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## INVENTORY OF ENVIRONMENTAL PROBLEMS IN THE AVIATION SECTOR

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## ИНВЕНТАРИЗАЦИЯ ПРИРОДООХОРОННЫХ ПРОБЛЕМ В АВИАЦИОННОМ СЕКТОРЕ ТРАНСПОРТА

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**Introduction.** In the air transportation system air traffic is centered on airports. For the population living in the vicinity of airports, this implies involuntary exposure to a number of impacts, including the risk of aircraft accidents. Current inventory of environmental problems in the aviation sector is groups them into seven categories [1*Юшибка! Источник ссылки не найден.*]: aircraft noise, air pollution near airports, global phenomena, airport/infrastructure construction, water/soil pollution near airports, airport waste management, and aircraft accidents/incidents.

Before to consider further the inventory as a whole and one of its particular elements – aircraft accidents/incidents, we may put a look on environmental safety in general. Environmental safety is a state of the environment, which ensures the prevention of its degradation and risks to human health [2]. Environmental safety is a component of the national safety and security, which provides the protection of vital interests of individuals, society, the environment and the state of real or potential threats posed by man-made or natural factors concerning the environment [3]. At current stage of human development the main real and potential threats to the national security of any country in the environmental area are the significant anthropogenic disturbances and technological overloads, increased risks of man-made and natural disasters [4].

The risk of man-made environmental disasters at considerable extent is determined by the state of “potentially dangerous objects” or “critical objects”. Prevention of emergency situations at critical objects is provided by implementation of the system of measures to reduce their risk at these sites. Based on the possibility of man-made environmental emergencies associated with the critical objects and their negative impact on the environment and particularly on people, these facilities require special attention to their technological development, because they bear powerful man-made threats [5].

The main requirements of the emergency prevention at critical objects and infrastructures include: development of executive and organizational documents on emergency prevention; development and implementation of action plans of emergency prevention at facility; forecasting emergency situation, determine the risk of emergencies for occupational personnel and population in the surrounding area; collection, processing and delivery of information in the field of emergency prevention, protection of population and territories from dangerous effects on them; declaration of safety, licensing and liability insurance for injuries when hazardous facilities are operating; creation of the reserves of material and financial resources to emergency response [5].

Environmental safety is considered as a dynamic component of the regional system, which ensures harmonious development of the protection from real and potential anthropogenic impacts. To manage effectively the environmental safety is possible only grounding on the study of the conditions of formation and manifestations of environmental hazards, analysis of specific hazards to identify regionally significant component of danger and its sources. Environmental risk is of a complex hierarchical structure in general (Fig. 1) [6].

Technological component of environmental hazards describes the impact on people and the environment associated with technological facilities and activities. One of the most representative objects of anthropogenic impact should be allocated airports with character concentration and dominance of certain types and classes of the hazards within them.

The main objective of the system of environmental safety management is a creation and maintenance of the necessary level of protection of vital interests of all the objects of environmental safety to guarantee

favorable conditions for the safe development of the individuals, society and environment and for their sustainable development. The main element of modern system of environmental safety evaluation is an assessment of risk and account of the probability of the negative impact of various anthropogenic factors. Therefore, the primary objective of the study of environmental safety is the identification of anthropogenic factors that can lead to violation of the environmental safety, particularly of the population in the vicinity of airports.

Airports of civil aviation provide an excessive anthropogenic pressure on environment, in conditions of simultaneous presence of hazardous constituents of the different genesis, and the unfavorable positioning of their sources. Placement and functioning inside a specific area of the powerful commercial systems of different profiles, stationary objects (mechanical and galvanic stations, storages for fuels and lubricants, painting stations and pumps for pumping petroleum products, boiler installations), vehicles, cause adverse in time and place neighborhood of the significant number of hazardous factors, and significantly enhance their negative impact on population around airports. Specific dominant environmental hazards of the airports are traffic accidents, including aircraft accidents and incidents, due to their unfavorable localization relatively to the natural and human environs to which they have an impact.

In particular in [6] there is proposed a hierarchical structure of man-made hazards, highlighting the hazards generated by operating factors, with a limited number of subtypes. On the basis of fulfilled investigations this hierarchical system of hazards was extended under normal and abnormal operational conditions of the . The class of man-made environmental safety consists of hazards produced by the factors: chemical, physical, biological, landscape-transforming, informational, innovative designing, operational. In particular operational factors are defined by: malfunctions in technologies, systems and designs, human insufficient performances and errors, malfunction in informational systems, which provide the management and control of the overall human-techno-systems, conditions of outer environment, inside which the human-techno-systems are operating. Among these man-made environmental hazards the specific factors are formed, which are associated with uncontrolled withdrawal of lands near the airports for industrial and residential construction.

Abnormal conditions can lead to accidents, in fact - to traffic or aircraft accidents related to impact on environment: the risk to third party (impairments in health of the population, even fatal consequences for people living around airports); risk to wildlife, especially for birds (with reverse risk to safety in collision with aircraft); risk associated with the infrastructures surrounding the airport areas (storages of hazardous substances, pipelines, other critical objects, etc.). In such case both types—the environmental and flight safety hazards—produce the genesis of the factors, which sufficiently enhance the environmental hazards. Only a balanced approach, similar to aircraft noise control, formulated by ICAO, may efficiently manage such complicated hazardous system.

The basis of the balanced approach to the general problem of environmental protection consists of: implementation of measures to reduce the adverse effects of aircraft during their operation in environment; zoning, planning and control of land use around; monitoring levels of exposure to adverse factors inside airport area and in its vicinity; implementation of economic regulations to environmental protection, etc.

The ICAO Airport Planning Manual (Doc 9184, first published in 1999) [7] includes a discussion on third party risk issues in its Part 2 on Land Use and Environmental Control. Third party risk (TPR) is in many ways similar to local air quality and noise issues in that it impacts mainly the population living close to airports: this population gains certain economic, employment or other benefits from air traffic but is also subject to its negative effects. Noise and third party issues also carry similar implications in terms of zoning and land use planning: different levels of protection zones with respect to noise and TPR exposure can be established around airports, restricting land use and further developments. Third party risk is therefore not merely a safety issue, although the accident rates (based either on historical data or modelling and simulations) used in TPR calculations are naturally related to aviation safety. Environmental problems might arise from aircraft accidents while incidents involving dangerous goods carried as cargo are likely to occur only under exceptional circumstances. Action taken to improve aviation safety helps to reduce the likelihood of these problems. The quantities of dangerous goods carried on aircraft are so small that they only pose environmental hazards of a very localized nature. In the event of accidents, fuel spills could be of environmental concern but a fire is a much greater risk.

It is important to note that ICAO and ACARE targets and goals are not only to reduce noise levels and air pollution concentrations: the novelty of the approach is the idea that noise and air pollution reduction at receiver point are not the final objective for the society, but a tool to achieve the real final goal which is the reduction of the noise and air pollution effects. This effect is defined currently by ICAO as a reduction of the number of people affected by aircraft noise and air pollution [8]. The same approach is needed when

analyzing the effects of aircraft accident risk—the aim is to reduce the number of people affected by this risk, while there can also be damage to material assets and ecological systems.

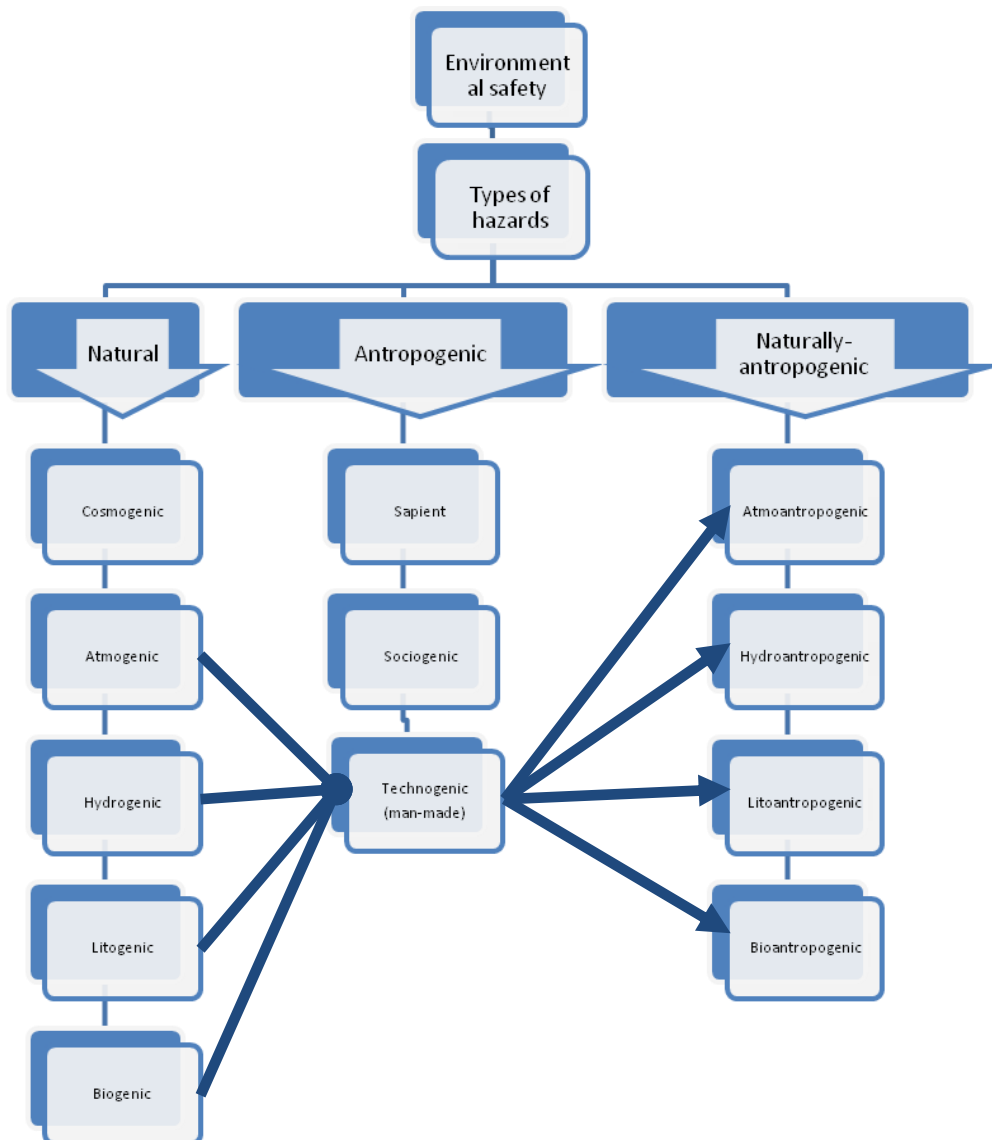


Figure 1. General hierarchical structure of environmental risk

Until recently, risks to health and life were defined largely from the purely scientific perspective, even though it has been recognized for some time that risks are commonly understood and interpreted very differently by different groups in a society, such as scientists, professionals, managers, the general public and politicians. Assessment and management of risks to human health and life is a relatively new area of study that has been expanding steadily since the early 1970s [9]. It began by focusing on developing scientific methods for identifying and describing hazards and for assessing the probability of associated adverse outcomes and their consequences. Particular attention has been given to the type and scale of the adverse consequences, up to mortality. Early studies on risk were mainly developed in the US and Europe [10].

During the early 1980s, risk analysis evolved into the two main phases of risk assessment and risk management, as more attention was given to how hazards or risk factors could be controlled at both the individual level (individual risk) and by society (societal risk) as a whole. The emphasis moved from determining the probability of adverse events for different risk factors to assessing the scale and range of possible consequences, and at the same moment reducing any uncertainties in used estimates [11]. Mortality is commonly seen as one of the most important consequences. Many risks were characterized as behavioural in origin and largely under individual control, which gave rise to the lifestyle approach in health promotion.

Risk assessment can be defined as a systematic approach to estimate the burden of disease and/or injury resulting from different hazards [8]. The first estimates of disease and injury burden attributable to a

set of different hazards were reported in the global burden of disease study [12, 13]. All the defined risk factors that were assessed were either exposures to the environment (for example, unsafe water [14]), human behaviour (for example, tobacco smoking [15]) or physiological states (for example, hypertension [16]). There was a lack of comparability between different risk factor assessments due to different degrees of reliability in assessing risk factors and lack of standard comparison between the groups.

World Health Organization (WHO) considers that transportation (road, aircraft, rail, etc.) traffic injuries are a major but neglected global public health problem, requiring concerted efforts for effective and sustainable prevention [17]. Worldwide, the number of people killed in transportation (mainly road) traffic crashes each year is estimated at over the 1 million, while the number injured could be as high as 50 million. Transportation traffic accidents are estimated to be the eighth leading cause of death globally, with an impact similar to that caused by many communicable diseases, such as malaria [18]. Forecasts for 2020 predict that this hazard will be the 3<sup>rd</sup> in rank order of disability-adjusted life years (DALYs) for the 10 leading causes of the global burden of disease [17]. At the national level transportation traffic injuries result in considerable financial costs, particularly to developing economies. Indeed, transportation traffic injuries are estimated to cost low- and middle-income countries between 1–2 % of their gross national product, estimated at over US\$ 100 billion a year [19].

Injuries represent 12% of the global burden of disease, the third most important cause of overall mortality, amounting to 2.3% of all deaths, and the main cause of death among 1–40-year-olds. Because many such deaths occur in young adults, with significant loss of life, the proportion of disease burden measured in DALYs is greater—about 2.8% of the total. According to WHO data, deaths from transportation traffic injuries account for around 25% of all deaths from injury [20]. Approaches to improving traffic safety fall into three broad groups: engineering measures (e.g. airport design and air traffic management), vehicle design and equipment (e.g. seat belts for passengers and airport runway light systems) and operational measures (e.g. speed limits, and restrictions on drinking for pilots and drivers).

Since the last major WHO world report on traffic safety issued over 40 years ago [17], there has been a major change in the perception, understanding and practice of traffic injury prevention—a shift of paradigms—among traffic safety professionals around the world. One of the main contributions to this shift is made by the approach that transportation safety is a multi-sectoral issue and a public health issue—all sectors, including health, need to be fully engaged in responsibility, activity and advocacy for traffic crash injury prevention. Traditionally, transportation safety has been assumed to be the responsibility of the transport sector, with the main focus within this sector limited to building infrastructure and managing traffic growth. In general, the public health sector was slow to become involved [21, 22].

The public health approach to transportation traffic injury prevention is based on science. The approach draws on knowledge from medicine, biomechanics, epidemiology, sociology, behavioural science, criminology, education, economics, engineering and other disciplines. Cross-sectoral collaboration is essential here, and this is something the public health sector is in a good position to promote. In all regions of the world, to prevent death and disabling injury during transportation, a traffic system better adapted to the physical vulnerabilities of its users needs to be created—with the use of better crash protected vehicles and transportation infrastructure. If greater attention in designing the transport system were to be given to the tolerance of the human body to injury, there would be substantial benefits [17]. While the health sector is only one of the many bodies involved in transportation safety—and usually not even the leading one—it nonetheless has an important role to play (see Figure 1). These include:

- discovering, through injury surveillance and surveys, as much as possible about all aspects of crash injury by systematically collecting data on the magnitude, scope, characteristics and consequences of the crashes;
  - researching the causes of traffic crashes and injuries, and in doing so trying to determine:
    - causes and correlations of crash injury,
    - factors that increase or decrease risk,
    - factors that might be modifiable through interventions;
  - exploring ways to prevent and reduce the severity of injuries in traffic crashes by designing, implementing, monitoring and evaluating appropriate interventions;
  - helping to implement, across a range of settings, interventions that appear promising, especially in the area of human behaviour, disseminating information on the outcomes, and evaluating the cost-effectiveness of these programmes;
  - working to persuade policy-makers and decision-makers of the necessity to address injuries in general as a major issue, and of the importance of adopting improved approaches to traffic safety;

- translating effective science-based information into policies and practices that protect third party individuals to transportation traffic;
- promoting capacity building in all these areas, particularly in the gathering of information and in research.

In global environmental policy deliberations, transportation safety was also recognized at the recent Rio+20 UN Conference on Sustainable Development. There a clear link was made between transportation safety and sustainable development. Encouraging sustainable transport policy must include making non-motorized forms of transport accessible and safe: 27% of global road traffic deaths are among pedestrians and cyclists (alsomay considered as third party to motorized transportation. To date, these road users have been neglected in transport and planning policy.



Figure 1 Transportation traffic injury as a public health problem [17]

The convergence of air traffic over areas surrounding airports implies for people living in the vicinity an involuntary exposure to a number of impacts, such as aircraft accidents [23, 24]. Whilst crashes with significant civilian casualties are infrequent, most aircraft accidents occur on take-off or landing [24] and people on the ground near airports run a heightened risk of death or serious injury. A fatal injury is defined as an injury that results in death within 30 days of the accident. Fatal injuries are further sub-divided into on-board fatalities and third party fatalities. If a fatality concerns persons outside the aircraft, then these are treated as third party fatalities. Accordingly, such a risk is known as Third Party Risk (TPR) when the people exposed are there for reasons unrelated to aviation, for instance people living in the airport vicinity.

**Conclusion.** There are a number of ways in which the environmental impacts of airports are currently regulated. Planning regimes and policies exist at local, regional and national levels and provide a framework that allows airports to seek permission to construct and operate facilities—runways, passenger terminals and so on—and expand to meet demand. These actions are subject to scrutiny of varying degrees. A zone policy with land use restrictions applied to domestic and commercial development and transport links based on rigorous risk assessment, consequence and cost benefit analysis (including societal risk) should underpin safety zone policy development. In TPR context, these zones are usually called Public Safety Zones (PSZs). The stated aim of this policy is: “to minimize the number of people on the ground at risk of death or injury in the event of an air crash on take-off or landing” [25,26].

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### РЕФЕРАТ

Запорожець О.І. Інвентаризація природоохоронних проблем в авіаційному секторі транспорту / О.І.Запорожець // Вісник Національного транспортного університету. Серія “Технічні науки”. Науково-технічний збірник. – К.: НТУ, 2015. - Вип. 2 (32).

В статті виконано узагальнення та порівняння відомостей щодо інвентаризації чинників довкілля в околиці аеропорту.

Об'єкт дослідження - процес інвентаризації чинників довкілля в околиці аеропорту.

Мета роботи - визначення, порівняння і обґрунтування перспектив інвентаризації чинників впливу на довкілля в околиці аеропорту, обґрунтування засобів та засобів захисту довкілля від впливу авіації.

Метод дослідження - аналіз, узагальнення та порівняння наявних відомостей про чинники впливу на довкілля в околиці аеропорту.

Використання інвентаризації чинників довкілля для їх моделювання та оцінки має відносно недавню історію. Сучасний акцент на інвентаризаційному аналізі обумовлений тим, що розроблений на сьогодні ряд так званих моделей другого покоління (наприклад, моделі PolEmiCa, Isobella, 3PRisk) для підтримки управління забрудненням повітря, шумом, безпекою, не враховує усі чинники і особливо їх особливості впливу. Результати інвентаризаційного аналізу сприятимуть більш ефективному використанню розроблених моделей на ГІС-платформах, частково через їх високу вимогу стосовно даних, як просторових, так і часових.

Результати статті можуть бути впроваджені в процесі експлуатації авіатранспортних засобів в умовах інтелектуальних транспортних систем.

**КЛЮЧОВІ СЛОВА:** АЕРОПОРТИ, ШУМ, МІСЦЕВА ЯКІСТЬ ПОВІТРЯ, БЕЗПЕКА, РИЗИК ТРЕТЬОЇ СТОРОНИ

### ABSTRACT

Zaporozhets O.I. Inventory of environmental problems in aviation sector. Visnyk National Transport University. Series “Technical sciences”. Scientific and Technical Collection. - Kyiv. National Transport University, 2015. - Issue 2 (32).

In the paper the synthesis and comparison of the available information on Inventory of environmental factors in the vicinity of the airports presented.

Object of study - the process of inventory of environmental factors around the airport.

Purpose - to identify, compare and study the prospects for inventory of the environmental impact factors in the vicinity of the airports.

Research methods - analysis and comparison of available information on the factors impacting the environment in the vicinity of the airport.

The use of inventory results for exposure modelling and assessment has a relatively recent history. The current emphasis on inventory analysis is due to the fact, that so-called second-generation models have been developed (eg, PolEmiCa, Isobella, 3PRisk) to support noise and air pollution and safety management, does not account for all factors and especially their impact features. To date the results of the inventory analysis will contribute to a more efficient usage of the developed models on GIS-platforms, partly because of their high demand on data, spatial and temporal.

The results can be incorporated into the operation of aviation vehicles in intelligent transportation systems.

**KEYWORDS:** AIRPORTS, NOISE, LOCAL AIR QUALITY, SAFETY, THIRD PARTY RISK

### РЕФЕРАТ

Запорожець А.И. Инвентаризация природоохранных проблем в авиационном секторе транспорта / А.И. Запорожець // Вестник Национального транспортного университета. Серія "Технические науки". Научно-технический сборник. – К.: НТУ, 2015. - Вып. 2 (32).

В статье выполнено обобщение и сравнение сведений по инвентаризации факторов окружающей среды в окрестности аэропортов гражданской авиации.

Объект исследования - процесс инвентаризации факторов окружающей среды в окрестности аэропорта.

Цель работы - определение, сравнение и обоснование перспектив инвентаризации факторов воздействия на окружающую среду в окрестности аэропорта, обоснование средств и средств защиты окружающей среды от воздействия авиации.

Метод исследования - анализ, обобщение и сравнение имеющихся сведений о факторах влияния на окружающую среду в окрестности аэропорта.

Использование инвентаризации факторов окружающей среды для их моделирования и оценки имеет относительно недавнюю историю. Современный акцент на инвентаризационном анализе обусловлен тем, что разработанный на сегодня ряд так называемых моделей второго поколения (например, модели PolEmitCa, Isobella, 3PRisk) для поддержки управления загрязнением воздуха, шумом, безопасностью, не учитывает все экофакторы и особенно их особенности воздействия. Результаты инвентаризационного анализа будут способствовать более эффективному использованию разработанных моделей на ГИС-платформах, частично из-за их высоких требований к данным, как пространственным, так и временным.

Результаты статьи могут быть внедрены в процессе эксплуатации воздушных средств в условиях интеллектуальных транспортных систем.

**КЛЮЧЕВЫЕ СЛОВА:** АЭРОПОРТЫ, ШУМ, МЕСТНОЕ КАЧЕСТВО ВОЗДУХА, БЕЗОПАСНОСТЬ, РИСК ТРЕТЬЕЙ СТОРОНЫ

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