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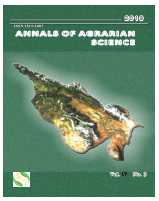

Determining the likelihood of emerging illegal dumpsite on the example of Georgia

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A B S T R A C T

On the example of the Mtskheta-Tianeti highland rural region of Georgia, the probability of illegal landfills is studied using the math-ematical equation developed within the research.Statistical and experimental data were collected and processed to calculate the likelihood of illegal landfills as a result of surveys andvisual inspections of municipal services and residents. As a result of airbrushing and visual field work, the results of determining theprobability of illegal landfills in the study area obtained by theoretical calculations were verified.It is established that the theoretically obtained results, which depend on the reliability of the data available in the municipality, are ingood agreement with the real picture. It is also estimated that, on average, the probability of illegal landfills in the study highland ruralareas is 52%. At the same time, the number of illegal landfills in the highland rural areas of five municipalities in the Mtskheta-Mtianetiregion varies from 0.1 to 1.6 units per village.

Keywords: Illegal Dumpsite, Likelihood of Emerging, Identification, Equation, Highland rural settlements, Mtskheta-Mtianeti region.

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Introduction

The uncontrolled occurrence of illegal dumpsites in populated areas is a global problem. It is especially relevant for Georgia as local governments are unable to provide appropriate services in the regions. This problem becomes even more urgent for the high mountainous rural regions.

Georgia's highmountainous regions are characterized by significant structural weaknesses compared to the lowlands and urban areas - weak economic diversification, population migration, extreme poverty, weak infrastructure, lack of health care facilities, limited access to public services, and more. 66% of the territory of Georgia consists of mountainous areas, where 6.5% of the country's population lives permanently [1,2]. The Mtskheta-Mtianeti region is particularly interesting in this regard, as 75% of the villages in the region (≈450 units) belong to high mountainous villages, and the population living in these villages is 22% of the total population of the region [3].

Mtskheta-Mtianeti region is located in eastern Georgia and includes the following historical-geographical provinces: Khevi, Ertso-Tianeti, Pshavi, Khevsureti, Mtiuleti, Gudamakari and partly Ksniskhevi. It is bordered on the north by the republics of the Russian Federation: North Ossetia, Ingushetia and Chechnya, on the east by the Kakheti region, on the south by Kvemo Kartli, and on the west by Shida Kartli. Mtskheta-Mtianeti region is a heterogeneous and, therefore, quite specific terrain, of which more than 4/5 belongs to the high mountainous category. The administrative center of the region is Mtskheta, and the region consists of the following administrative units: Akhalgori Municipality, Dusheti Municipality, Tianeti Municipality, Mtskheta Municipality, Kazbegi Municipality. The total area of the Mtskhe-

ta-Mtianeti region is 5.8 thousand sq. km. (8.3% of the total territory of Georgia), and the population in recent years is 94 3701 people (2.53% of the population of Georgia); Population density - 1 sq. Km. 16.3 men per km [4].

Today, 40% of the region's population lives in the territory of Mtskheta Municipality, and the lowest, 5% - in Kazbegi Municipality (Table 1) [5]. As mentioned, the share of rural population in the total population of the region is 75%. The region is characterized by an abundance of small villages. There is only one village in the whole region with 5,000 inhabitants (Mukhrani village of Mtskheta municipality, which does not belong to the category of high mountainous villages) [3].

Objectives and methods

The aim of the study was to develop and use an integrated methodology for determining the probability of illegal landfills in the border, highland rural regions of Georgia.

The research methodology is an innovative approach that involves determining the likelihood of illegal landfills in a geographically complex area of the country (particularly highland villages) based on statistics provided by municipalities. The results obtained using the developed theoretical methodology were verified by visualization (using a remote-controlled unmanned aerial vehicle-drone and with the help of expedition work) and a population survey. Based on the collection of statistical data on the study areas, relevant municipalities and population, the probability of illegal landfills was determined using a mathematical formula developed by us(1). This formula allows to determine the approximate amount of waste left without service in the study area and, consequently, to determine the likelihood of the existence / occurrence of an illegal landfill / landfills. In order to collect data, questionnaires were compiled and used for the representation of both the population and the municipality representatives , which were filled out on the basis of the on-site (expedition) survey. In particular, the questionnaire was filled with the following data - population, availability of specific service / frequency / efficiency, number of containers (by size), amount of waste per capita, presence of waste recycling, etc. (Table 2).

$$D=(AC-(Ln(L)+Sn(S))f(q/h))/AC\bullet 100\% \quad (1)$$

where,

D- Percentage generating possible illegal dumpsite;

A- amount of waste per capita;

C- population;

L- Large container capacity, kg;

n (L) - number of large containers, pieces;

S- small container capacity, kg;

n (S) - number of small containers, pieces;

f- collection frequency (frequency of waste truck service per week), coefficient from 0 to 1;

q- collection efficiency (ratio between the result achieved and the resources used, which implies the actual state of waste collection), coefficient from 0 to 1;

h - the relative rate of container overload, a ratio of 1 to 10, which shows how full the container is at the time of its emptying, and which depends on the population and the number of containers).

Parameter A: From 2015 to 2017, using the gravimetric method, we examined the amount of solid household waste (SHW) per capita and its morphological composition, which was supported by the Shota Rustaveli National Science Foundation (SRNSFG) [6] project "Development of a methodology for determination of amounts and morphological composition of municipal solid waste and creation of a data base" #FR/88/9-220/14 (Table 1) [7-10]. Accordingly, the average quantity of municipal solid waste (MSW) per capita living in cities in Georgia is 250 kg / person / year, and 75-80 kg / person / year per capita living in the region. This sharp difference, as already mentioned above, is due to the difference in living conditions and peculiar standards.

Table 1. *Morphological Composition of Municipal Solid Waste in Georgia*

#	Regions	Glass	Paper	Metal	Plastic	Nappies	Rubber / Leather/ Textile	Wood/ green waste	Fine Fraction	Hazardous	Food	Total
1	Tbilisi	3.5	13.2	1.7	15.2	8.0	2.2	0.7	3.7	0.8	51.1	100.0
2	Ajara	2.8	15.5	2.5	15.4	7.2	1.7	0.2	9.8	0.8	44.1	100.0
3	Guria	2.2	11.6	3.5	15.5	5.7	0.4	0.5	17.7	0.8	42.2	100.0
4	Samegrelo-Zemo Svaneti	2.6	9.9	1.9	12.1	7.0	1.2	1.5	19.5	0.8	43.8	100.0

5	Racha-Lechkhumi	2.4	13.5	1.5	13.2	9.0	1.3	0.2	16.5	0.4	42.0	100.0
6	Imereti	0.5	9.2	0.3	1.9	9.1	1.0	0.1	29.2	0.6	48.2	100.0
7	Mcxeta-Mtianeti	1.5	9.9	3.8	15.5	5.9	1.8	0.7	16.0	1.0	43.9	100.0
8	Shida Kartli	3.1	11.3	2.8	15.6	5.2	0.5	0.7	16.7	0.3	43.7	100.0
9	Kvemo Kartli	0.7	11.3	3.0	13.8	7.9	1.6	0.4	19.2	0,7	41.4	100.0
10	Samtskhe-Javakheti	2.8	12.0	3.2	13.8	6.8	0.8	0.8	10.8	0.4	48.7	100.0
11	Kakheti	2.8	11.2	2.9	11.5	5.0	1.0	0.3	22.6	0.5	42.3	100.0
12	Average	2.4	11.9	2.7	14.2	6.8	1.3	0.6	15.3	0.8	44.1	100.0

The parameters C, L, S, n (L), n (S) provided and subsequently determined by the specialists of the municipal service and as a result of a population survey.

Table 2 presents an example of a questionnaire compiled for municipalities to determine the above parameters.

Table 2. *Questionnaire for Municipal Service*

#	1	2
1	Municipality	Name
2	Population	Person
3	Population which have not served of waste disposal service	Person/household
4	Number of villages	Units
5	Number of high mountain villages	Units
6	The least populated high mountain villages	Units and Name
7	High mountain villages with the densest settlements	Units and Name
8	High mountain villages where there is no road infrastructure	Units and Name
9	Total number and type of waste containers (volume)	Units and Name
10	High mountain villages where there are not waste containers	Units and Name
11	High mountain villages where there is no waste truck	Units and Name
12	Total number of waste trucks	Units and Name
13	High mountain villages where illegal dumpsites are registered	Units and Name

Table 3 shows the gradations of the parameters f, q and h in Formula 1, which are selected during the calculations by visual evaluation at the study site.

Table 3. *Ratios Classification of Waste Collection Frequency and Waste Collection Efficiency*

f	Waste Collection Frequency	q	Waste Collection Efficiency	h	Relative rate of container overload
0	Not	0	Not	0	There is no container
0.2	Once a week	0.2	Very bed	1	Too overloaded
0.4	Twice a week	0.4	Bed	2	Overloaded
0.6	Every second day	0.6	Satisfactorily	4	Full
0.8	Every day	0.8	Good	6	Incompletely filled
1	Twice a day	1	Very good	8-10	Less than half / insignificant

Additional information about the survey region was obtained with the help of the online resource of the National Statistics Office of Georgia [11], (Table 4).

Currently, about 1/6 of Mtskheta Mtianeti - the entire territory of Akhalgori Municipality is occupied by the Russian Federation and information about it is not officially found (Map 1). A total of 601 villages are registered in the regions controlled by Georgia, of which 448 are mountainous villages, the total population of the municipality is 102,044 people (in the case of Akhalgori municipality according to the Geostat data of 2008), territorial area: 6 785 km2. The share of the population using the municipal cleaning service is 65%, which is served by three official dumpsites.

The average result of the calculation by our proposed formula for the individual regions studied is given in Table 4, which shows that the average likrlihood of illegal dumpsites in the high mountainous rural areas for the study region is 52%. In addition, significant differences were identified be-

tween municipalities in terms of waste management (Table 4). Table 4 shows that the situation is more difficult in the mountainous villages of Dusheti and Mtskheta municipalities, where the result is more than 50%, while the situation is better in Kazbegi municipality, which is mainly explained by the influence of tourism policy and responsible local government work.

Results and analysis

Table 4. *Calculation of Likelihood of Emerging Illegal Dumpsites in High Mountainous Rural Areas of Some Border Region of Georgia*

Parameters	Measurement	Symbol	Index of Regions					
			Dusheti	Tianeti	Kazbegi	Mtskheta	Akhalgori	Total
Quantity of MSW	kg/Person/ day	A	0.3	0.3	0.3	0.3	0.3	0.3
Quantity of village	Units	-	289	87	47	62	116	601
Quantity of high mountain village	Units	-	242	87	47	19	53	448
Population	Person	C	9100	7700	2469	1 632	1500	22 401
Residents of high mountain village who are not provided with a waste disposal service	Person	-	6777	664	0	1632	1500	10573
Value of big containers	kg	L	220	220	220	220	220	220
Quantity of big containers	Units	n(L)	90	60	40	0	0	190
Value of small containers	kg	S	20	20	20	20	20	20
Quantity of small containers	Units	n(S)	0	0	0	0	0	0
Waste Collection Frequency	0-1	f	0.2	0.2	0.6	0	0.2	0.4
Waste Collection Efficiency	0-1	q	0.3	0.5	0.8	0	0.2	0.4
Relative indicator of container load	1-10	h	1	1	6	0	1	1.8
Total quantity of emerging waste	kg/day	B AC	2730	2310	740.7	489.6	450	6720.3
Total quantity of disposal waste	kg/day	E L*n(L)+S*n (S)*f*(q/h)	1188	1320	704	0	0	3212
Total quantity of remaining waste	kg/day	H B-E	1542	990	36.7	489.6	450	3508.3
Likelihood of Emerging Illegal Dumpsites	%	D H/B*100	56.48	42.85	4.95	100	100	52.20

By entering some of the values taken from Table 4 into Equation 1, we obtain the corresponding results for the likelihood of emerging an illegal dumpsite, according to the districts we have selected. The results show which of them is more unsatisfactory or better, and also where and what type of work needs to be done to improve the current situation.

The results can be presented as follows - for example: in the example of Kazbegi in 47 high mountainous villages (MMS) we got the likelihood of only 5 illegal dumpsites, if we recalculate these values for one village (or how many dumpsites can be emerging in one village), we get that in one village Generate only 0.1 dumpsites; According to the relevant data - the likelihood of creating a dumpsite in one of the high mountainous villages of Dusheti district is 0.2 dumpsites; 0.6 dumpsites in one village of Tianeti, 0.9 dumpsites in Akhalgori, 1.6 dumpsites in Mtskheta.

The obtained results are well presented in Fig.

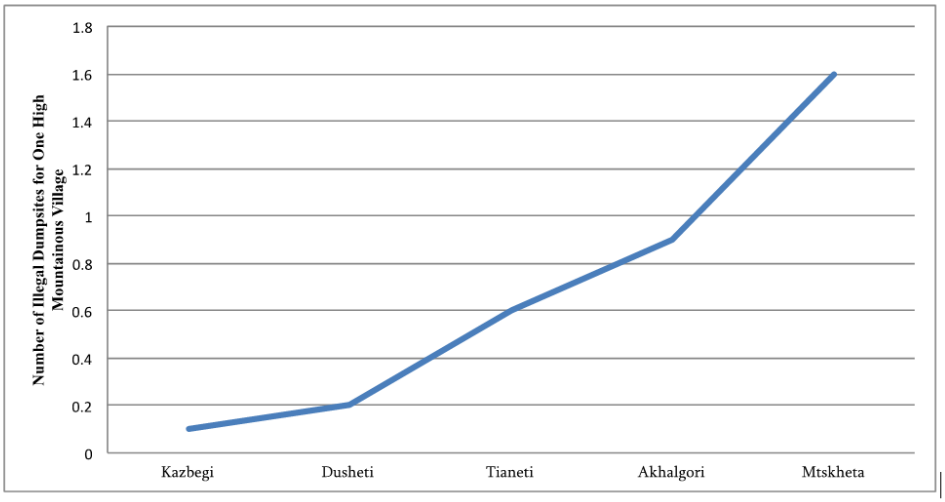

Fig. *Likelihood of Quantitative Emerging of Illegal Dumpsites for One High Mountainous Village (Example of Mtskheta-Mtianeti Region) The results obtained are well presented in Graph 1.*

Conclusion

1. It is established that the results obtained using Equation-1 (with their values) are descriptive and fairly close to the real picture observed by the fieldwork team in the field of the project.
2. The number of illegal landfills that may arise in each municipality has been reduced to one village. Accordingly, it was determined how many illegal landfills are likely to occur in a single village in a particular district. The results show that this figure ranges from 0.1 to 1.6 units.
3. Based on the data obtained from the study, the most satisfactory situation is in Kazbegi region, while the situation is relatively poor in the villages of Akhalgori and Mtskheta regions, where the local government pays less attention to the population living in these mountainous villages. In particular, they are not provided with all the necessary services needed to solve these existing problems

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References

[1] Internet resourse: https://1tv.ge/news/maghalmtiani-dasakhlebis-statusi-1715-dasakhlebas-maghalmtian-dasakhlebashi-mudmivad- mckhovrebi-piris-statusi-ki-237-469-moqalaqes-mienicha (in Georgian);

[2] Buachidze N. , Dvalishvili N. Determining a Probability of the uncontrolled landfills emergence in Georgia's Rural Areas using Integrat-

ed Methodology, 16 th International Conference on Environmental Science and Technology Rhodes, Greece, 2019, https://cest2019.gnest.org/sites/default/files/presentation_file_list/cest2019_00882_posterf_paper.pdf ;
[3] Report of Mtskheta-Mtianeti Regional Administration, https://mtskheta-mtianeti.gov.ge/;
[4] Mtskheta-Mtianeti, https://en.wikipedia.org/wiki/Mtskheta-Mtianeti;
[5] Population by cities and boroughs, as of 1 January 2021, https://www.geostat.ge/en/modules/categories/41/population;
[6] Shota Rustaveli National Science Foundation (SRNSFG), http://rustaveli.org.ge;
[7] N. Dvalishvili, Report of the SRNSFG project FR/ 88/9-220/14: "Development of a methodology for determination of amounts and morphological composition of municipal solid waste and creation of a data base", http://ecohydmet.ge/projects.html (in Georgian);
[8] N.L. Dvalishvili, Assisment of OF Eco-Efficiency of Separation of some Fractions of MSW: a Case Stady of Georgia, South Caucasus, Waste Management and the Environment IX, WIT Transactions on Ecology and the Environment, 2019, https://www.witpress.com/elibrary/wit-transactions-on-ecology-and-the-environment/231/37093
[9] N.L. Dvalishvili, Establishment of energy potential of Norio landfill of municipal solid waste of Tbilisi, Procedia Environmental Sciences, Volume 35, 2016, Pages 377-380, https://www.sciencedirect.com/science/article/pii/S1878029616301062;
[10] N.L. Dvalishvili, M.S. Tabatadze, The influence of municipal solid waste of Georgia on climate changes, Waste Management and Resource, 2019 – Springer, https://link.springer.com/chapter/10.1007/978-981-10-7290-1_16; National Statistics Office of Georgia, http://geostat.ge/en.