Concept of Ensuring Environmental Human Well-Being

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Abstract. The influence of environmental factors on the population life and activities is beyond any question. Technogenic objects change the quality of the environment and influence its state. It is extremely important to take measures on control and minimization of such action with the use of modern technologies. A large number of researchers study this problem and propose their solutions based upon the principles of the program “Digital Economy”. The advantages of these projects include the line of the research targeted at the prevention of possible threats to human life and safety. The disadvantages consist in the fact that the papers consider either normal or emergency situations; besides, there is no an integral indicator used to describe the human state in such designed environment. The authors propose a Concept of human environmental well-being (HEW CONCEPT) allowing for the generation of methods, ways, algorithms and methodologies for timely identification and elimination of hazard parameters and medical aid provision with the application of modern technologies.

1. Introduction

According to the WHO’s data, the health of every human depends on one’s mode of life by 50%, the environment state by 20%, the genetic background by 20% and medicine by 10% [1]. Judging by expert forecasts, these values are going to change in the next 30-40 years, and the dependence of the human physical state and well-being on the environment state will increase up to 50-70% manifesting itself both via the genetic background and mode of life. Today medicine is virtually helpless when it comes to the environment related diseases. In Russia there are only few hundreds of doctors specializing in chemical etiology; it means they will be unable to help all people affected. That is why it is very important to start controlling the environment quality and human environmental well-being with the use of modern technologies even today.

2. Problem statement

[3] gives the definition for the term “human environmental well-being”. It is defined as “the state of population health, natural environment at which no harmful effects of such environment factors act on the human and provide favorable conditions for human life and activities”.

The authors think this definition does not fully cover the situation that changed for the last ten years and does not correspond to the applied terms. First and foremost, the population well-being consists of the well-being of separate individuals. In addition, the term “health” is rather general and is defined through physical, psychological and social human well-being without giving any definition of the human capability for any activity. In authors’ view, a more acceptable term is a “functional state of a human body” (FSB), i.e., an integral set of those human functions and traits that either directly or indirectly induce the professional activity performance. The FSB predetermines the human physical
and psychological state, progress in one’s activity, learning, creative process. Besides, one should bear in mind that the environmental well-being state is not a static parameter but rather a dynamic one; it changes in time, and so do the values of hazard parameters (HP) sourcing from technogenic objects. HP may occur both at a normal operation mode of technogenic objects and in emergency situations (ES).

Taking this into account, the authors suggest the following definition for HEW: “Human environmental well-being is a functional state of the human body and the environmental state at which HP action on the human should tend to zero against the provision of favorable conditions for the human activity”.

Providing human environmental well-being is a main task of each state. To resolve it, it is necessary to combat a set of threats using all scientific and technical achievements. Under the conditions of digitalization the Russian Federation implements the task in form of an integrative platform “Smart city”. This idea is presented in the papers of many researchers [5-8] at various levels and with various detailing. Despite all the differences in its implementation approaches, these research have a lot in common. In the first instance, it is an infrastructure making “Smart city” and not so much intended for creating a comfortable human environment as for the prevention of possible threats to human life and safety. Thus, [9] identified three clusters of key problems posing a real threat to further civilization development: nature, society and human beings. The cluster “nature” contains geophysical, biospheric and cosmologic threats, the cluster “society” - threats in a social sphere, the cluster “human” includes the threats to human safety as well as technogenic threats to nature, society and other people. [7] specifies these sources and present them in the form of social institutions providing for the human life-sustaining activity: safety, smart buildings and companies, smart transport, environmental protection, improvement, health care, education, communications, barrier-free environment, any other objects. [8] suggests and provides substantiation for the system consisting of 26 indicators combined in eight groups, on the basis of which one can identify the level of “Smart city” technology development and, correspondingly, the population safety level.

The analysis of sources [10-13] allows formulating the methodology “HEW Concepts”.

Beside common advantages, the papers have also common drawbacks. Each of the research considers either a normal situation or an emergency one and does not provide the integral indicator describing the human state in such design environment. That is why it is necessary to have a Concept of ensuring human environmental well-being and generating the methods, ways, algorithms and methodologies to timely reveal and eliminate HP and provide medical assistance, including emergency medical care (EMC) with the application of modern technologies (information&communication technology, heterogeneous groups (HG), unmanned aircraft (UAC), multiagent technology, etc.) (Concept HEW) [14].

3. Theoretical part

The problem of HEW provision is connected with a potential activity threat: “any human activity is potentially hazardous”, consequently, it is impossible to find an activity or make a technical system providing for absolute HEW. HP will always exist both in the normal situation and in the emergency one but the key point is to timely reveal them and minimize to some acceptable level if there is no way to eliminate them completely.

An acceptable (permissible) level of HEW is the level of well-being achievable on the basis of scientific, technical, economic and technological opportunities of the society. Therefore, an acceptable level of HEW is some middle ground between a desirable HEW level and the possibilities of its achievement. The graphical level of the HEW acceptable level is given in figure 1. At the increase of costs for the improvement of technology safety and equipment upgrade the HEW increases but the level of social well-being decreases. The general well-being level has some minimum providing for a specific ratio of the investments into the technical and social spheres.

The dependence of HEW level on the economic strategy has a statistical and averaged nature [15]. That is why one should consider not a minimum risk (lower point of a general curve) but some
maximum acceptable level located just higher on the curve. The interval between two values includes the region where a decision-making person has a possibility to select measures for HEW provision.

The concept is formulated for solving some theoretical or practical problem and is a set of views at the solving of problem tasks, expressed in terms of methods, methodologies, ways and algorithms of their solution as well as the tools developed for the concept implementation. The concept presence in the problem area will allow for the development of the studied problem solution methodology in the most comprehensive and consistent way. A graphical representation of the “HEW Concept” is given in figure 2.

![Figure 1. Defining acceptable environmental human well-being.](image1)

![Figure 2. Graphical representation “Concept of human environmental well-being”](image2)

The nature of “HEW Concept” consists in covering both a normal situation at the technogenic object and an emergency one as well as in the evaluation of the human state with the use of the integral indicator reflecting the level of human environmental well-being.

The methodology “HEW Concept” includes the following stages: identification of HP originating from technogenic objects, the assessment of the values including the measurement of HP values, defining permissible values for each of them, further introduction of one or several control boundaries, comparison of HP measured values with all the set limit values, formation of the options of correcting actions for a decision-making person (DMP).

HP identification means matching them to the hazard sources - technogenic objects. For HP identification the authors apply the following methods: identity method, digital number method, classifying and automatic identification methods. The HP identification system (IS) carries out a quality analysis of the company’s technological processes, equipment, raw and other materials [16, 17]. As a results the authors obtain a list containing a large number of HP (in some cases - several dozens). To identify the most significant HP, use a criterion analysis to select those which will make the most serious impact to HEW decrease out of hundreds of HP, i.e., to select the most informative ones. For this purpose, the authors use the hierarchy analysis method, ranging method and scoring method. The result of identification is the list of significant HP of this technogenic object.

The evaluation of HP values starts from the identification of their qualitative characteristics by means of direct or indirect measurements conducted by the environmental monitoring system (EMS) [18]. As for the detailed analysis the authors selected HP influencing the environment quality and the FSB and making the highest impact to the HEW decrease, the problem of staff access to the HP measurement points occurs. To eliminate a “human factor”, the measurements are organized...
remotely or with the application of robots (HG UAC) [15]. After registering actual HP values, conduct a comprehensive control (CC) of a multi-parameter object (MPO) state (technogenic object state). To do this, set a PV for each HP and, in view of this, form a multi-boundary scale of assessing the MPO state [19, 20]. Such scale should increase the efficiency and accuracy of the MPO CC.

On the basis of the results of MPO CC a subsystem for decision making support (DMC) operates. It proposes the options of control actions to DMP for normalizing a situation in the territory of increasing and/or recovery of the required HEW level.

4. Practical significance, suggestions and results of implementation

The suggested “HEW Concept” is developed with the account of using information&communication technologies and is built in compliance with a three-level scheme of information exchange:

1. 1st level – collection and processing of the raw data on the environment state and the FSB,
2. 2nd level – assessment of the obtained information and taking grounded decision on its basis,
3. 3rd level – implementation of the decisions taken.

In the framework of the platform “smart city” the authors suggest a hardware-software complex for assessing human environmental well-being (HSK HEW), developed on the basis of the “HEW Concept” and intended for monitoring the human environments and the FSB (see figure 3).

Figure 3. A functional diagram of system interaction, channels and means of communication of HSK HEW.

HSK HEW is intended for the application both in the standard operation mode of a technogenic object and in case of emergency. In the standard (accident-free) mode of operation a constant monitoring of the environment state is conducted with the use of stationary and mobile EMS components [18]. The EMS stationary components are located at the boundaries of sanitary protection zones of technogenic objects, at the sections of pollution discharge sources, i.e., in the places where environment is continuously subject to technogenic action. Mobile EMS components [18, 21] (specially equipped UAC) control the “problem” territory sections in the patrolling mode. These sections include busy crossroads, industrial city microdistricts.
All the detected data are submitted in real time to various data transmission networks and then transferred to the Center of Control and Management where they are processed in the MPO CC subsystem [15].

This subsystem implements the method consisting in the identification of several regions of normal values in the range of PV, as well as several regions of limit and off-limit values beyond the PD range.

Each region is separated by a boundary set at the level:

\[ n \cdot PV, \text{ where } n < 1 \text{ - within the PV range}; \]
\[ n \cdot PV, \text{ where } n > 1 \text{ - beyond the PV range}. \]

When a HP actual value crosses each of the formed boundaries a message is displayed on the DMP monitor; this message has the form of the HP actual value, the range of this value and color indication.

In addition, this information is submitted in the DMC subsystem and, upon the results of its work, the monitor displays the information on the necessity of implementing correction actions and suggestions of the options for such actions with the account of the HP level and the region specific features.

In case the DMP monitor displays the message that one or several HP values passes beyond the PV range this means the state of emergency occurs in the region. After that, a mobile telemedicine complex (MTC) equipped with HG UAC as part of a coordinating UAC, search UAC, environmental UAC, medical and evacuation UAC are directed to the section where the excess of HP is registered. The coordinating UAC “guides” HG UAC to a targeted emergency section, picks minor wounded and affected by means of public address, coordinates their actions for providing mutual aid, searches for the ways of escape on foot for minor wounded and affected, guides minor wounded and affected to the evacuation location, transmits information to the MTC operator.

The search UAC scans, searches for and identifies the location of the injured people, monitors and evaluates the FSB of injured people.

The environmental UAC collects data on HP in the emergency zone, minimizes the HP action levels, provides the injured people with PPE, mobile phones and monitors the emergency zone section.

The medical UAC provides medical kits with the injured people, render medical assistance by means of a medical manipulator, makes X-ray images, provides the injured people with a portable electrocardiosignal registering device and marks the injured people.

The evacuation UAC evacuates transportable injured people from the emergency section, supports life-critical functions of the injured people in the course of evacuation.

On the basis of these data a DMP manages search&rescue operations [22, 23] directing a necessary number of rescuers and medical staff to the emergency section and preparing medical organizations for the injured people admission.

5. Conclusions

A set of possibilities incorporated into HSK HEW allows resolving the main tasks at HEW ensuring:

- collect, sum up and analyze the data on the state and events at technogenic objects in real time;
- provide a DMP with all necessary data on the state of technogenic objects, their action on the environments and the FSB.
- issue recommendations for a DMP for taking measures in the situation emerging.

Introducing HSK HEW allows reckoning upon the increase in the HEW level by means of reducing health risks in the normal mode of technogenic object operation as well as decreased injury and fatality rates in case of emergency.

6. References

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