Resource-saving accommodation of the enterprises of service for travelling by car in the context of sustainable development of territories

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Abstract. Sustainable development of trailering in Russia needs energy efficient and environmentally safe localization of the providing infrastructure which includes customer services, such as enterprises of hospitality (campings). Their rational placement minimizes the fuel consumption by vehicles, but also emissions of harmful substances into the atmosphere. The article presents rational localization of the sites for the construction of such enterprises using the MATLAB program. The program provides several levels of the task solution: from the total characteristic of the territory (the head interface) to the analysis of the possibility of forwarding charges on visit of the enterprises of car service (petrol station, automobile spare parts shops, car repair enterprises, cafe, campings and so on). The program offered implementation of the optimization by the criterion of decrease in energy costs allows to establish the preferable fields of their rational localization.

1. Introduction
Trailering [1, 2] is becoming more and more popular nowadays. However, it is necessary to solve following problems in order to provide its sustainable development. The problems are preventing from environmental pollution with motor transport waste; minimization of energy consumption (consumption of petrol, the electric power, etc.) within the high-quality service for both autotourists, and motor transport, etc. [3]. At the design stage of the enterprises of service of trailering the determination of rational energy saving system of its localization becomes very important. Therefore, the technique of rational localization of the service enterprises for autotourists with the use of MATLAB program is offered in the article taking into account the minimization of energy consumption for those enterprises functioning.

We use digital modeling of rational energy saving localization of the service enterprises as the method of a research, taking into account providing a minimum risk of safety and the maximum comfort. The object of research is providing requirements of energy saving, safety and comfort at the choice of placement of the platform under the enterprises of service of trailering.

2 Materials and Methods
Basic data are presented as the electronic database about the set of N data \( T \) for the probable sites \( t_k \) of the enterprises of service in the recreational territory I [4]: with the indication of their geological
coordinates $g_k^T$; road net and its loading for the motor transport movement, localization of the enterprises of roadside service, campings and services, supervised by Ministry of Emergency Situations; to territory attraction $a_{k,i}^{(c)}$; the motivating tourists for travel; the factors influencing comfort $G_k(A_k)$ and costs for rest $Z_k(A_k)$ and data on threats $u_{k,j}^{(d)}$ safety, etc. Attraction $A_k$ at the territory I the region of autotourist rest is established according to its analysis on different types of its tourist resources. The more the compliance of attraction $a_{k,i}^{(c)}$ and expectations, the higher the powerful coefficient $q_i$, and therefore

$$A_k = \sum_{i=1}^{D} q_i \cdot a_{k,i}^{(c)} \to \text{max}$$  \hspace{1cm} (1)

The energy saving arrangement in the territory of the region I and functioning of the platform for the enterprises of service is defined as the amount of estimated cost reduction $Z_k(A_k)$ on visits of tourist sights [5-9] and the service enterprises according to the extent of each $i$-th site and its performance determined taking into account available $j$-th kind energy costs $g_j$ (fuel consumption, difficulties of the route, high-speed mode, etc. [10]):

$$Z_k(A_k) = \sum_{i=1}^{n} \Pi_{j=1}^{l} L_i g_j \to \text{min}$$ \hspace{1cm} (2)

Data on safety $u_{k,j}^{(d)}$ of each $j$-th of the site (figure 1) of a route and localization of $k$-th of the service enterprise it can be received through the application of diagnostic sheets on probability and effects of action of threats.

![Diagnostic table](image)

**Figure 1.** Interface for defining the likelihood of fire hazards on a camping site
Those data can be originally input into the program through its main interface (figure 2) and addresses through the windows existing in it.

The search of rational localization of the site of the enterprises of service in the region are established according to the accepted algorithm from calculation of estimates on each platform, namely:

1. The quality evaluation $G_k(A_k)$ of stay of the autotourist in the site of the enterprise [8] forms at the rate of costs on time and length of the way for the visit of attraction and the indication of expert evaluation on the accomplishment at the enterprises of service of necessary conditions on comfortable stay in it, proximity of the attraction $A_k$ in the territory of the region from the site and costs $Z_k(A_k)$ for visits of tourist sights and the enterprises of service according to motivations of tourists.

2. Danger $B_k$ of the arrangement of the site for the service enterprise is estimated according to the availability or lack of risk from probable $j$-th threats $u_{k,j}^{(d)}$ of the $d$th kind for the safety providing at the $k$-th enterprise, and also their effects. Threats include not only threats to life, health and property of traveling, but also environmental safety. The harmful emissions of the car are based on fuel consumption during the passage of the route. The lower the safety level is lower, the higher is the indicator $B_k$.

$$B_k = \sum_{i=1}^{h} \sum_{l=1}^{n_{(l)}} \left\{ \prod_{j=1}^{m_{(j)}} L_j S_j Q_l \right\} \rightarrow \min$$  

(3)

where $Q_l$ specific emissions of $l$-th type of harmful substances of the car with the passage of $i$-th route.

General security risk $B_k$ recreation area includes all $U$-e the types of possible threats
\[ B_k = B_k^0 + \sum_{j} u_{k,j}^0 \rightarrow \min \quad (4) \]

When exceeding the permissible levels (contaminant - concentration limits, fire safety is a significant likelihood of threats and their implications, etc.), i.e. when a significant breach of security the value \( B_k \gg Z_k(A_k) \).

3. The assessment of variants of the sites provided in the array in the region can be carried out during more careful project analysis of the enterprise using models expense determination on its operation (the product delivery, service of the enterprise by other enterprises, etc.). Also, each accommodation site is assessed on the likelihood of security threats and consequences of its impact, including the threat to environmental security.

4. From the set \( M^T \) of data on sites for the enterprises of service in the territory and to their compliance to requirements to decrease in energy costs and destruction of the environment \( W \), namely availability of travelling trasses \( Z_k(A_k) \) tourist resources, roadside service, and also the possibility of receiving additional services and the appreciation of the tourists’ stay in the territory \( G_k(A_k) \) the rational space \( R \) decisions is established:

\[ W = \bigcup_{i=1}^{R} t_i \mid t_i \in M^T \text{ while } \left\{ (G_k(A_k))^{-1} \cdot Z_k(A_k) + B_i \right\} \rightarrow \min \quad (5) \]

From the selected set of preferences of sites for the construction of the enterprise of service \( R \) the entrepreneur in coordination with local administration of the territory makes the decision on its resource-saving localization \( W \rightarrow \min \) taking into account sustainable development of recreational territory [2].

3. Results
According to the provided technique, the program of rational energy saving localization of the site of construction of the enterprise of service is developed in the MATLAB program. The designed program contains several blocks for the accomplishment of stages of filling, processing, expert evaluation of comfort and safety of the site, using diagnostics, modeling and forecasting of the development of threats to security, to search of a rational energy saving design of the site of the enterprise of service. The structure of the program includes the main window in which interfaces for the interaction with those blocks and displays of the results of the research are located.

The application of the program allows to make the assessment of energy saving, application of rational zoning of the region, to provide its steady development and to reflect those requirements in the recommendations on the strategic planning of the region. the programm is approved for the rational localization of the enterprises of service (first of all the enterprises of hospitality, campings) in a recreational cluster (for the Kalyazin district of the Tver region), but it can be applied for the creation of preferable fields of localization of the service enterprises not only in the region, but also in the whole country by analogy with the conducted research. Shipping costs of the visits of the enterprises of hospitality and the attraction existing in the region are considered in the research, however we do not consider safety of its construction in the site. But the program differs from the research, provided in the works. The program of rational energy saving and safe localization of the site of construction of the enterprises of service provides more exact results taking into account bigger number of factors.

4. Conclusions
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References
[1] Brooker E and Joppe M 2014 Journal of vacation marketing 20(4) pp 335-351
[2] Lazarevska M, Cvetkovska M, Knezevic M, Trombeva Gavriloska A, Milanovic M, Murgul V and Vatin N 2014 Applied Mechanics and Materials 627 pp 276-82 DOI: 10.4028/www.scientific.net/AMM.627.276
[3] Ermakov A and Cherepanov D 2016 Pozharovzryvobesopasnost 25(7) pp 48-57
[4] Ermakov A and Cherepanov D 2017 Pozharovzryvobesopasnost 26(2) pp 62-71
[5] Ermakov A et al 2015 2nd International Multidisciplinary Scientific Conference on Social Sciences and Arts pp 869-874
[6] Sakharchuk E et al A 2013 World Applied Sciences Journal 27 pp 474-477
[7] Sakharchuk E et al 2014 Destination of amateur tourism in the Russian Federation: the scheme of development of service zones on the basis of the analysis of transport flows (RGUTiS Moscow)
[8] Ermakov A et al M 2014 Service in Russia and abroad 8(7) pp 54
[9] Lobach V 2006 Belarus-and-Russian University Bulletin 4(13) pp 23-27
[10] Simpkina R et al Conference Transport Research Arena pp 1-13