of toxic materials>; <modeling of dynamics of petroleum floods and operational dumps, methods for calculating emissions in atmosphere>;<methods of an estimation of strategic risks>; <methods of ecological forecasting in conditions of uncertainty and risk>.

of operative response.
4. Strengthening the international cooperation in the field of estimating transboundary consequences in developing plans, programs, social and economic politics, and nature protection legislations by Caspian countries .

5. Fields of application. Developed tools can be used by competent organizations of the Country of an origin and the Azerbaijan Republic, as well as by developers of projects in the

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Caspian region. They can also be used at public discussions, for storage and preservation of ecological knowledge (the Ecological chronicle of the Caspian Sea) and for including them in the ecological block *of the e-government.*

Conclusion. The objective time history of the economic development of the Caspian region, a pressing ecological situation and scales of possible negative consequences testify that the ecological researches connected with EIE, can soundly be referred to a number of fundamental and priority directions of regional science. These researches and, first of all, creating the adequate *concept of quality of environment,* will primarily determine the efficiency of further works on ecological management (ISO 14001) and all growing effort on preventing ecological accident in the region of the Caspian sea. These researches completely meet the requirements of Espo Convention: «*to pay the special attention to the development or more active performance of the concrete research programs aimed at perfection of existing methods of a qualitative and quantitative estimation of consequences of planned kinds of activity*».

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