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ORIGINAL PAPER

LOGISTIC SUPPORT FOR A RESCUE OPERATION IN THE ASPECT OF MINIMIZING THE ECOLOGICAL FOOTPRINT AS AN ENVIRONMENTAL REQUIREMENT WITHIN SUSTAINABLE DEVELOPMENT ON THE EXAMPLE OF A NATURAL DISASTER

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ABSTRACT. **Background:** The aim of the considerations is to present the concept of the ecological footprint of logistic support for a rescue operation on the example of a natural disaster. Increasing pressure of environmental requirements placed on all logistic activities, including logistic support, justifies the attention drawn to the subject.
Methods: Selecting a natural disaster – as a reference for the concept of the ecological footprint – constitutes an attempt to draw attention to the fact that logistic support for a rescue operation in the case of a natural disaster – apart from an unquestionably positive role – also negatively affects the environment, which should be exposed, and this will be manifested by creation of measuring and analysing instruments necessary within undertaken activities aimed at minimalization of the negative impact of logistic support on the environment. The ecological footprint can be considered to be such an instrument.
Results: Based on the general formula of the ecological footprint and its methodology presented in "Working Guidebook to the National Footprint Accounts 2014", a formula of the ecological footprint of logistic support for a rescue operation on the example of a natural disaster was created.
Conclusions: The assumptions of the concept of the ecological footprint of logistic support for a rescue operation on the example of a natural disaster were based on the assumptions of logistic support for a rescue operation and on the assumptions of the resource concept and external costs of logistic support for a rescue operation on the example of a natural disaster.

Key words: sustainable development, logistic support, natural disaster, ecological footprint, environmental protection.

INTRODUCTION

Progressing and deepening climate changes cause natural disasters with increasing frequency. According to the EM-DAT [2017] data between 2000 and 2016 in Europe nine hundred eleven natural disasters occurred. It is seventy times more than one hundred years ago, i.e. between 1900 and 1916, when thirteen natural disasters occurred. Annually, the global economy loses 250-300 billion USD as a result of natural disasters.

The term of a natural disaster has not been given an unambiguous meaning. According to the definition of the United Nations, implementing the International Catastrophe Reduction Strategy, a natural disaster is a situation involving a serious disruption in the functioning of the community or society related to human suffering, material, economic or environmental loss, or an impact that exceeds the capacity of the aggrieved community or society to deal with, using their own resources [UNISFR Terminology…,

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2009]. CRED defines a disaster as "a situation or event [which] overwhelms local capacity, necessitating a request to a national or international level for external assistance; an unforeseen and often sudden event that causes great damage, destruction and human suffering." [Disaster Types…, 2017]. A natural disaster can be determined as an event related to the forces of nature, in particular such as atmospheric discharges, seismic shocks, strong winds, heavy atmospheric precipitation, prolonged occurrence of extreme temperatures, landslides, fires, droughts, floods, ice phenomena on rivers and the sea as well as lakes and reservoirs, the mass occurrence of pests, plant and animal diseases or infectious diseases of people or the action of another element. The complete EM-DAT [2017] divides disasters into 2 categories (natural and technological), and further divides the natural disaster category into 5 subcategories, which in turn cover 12 disaster types and more than 30 subtypes. The principal categories and subcategories are shown below.

Table 1. The principal categories and subcategories of the natural disasters

No.	Category		Definition	Subcategory/Types
1	Biological		Disaster caused by the exposure of living organism to germs and toxic substances	Epidemic – Viral infectious disease, – Bacterial infectious disease, – Parasitic infectious disease, – Fungal infectious disease, – Prion infectious disease. Insect infestation Animal stampede
2	Geophysical		Events originating from solid earth	Earthquake Volcano Mass movement (dry) – Rockfall, – Landslide, – Avalanche, – Subsidence.
3	Hydrometeorological	Hydrological	Events caused by deviations in the normal water cycle and/or overflow of bodless of water caused by wind set-up	Flood – General flood, – Strom surge/coastal flood Mass movement (wet) – Rockfall, – Landslide, – Avalanche, – Subsidence.
		Meteorological	Events caused by short-lived/small to meso-scale atmosphere processes (in the spectrum form minutes to days)	Storm – Tropical cyclone, – Extra-tropical cyclone.
		Climatological	Events caused by long-lived/meso- to macro-scale processes (in the spectrum from intraseasonal to multi-decadal climate variability)	Extreme temperature – Heat wave, – Cold wave, – Extreme winter condition, Drought/wildfire – Forest fire, – Land fire.

Source: EM-DAT, 2017

The intensifying impact of natural disasters and the related increasing economic, environmental and social constraints require the use of various instruments and tools to eliminate or mitigate their effects [Pelling et al. 2020, Noy 2009, Hallegate and Przyluski 2010, Weihua et al. 2017]. Logistics offers great potential in this respect. Logistics provides not only a comprehensive and systematic approach to the problem of natural disasters, especially rescue actions or elimination of consequences, but through appropriate logistical support can cause that the actions taken will be effective and efficient [Hollstein Ch., Himpel F., 2013].

Logistic support in the general perspective includes logistic services, materials and

transport necessary to implement specific operations [DoD 2017, NATO 2012, Pinzariu 2012]. In the general perspective logistic support in this sense includes planning, organizing and implementation functions, the subject of which are material resources (among others ensuring deliveries, availability of the infrastructure and superstructure, testing of devices, maintenance), infrastructural, human (among others, ensuring labour force, training support), informative, and references are specific programs or projects (it can be assumed that it is an object of impact), and to be more precise – all stages of their life cycle.

A logistic support system is required to keep the installed base available. When a system of the installed base fails, the logistic support systems is responsible for the repair of the system. Because of high-downtime costs for capital goods, in general the repair is done by replacing the failed component from the system by a spare part. As a result, the system is operational within a short period of time. Thereafter, the failed component is either repaired or discarded [Kusters 2012].

B.S. Blanchard uses the term of integrated logistic support which – based on the approach used in military logistics – is understood as a deliberately organized subsystem of the technical system supporting its basic process by integrating all operations related to an effective and beneficial flow of necessary material resources and information as well as supporting service of the operation process in terms of ensuring the supporting, controlling and measuring equipment necessary for this process [Blanchard 2002, 2013]. Blanchard indicates that integrated logistic support is required to ensure effective and economic support for the system being the object of impact at all stages of its life cycles [Blanchard 2013]. J. Jones [2006] presents integrated logistic support as a methodology for process analysis and management (created based on the systemic approach) used to achieve a measurable result (purpose) fulfilling the condition concerning the acceptable level of costs. Operational elements of logistic support are deliveries, transport, maintenance and training.

The integrated logistics support is concerned with the efficiencies achieved by systematic planning, implementation, and management of maintenance and logistics support resources throughout a system's useful life. In many cases, the impact of maintenance and logistics support factors will directly affect decisions made in equipment selection and/or design. In some cases, it can be the controlling issue in the selection and/or design process. For this reason, the integrated logistics support process is required to be initiated as early as possible in the planning stages of a project, due to the critical nature and potential impact of maintenance and logistics factors on the overall project costs, performance, and reliability. [Maintenance, Logistics and Fecilities … 2017]

In crisis situations logistics differs from civil logistics and military logistics in its essence both in terms of potential recipients/customers (target group) of logistic services, assumed requirements to handle the target group as well as purposes to be achieved and optimization criteria [Brown and Vassiliou 1993, Kash and Darling 1998, Kovacs and Spens 2007, Perry 2007, Leiras et al.2014]. In his opinion, carrying out operations in crisis situations, e.g. a rescue operation, involves synergy, coordination and synchronization of activities of public administration bodies, rescue formation units and external contractors supporting rescue forces to a greater or lesser extent depending on the severity of operations and existing threats. Logistics of a rescue operation deals not only with the subject of delivery and provision of specialist services and economic and utility services for the victims. It also deals with logistic security of entities (teams, units, institutions) carrying out rescue operations and preventive operations as well as with logistic aspects of operations related to reconstruction of facilities within the critical infrastructure, transport infrastructure, etc., however the subject is perceived from a different perspective that logistic security of the victims and it is accompanied by different (specific) procedures [Nowak and Nowak 2009].

In terms of sustainable development, which determines an increasing number of fields of

social and economic activities [Waas et al. 2011, Hopwood 2005], logistic support should be ensured at a level allowing the so-called ecological footprint to be decreased [Ransom 2002]. The concept of the ecological footprint [Wackernagel and Rees 1996, Wackernagel 2005, Wackernagel et al. 1999, Yin and Han, Wu 2017] allows the human pressure on the environment to be evaluated through the scope of consumption of goods and services. The value of the ecological footprint determines the surface area of a biologically productive area necessary to fulfil the life needs of the population of people, taking their lifestyle into account. The ecological footprint constitutes a conversion of economic activities motivated by satisfying people's needs for the sectoral expressed ecological functions enabled or conditioned by these activities. Such a conversion requires the area taken directly or used in the case of a given technology, necessary to obtain resources required for an individual, society or any studied population to live to be estimated [Wiedmann and Barrett 2010, Venetoulis and Talberth 2008]. Today the analysis of the ecological footprint is commonly used to measure our dependence on nature and the indicator of the degree of sustainable development [Gu and others 2015, Liu et al. 2015, Wu and Liu 2016, Yue and others 2016, Szopik-Depczyńska et al. 2017].

The purpose of the considerations is to present the concept of the ecological footprint of logistic support for a rescue operation on the example of a natural disaster. Selection of this subject is justified by increasing pressure of environmental requirements placed on all logistic activities, including logistic support. Selecting a natural disaster – as a reference for the concept of the ecological footprint – constitutes an attempt to draw attention to the fact that logistic support for a rescue operation in the case of a natural disaster – apart from an unquestionably positive role – also negatively affects the environment. Such effects should be effectively exposed, which is manifested in the creation of measuring and analysing instruments required when undertaking activities aimed at minimalization of the negative impact of logistic support on the environment. The ecological footprint can be considered to be a useful instrument in this aspect.

MATERIALS AND METHODS

Developing the concept of the article, a review of world literature was conducted to verify whether the concept of the ecological footprint of logistic support for a rescue operation on the example of a natural disaster has already been developed and what its assumptions are. A gap in this scope was found which gave the basis to commence works on the concept. The assumptions of the concept were based on the following research areas: crisis management, logistics in crisis situations, military logistics, logistic support, sustainable development, ecology, ecological footprint. Also, a review of legal regulations, national regulations and regulations of the European Community concerning natural disasters was performed. To create a formula of the ecological footprint of logistic support for a rescue operation in the case of a natural disaster, the general formula of the ecological footprint and its methodology presented in "Working Guidebook to the National Footprint Accounts 2014" [Working Guidebook to the National… 2014] was used.

The considerations are of a theoretical and conceptual nature. First, a set of activities, which can be implemented within logistic support for a rescue operation in the case of a natural disaster was determined. Then, the resource approach of the activities was applied. The assumptions of the analysis of resource intensity and negative external effects of logistic support for a rescue operation in the case of a natural disaster, which became the basis for the assumptions within the concept of the ecological footprint of logistic support for a rescue operation on the example of a natural disaster were subsequently presented.

RESULTS

Logistics is a process involving planning, implementation and monitoring of an efficient and economically effective flow of resources, funds and materials from the point of origin to

the point of consumption to meet the customer's needs. Translating the definition to the needs of rescue services, it can be said that logistics is a process of planning and implementing the approved procedure at the location of a disaster. A rescue operation means rescue activities, works aimed at rescuing people in danger and property in the case of an accident, failure or disaster. Therefore, logistic support for a rescue operation in the case of a natural disaster constitutes a large set of various operations, such as:

- forecasting, acquiring and ordering the necessary resources needed to carry out the rescue operation,
- asset status monitoring (asset tracking),
- storing resources,
- stock-taking,
- establishing and coordinating areas of logistic positions and operations of distribution points within the service area (area of the rescue operation),
- deployment, displacement of resources within the service area (area of the rescue operation),
- management of transport and traffic control units within the service area (area of the rescue operation), including among others developing a traffic plan, setting priorities, coordinating traffic and tracking traffic, ordering and acquiring resources and transport services, development of time schedules for traffic (schedule), organization of night stands for vehicles, emergency towing and repair, determination of fuel, oil and water tanks,
- creating maps of the service area (area of the rescue operation),
- development of staff response guidelines,
- re-use or disposal of materials,
- demobilization within the service area (area of the rescue operation),
- documenting all transactions.

The functional area of logistic support for a rescue operation in the case of a natural disaster also involves determination of the location and choice of facilities (buildings, structures), management of available space and – depending on the needs – construction services both for stationary and portable facilities. Moreover, in the case of evacuation rescue operations logistic support is responsible for evacuation operations of the population, including delivery of certain transport assets – delivery vehicles, buses, planes, ships, trains, trucks, etc., for the special needs of the evacuated population, helping fulfil the needs related to mass traffic, assistance in coordinating entities providing first aid and assistance in the form of mass care in terms of temporary shelter, management of rest areas, provision of food and water, provision of humanitarian services, as well as identification of facilities and management of places for mass care of displaced people. The scope and type of logistic support for a rescue operation in the case of a natural disaster depends on the size, complexity and difficulty of a disaster.

Citing the concept of the life cycle of a natural disaster, we can list:

- the stage before a disaster, involving preventive and planning operations,
- the stage of a disaster,
- the stage after a disaster, involving operations related to elimination of its consequences.

Therefore, logistic support plays an important role before a disaster and at the stage of its consequences, as the preventive role of logistics ensures the possibility to manage the course of the disaster and to effectively undertake activities eliminating its consequences [Marzantowicz 2016].

Logistic support for a rescue operation in the case of a natural disaster does not have a subjective nature, as in the case of military logistics or logistics in light of steering the process in the delivery chain. The key aspect in considering logistic support for a rescue operation in the case of a natural disaster is analysing the course of the operation in light of the demand for resources, and therefore in the aspect of the subjective approach (table 2) with the condition to fulfil the postulate of efficiency and effectiveness of activities within logistic support.

Table 2. Characteristics of operations within logistic support for a rescue operation in the case of a natural disaster in light of using logistic resources

No	Resource	Demand	Access	Characteristics
1	Material resources	In terms of infrastructure: built-up areas to provide shelter, open spaces, providing communication passageways In terms of superstructure: Means of transport, rescue equipment In terms of assistance: Medical supplies, food, access to hygiene, providing access to water, electricity and heat	Public buildings, natural areas as convergent points in non-hazardous places, public transport and medical transport.	The central crisis management body at a rapid pace considered and ensured the possibility of directing victims to the points where basic medical care was provided and basic needs were met. The rescue operation used public funds, and in terms of superstructure, private enterprises and the local community joined up to help.
2	Financial resources	Providing funds for real needs in a state of disaster and providing funds for prevention and programs supporting risk reduction management - public funds and private funds	Funds included in the state budget, budget reserve, EU assistance funds related to programs for sustainable development, Budget subsidy funds	Public funds to implement rescue operations were organized and ensured, but also a rescue fund for uninsured people was provided. Central budget funds and budget reserve resources of local government units reserved for the needs of eliminating the consequences of the disaster and providing logistic support.
3	Human resources	In terms of assistance: Doctors, paramedics, emergency services, army, fire brigade, specialists in crisis management, police, veterinary services. In terms of organization: Help centres, information centres, management centres	Main crisis management centre and regional centres - industry specialists	All emergency services, army, police and humanitarian organizations participated in the rescue operation. Control of the help processes took place from the Crisis Management Center, which consisted of industry specialists.
4	Informative resources	Media, information corridors, information control, real-time access, information on centres and help places, information on the availability of public buildings	Information flow in nationwide and local media	Information about the assistance processes and the current state of the disaster was transmitted in real time by the media – obliged to distribute information to local media. The management centre had information on the availability of infrastructure and superstructure. No information about the possibilities of relocation of the victims.

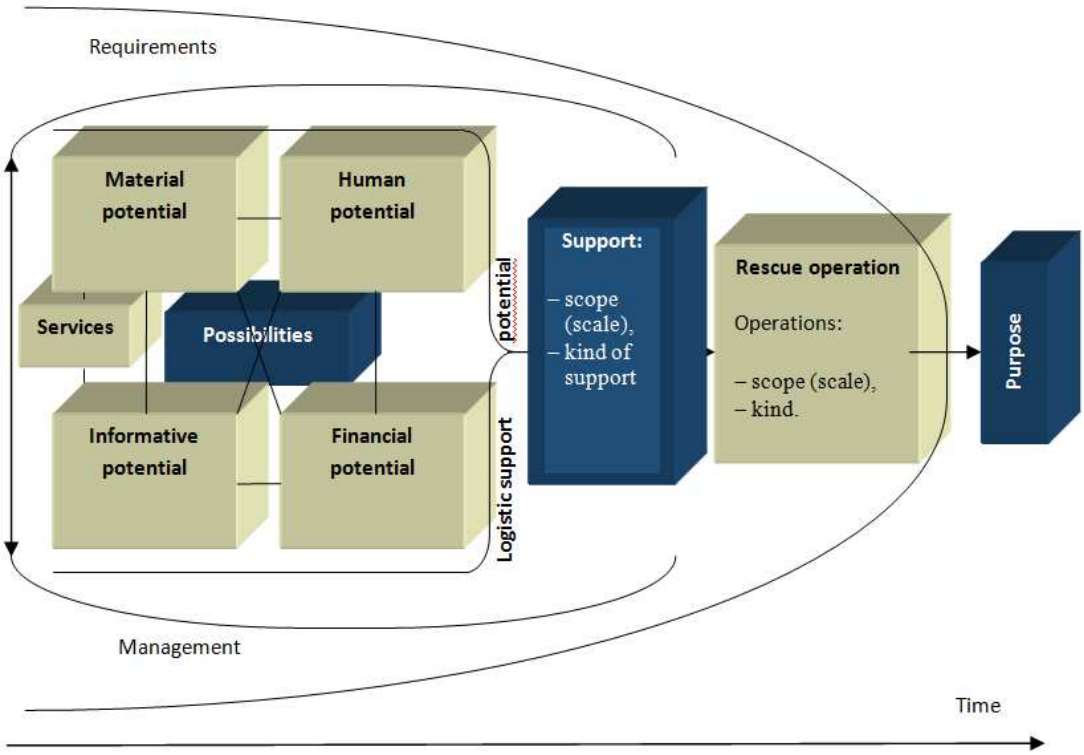
Source: own elaboration

Logistic resources and logistic possibilities are often determined as a logistic potential. From a narrow perspective, logistic resources can be identified as logistic streams. From a broader perspective, service resources should also be taken into account. From a general perspective, we can talk about a logistic potential as:

- material potential - materials, natural resources, superstructure, infrastructure;
- human potential – employees, advisers, experts, decision-maker;
- informative potential – data, information, message, instructions, knowledge;
- financial potential,
- service potential – transport, storage, management.

Possibilities within logistics can be interpreted in the category of capabilities or manners created or used in logistics. The concept of the logistic support potential of a rescue operation in the case of a natural disaster is presented in fig. 1.

The analysis of using logistic resources indicates the possibility to determine the level of effectiveness of logistic support, especially in terms of resource intensity of support processes. The impact of logistic support on the success of a rescue operation in the case of a natural disaster depends on the type and scope of the disaster on one hand, and on the other – on the access to logistic resources and the possibilities and efficiency of managing them. The main task of logistic support for a rescue operation in the case of a natural disaster is to use available resources in a way allowing efficient management of a rescue operation. It is possible in the situation when efficiency in resource flow streams in limited time and in given space is ensured.



Source: own elaboration

Fig. 1. Schematic diagram of a logistic support potential of a rescue operation in the case of a natural disaster

DISCUSSION

Understanding and respecting environmental principles of sustainable development, one should pay attention to the fact that logistic support for a rescue operation in the case of a natural disaster negatively affects the environment (fig. 2). The term "affect" is commonly used when discussing the subject of relations between human activity and the natural environment. For the needs of further considerations, it can be assumed that "affect" means "impact". The natural environment, and to be more precise resources creating it, and logistic support for a rescue operation in the case of a natural disaster are understood as an object of impact and logistic support for a rescue operation in the case of a natural disaster as an influencing object. Depending on the direction, impact may have a supplying nature, when resources fulfil the role of objects supplying logistic support, and a generating nature, when logistic support for a rescue operation in the case of a natural disaster is an object generating external effects, and the environment fulfils the function of an absorbent.

Evaluation of a negative impact of logistic support for a rescue operation in the case of a natural disaster on the environment can be carried out concerning the diversity in time and space, and it may include various elements and scopes. Their selection depends most of all on the purpose for which they are made. Treating the natural environment as a set of resources, the basic area of analysis of such impact is determined by the structure of the resources. In other words, the study will involve considerations whether logistic support for a rescue operation in the case of a natural disaster affects a specific resource or not, and in a more detailed scope, what activity within logistic support for a rescue operation in the case of a natural disaster affects a given resource (fig. 3). Such a specification of the analysis is justified.

Negative impact of logistic support for a rescue operation in the case of a natural disaster on the environment should be presented symmetrically. This means that the analysis should involve supplies of logistic support for a rescue operation in the case of a natural disaster (various forms of logistic support) with environmental resources at each stage of the life cycle on one hand, and on the other – negative external effects generated by logistic support for a rescue operation in the case of a natural disaster (various forms of logistic support).

The scope of the analysis and evaluation of the impact of logistic support for a rescue operation in the case of a natural disaster on the environment can be even broader. Later, the use of characteristics, such as impact, area of impact, durability of impact effects, measurability of impact effects, can be considered. The valuable expression of impacts, especially in the cost category, is also justified. All the characteristics allow us not only to get to know the impact as a process better, but they also allow their evaluation and for the comparative analysis to be carried out.

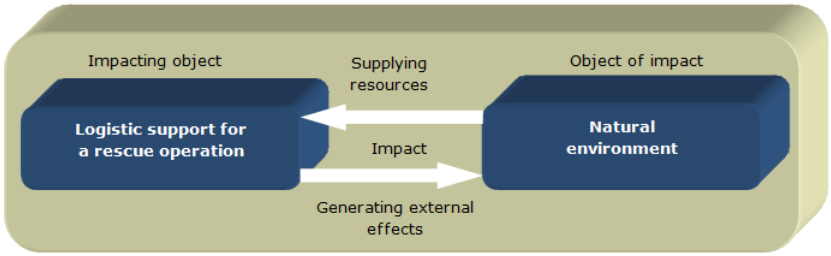


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Fig. 2. Simplified model of interactions between the environment and logistic support for a rescue operation in the case of a natural disaster

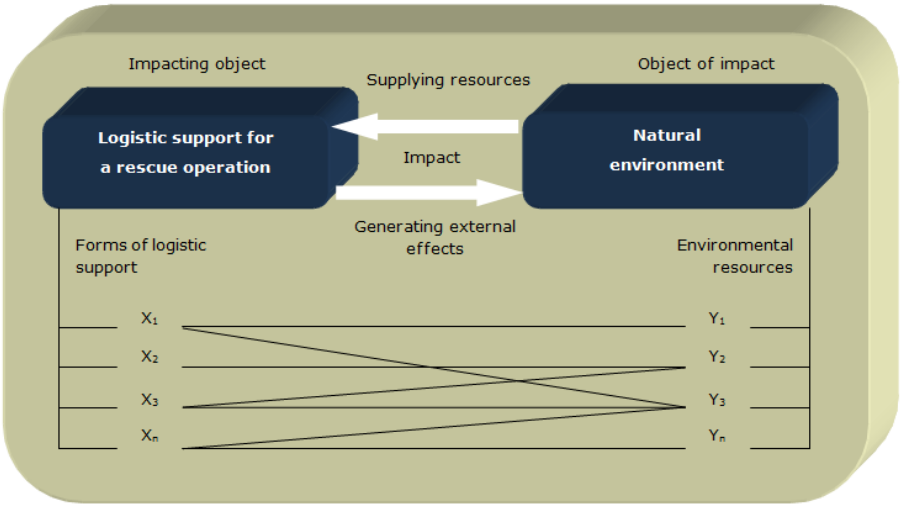

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Fig. 3. A model view of the analysis of interactions between the environment and logistic support for a rescue operation in the case of a natural disaster

Use of environmental resources for the needs of logistic support for a rescue operation in the case of a natural disaster, as mentioned before, can be perceived in the category of supplies, while their amount needed or used can be perceived in the category of intensity. Resource intensity of logistic support for a rescue operation in the case of a natural disaster, and actually a specific operation implemented within logistic support for a rescue operation indicate the scope of use of resources, which means that it is a measurable characteristic. In relation to the fact that to measure the use of particular resources various

measuring units are used, in practice determination of resource intensity of logistic support for a rescue operation as a complex measure is not possible. Therefore, it can be presented as a component of the following intensity types (fig. 4): land use, energy consumption, material consumption, which can be referred to each operation within logistic support for a rescue operation in the case of a natural disaster. The basic scope of the analysis of supplies of logistic support for a rescue operation in the case of a natural disaster with resources of the natural environment, apart from the structure and scope, also involves intensity of supplies. Therefore, it allows specification of not only what is needed and in what quantity to implement a specific task within logistic support, but also with what frequency. Characterization of determinants for such characteristics is also justified.

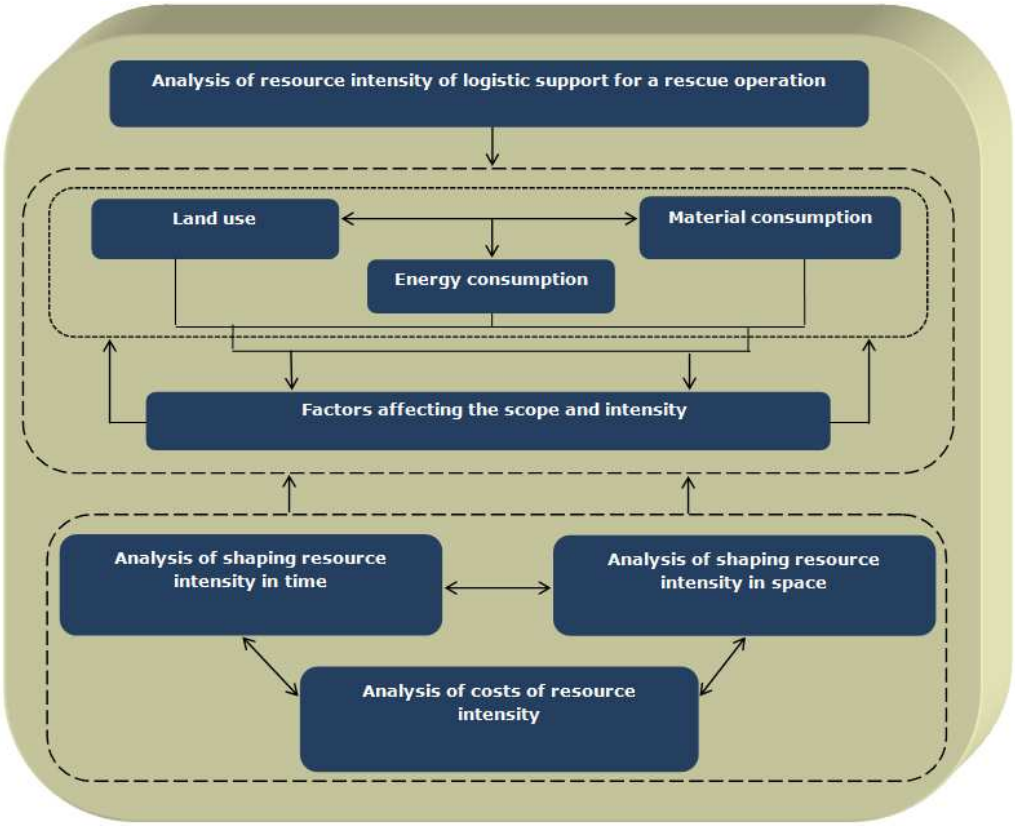

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Fig. 4. Concept of the basic scope of the analysis of the structure of supplies for logistic support for a rescue operation in the case of a natural disaster with resources of the natural environment

As a result of implementing logistic support for a rescue operation in the case of a natural disaster external effects are generated. It is generally assumed that a person, a system, a process or an operation contributes to external effects. It takes place when operations are undertaken which do not have positive or negative results for other people or systems, which in turn do not pay for them or do not receive any compensation. Based on such understanding of external effects, for the needs of these considerations, negative external effects of logistic support for a rescue operation in the case of a natural disaster can be defined as undesirable and destructive consequences of logistic support for a rescue operation, experienced by the natural environment, which does not receive any compensation.

There are various forms of negative external effects of logistic support for a rescue operation in the case of a natural disaster (fig. 5). They include: noise, vibrations, sewage,

waste, dust and gases, electromagnetic fields, fragmentation of the spatial structure of the landscape. The form of negative external effects obviously depends on the type of operations implemented within logistic support for a rescue operation in the case of a natural disaster. In other words, a given operation within logistic support for a rescue operation does not have to generate all listed negative external effects. Negative external effects of logistic support for a rescue operation in the case of a natural disaster can be identified at various impact levels (reference impact), such as: air, water, soil, space, landscape, acoustic climate, animate and inanimate nature.

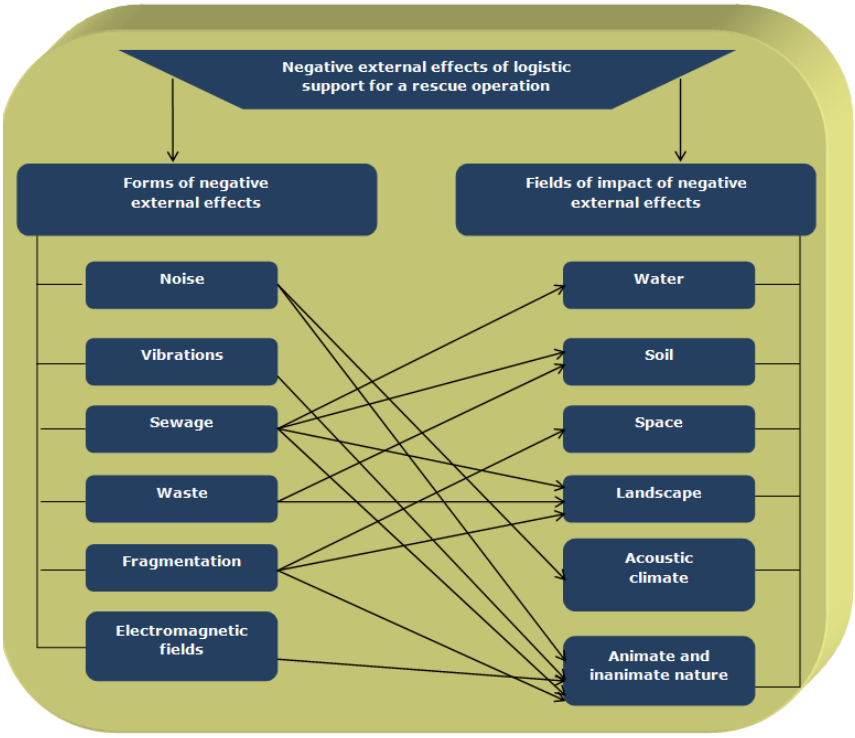

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Fig. 5. Forms and fields of impact of negative external effects of logistic support for a rescue operation in the case of a natural disaster

To measure negative effects of logistic support for a rescue operation in the case of a natural disaster various methods more or less precise – can be used. The ecological footprint is one of such methods. The ecological footprint of logistic support for a rescue operation in the case of a natural disaster shows a demand for natural resources, i.e. it determines how many biologically productive lands and marine areas is necessary to ensure resources necessary to implement activities within a rescue operation and to assimilate waste related to such activities.

The ecological footprint of logistic support for a rescue operation in the case of a natural disaster as a standardized measure of the demand for Earth's ecosystem resources can basically be calculated for a specific time interval or for a given rescue operation. From the practical perspective, the second approach is more useful, not only because it is easier to make calculations, but also because it allows for various comparisons to be made, e.g. comparisons made in time, comparisons between particular types of disasters, comparisons between rescue operations in the case of the same disasters but occurring in various areas. Assuming such an approach, one must state that the ecological footprint of logistic support for a rescue operation in the case of a natural disaster will be a sum of ecological footprints of particular tasks within logistic support for a rescue operation in the

case of a natural disaster, which can be presented as the following formula:

$$EF_L = \sum(EF_{l_1} + EF_{l_2} + \cdots + EF_{l_n})$$

where:

EFL – the ecological footprint of logistic support for a rescue operation in a natural disaster,

EFl – the ecological footprint of a logistic activity (task) performed within a given rescue operation in the case of a natural disaster,

n – the number of logistics activities that make up a given rescue operation.

The formula to calculate the ecological footprint of logistic support for a rescue operation in the case of a natural disaster (EFL) can be assumed based on the method presented in "Working Guidebook to the National Footprint Accounts 2014" [38]:

$$EF_L = \frac{P}{Y_n} \times YF \times EQF$$

where:

FL – the ecological footprint of logistic support for a rescue operation in a natural disaster,

P – the annual production or emission of waste generated during the implementation of logistic support for a rescue operation in the case of a natural disaster,

Yn – the national average production of good or waste emission,

YF – the quotient of Y and global average production / emission,

EQF – the equivalent of the area used for production / emission presented in the world average biologically productive unit area (ha).

It can be assumed that the ecological footprint of logistic support for a rescue operation in the case of a natural disaster is a sum of the following elements of land management:

- the area of arable land needed to obtain the crops necessary to produce food used as part of logistic support for a rescue operation in the case of a natural disaster,
- pasture area needed for breeding animals to produce food used as part of logistic support for a rescue operation in the case of a natural disaster,
- area needed to obtain natural resources used for logistical support of a rescue operation in the case of a natural disaster in a processed or unprocessed form (e.g. as a raw material to produce materials, equipment, devices, means of transport, fuel),
- forest area needed to obtain wood and paper used for logistic support for a rescue operation in the case of a natural disaster,
- area of marine fishery needed to obtain living resources of the seas and oceans used for logistic support of a rescue operation in the case of a natural disaster,
- area occupied by construction and roads used for logistic support for a rescue operation in the case of a natural disaster,
- area of greenery and terrain needed to assimilate CO_2 resulting from the implementation of the logistical support activities for a rescue operation in the case of a natural disaster.

The elements listed above can be treated as basic elements or universal elements as they will constitute a component of the characteristics for logistic support for a rescue operation regardless of the kind of natural disaster. This means that it is possible to specify elements of land management, which will be specific for a given kind of natural disaster. For instance, for floods such elements are areas of temporary or new housing for flood victims, areas used for the needs to create temporary transport infrastructure (temporary access roads to the areas covered by the flood), areas used to store consumables used during a rescue operation (e.g. sandbags).

Principles of sustainable development, in particular principles for the environmental area, require reduction of the ecological footprint, which obviously is a natural requirement for the ecological footprint of logistic support for a rescue operation in the case of a natural disaster. Previously, it was

observed that the general determinant shaping the scope of the ecological footprint of logistic support for a rescue operation in the case of a natural disaster is the kind of natural disaster. It is a determinant people basically cannot affect. However, the level of the ecological footprint of logistic support for a rescue operation in the case of a natural disaster also depends on the management method which is a factor affected by people, as knowledge, skills and experience of people involved in the process of managing logistic support for a rescue operation in the case of a natural disaster play a decisive role. Therefore, decreasing the ecological footprint of logistic support for a rescue operation in the case of a natural disaster can be achieved by increasing reliability, accuracy, effectiveness of activities within a rescue operation as well as by intensification of forecasting and diagnostic operations.

Formal and legal regulations should refer to efficiency and effectiveness of the logistic support system for a rescue operation in the case of a natural disaster. With such an assumption, it is possible to determine the basic requirements for formal and legal regulations in terms of logistic support for a rescue operation in the case of a natural disaster, such as:

- there is a need to determine the scope of using logistic resources consisting the potential of logistic support of a rescue operation in the case of a natural disaster,
- there is a need to integrate the territorial division of responsibility in the logistic support system for a rescue operation in the case of a natural disaster with the functional division, taking the use of logistic resources available in time into account,
- there is a need to determine communication principles in terms of the functional division of tasks within logistic support for a rescue operation in the case of a natural disaster, taking the level of logistic resources held into account,
- there is a need to include specialists-logisticians in the competencies of teams appointed within response centres and in the scope of crisis management.

Such regulations should be the subject of works on the forum of the European Community.

CONCLUSIONS

The purpose of the article was to present the concept of the ecological footprint of logistic support for a rescue operation in the case of a natural disaster. The suggested concept constitutes an attempt to initiate discussions on the subject. The authors are aware that it requires work on theoretical assumptions as well as analyses in terms of empirical verification. Detailed and precise calculations are not easy and they require a lot of statistical data, which is not always available. It should be noted that the scale of difficulty of collecting statistical materials and carrying out reliable calculations depends most of all on the kind of natural disaster, formal regulations and the method of managing a rescue operation.

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WSPARCIE LOGISTYCZNE AKCJI RATUNKOWEJ W ASPEKCIE MINIMALIZACJI ŚLADU EKOLOGICZNEGO JAKO WYMOGU ŚRODOWISKOWEGO ZRÓWNOWAŻONEGO ROZWOJU NA PRZYKŁADZIE KATASTROFY NATURALNEJ

STRESZCZENIE. **Wstęp:** Celem rozważań jest przedstawienie koncepcji śladu ekologicznego wsparcia logistycznego akcji ratunkowej na przykładzie katastrofy naturalnej. Coraz większa presja wymogów środowiskowych wywierana na wszelką działalność logistyczną, w tym również tą, w formie wsparcia logistycznego, uzasadnienia atencję dla podjętej problematyki.
Metody: Wybór katastrofy naturalnej - jako płaszczyzny odniesienia koncepcji śladu ekologicznego - jest z kolei próbą zwrócenia uwagi, że wsparcie logistyczne akcji ratunkowej w sytuacji katastrofy naturalnej, oprócz bezsprzecznie pozytywnej roli, również oddziałuje negatywnie na środowisko, które należy eksponować, czego przejawem będzie tworzenie instrumentów pomiaru i analizy, niezbędnych przy podejmowaniu działań, mających na celu minimalizację negatywnego oddziaływania wsparcia logistycznego na środowisko. Ślad ekologiczny można uznać za taki instrument.
Wyniki: W oparciu o ogólną formułę śladu ekologicznego oraz jej metodykę przedstawioną w „Working Guidebook to the National Footprint Accounts 2014", utworzono formułę śladu ekologicznego wsparcia logistycznego akcji ratunkowej na przykładzie katastrofy naturalnej.
Wnioski: Założenia koncepcji śladu ekologicznego wsparcia logistycznego akcji ratunkowej na przykładzie katastrofy naturalnej oparto na założeniach wsparcia logistycznego akcji ratunkowej oraz na założeniach koncepcji zasobowej i kosztów zewnętrznych wsparcia logistycznego akcji ratunkowej na przykładzie katastrofy naturalnej.

Słowa kluczowe: sustainable development, wsparcie logistyczne, katastrofa naturalna, ślad logistyki, ochrona środowiska

LOGISTISCHE UNTERSTÜTZUNG BEI RETTUNGSAKTIONEN UNTER DEM ASPEKT DER MINIMALISIERUNG DES ÖKOLOGISCHEN FUSSABDRUCKES ALS EINER ANFORDERUNG FÜR DIE NACHHALTIGE ENTWICKLUNG DES UMWELTSCHUTZES AM BEISPIEL EINER NATURKATASTROPHE

ZUSAMMENFASSUNG. Einleitung: Das Ziel der vorliegenden Erwägungen ist es, ein Konzept des ökologischen Fußabdruckes für die Unterstützung einer Rettungsaktion am Beispiel einer Naturkatastrophe darzustellen. Ein steigender Druck seitens der Umweltschutz-Anforderungen, der auf jegliche logistische Aktivität, darunter auch auf die logistische Unterstützung, ausgeübt wird, begründet die Wahrnehmung dieser Problematik.

Methoden: Die Auswahl einer Naturkatastrophe als Bezugsebene für das Konzept des ökologischen Fußabdrucks zielt auf die Feststellung hin, dass die logistische Unterstützung einer Rettungsaktion im Falle einer Naturkatastrophe, neben einer durchaus positiven Rolle, auch die Umwelt negativ beeinflussen kann. Dies muss unbedingt wahrgenommen werden. Ein Ausdruck der Überzeugung werden die Konzipierung und Anfertigung von Werkzeugen für die Bemessung und Analyse von Indikatoren, die beim Treffen von Entscheidungen unentbehrlich sind und welche eine Minimalisierung der negativen Beeinflussung der Umwelt im Falle einer logistischen Unterstützung, zum Zweck haben. Der ökologische Fußabdruck gilt wohl als ein solches Werkzeug.
Ergebnisse: In Anlehnung an die allgemeine Formel des ökologischen Fußabdrucks und deren Methodik, die im Werk „Working Guidebook to the National Footprint Accounts 2014" dargestellt wurde, ist die Formel des ökologischen Fußabdruckes der logistischen Unterstützung einer Rettungsaktion am Beispiel einer Naturkatastrophe festgelegt worden.
Fazit: Die Annahme für das Konzept des ökologischen Fußabdrucks der logistischen Unterstützung einer Rettungsaktion am Beispiel einer Naturkatastrophe stützte man auf die Voraussetzungen einer logistischen Unterstützung im Falle einer Rettungsaktion am Beispiel einer Naturkatastrophe sowie auf die Prämissen des Ressourcenkonzeptes und der äußeren Kosten, die für die logistische Unterstützung bei einer Rettungsaktion im Falle einer Naturkatastrophe in Anspruch genommen werden.

Codewörter: sustainable development, logistische Unterstützung, Naturkatastrophe, ökologischer Fußabdruck, Umweltschutz

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