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Preliminary Results of a Study of the Relationship Between the Monthly Mean Sum of Atmospheric Precipitation and Landslide Cases in Georgia

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ABSTRACT

Preliminary results of the study of the influence of the mean monthly sum of atmospheric precipitation on landslides in Georgia are presented. In particular, it was found that with an increase in the monthly amount of atmospheric precipitation, there is a linear tendency for an increase in the number of landslides.

Key words: *Landslide, atmospheric precipitations*.

Introduction

Landslides occupy an important place among natural disasters. Landslide processes are dangerous in their almost ubiquitous distribution, the damage they cause, and the frequent accompaniment of human victims [1,2]. This problem is very relevant for Georgia, where the number of landslides included in the inventory reaches 7000 [3]. Therefore, special attention has always been paid to the study of landslide processes in Georgia [4-8].

Landslide phenomena depend on many processes, in particular on atmospheric precipitation [3,9,10]. The time scale of the influence of atmospheric precipitation on the provoking of landslides has a wide range - from several tens of minutes to several days, months and years (climatic time scale). In particular, in work [11] it was found that in Georgia with an increase in the annual sum of atmospheric precipitation, the tendency of increase in the number of landslides is observed in accordance with a second power of polynomial.

This paper is a continuation of previous research [11]. The preliminary results of a study of the relationship between the variability of the mean monthly sum of atmospheric precipitation and landslide processes in Georgia is presented below.

Study area, material and methods

Study area – territory of Georgia.

The data of Georgian National Environmental Agency about the mean monthly sum of atmospheric precipitations for 39 meteorological stations and number of landslides are used. Period of observation: 1936-2015 for precipitation (80 years) and 2014-2018 for landslides (5 years). The locations of meteorological stations and their names in [11] is presented.

In the proposed work the analysis of data is carried out with the use of the standard statistical analysis methods.

The following designations will be used below: Mean – average values; Min – minimal values; Max - maximal values; St Dev - standard deviation; σ_m – standard error; Sum - monthly number of landslides over five years; Rel Sum - the ratio of the monthly number of landslides in five years to the total amount of landslides in five years,%; 99% _Low and 99%_Upp – 99% of lower and upper levels of the mean accordingly; R^2 – coefficient of determination; R – coefficient of linear correlation; α - the level of significance.

Results and discussion

Results in fig. 1-3 and table 1 are presented.

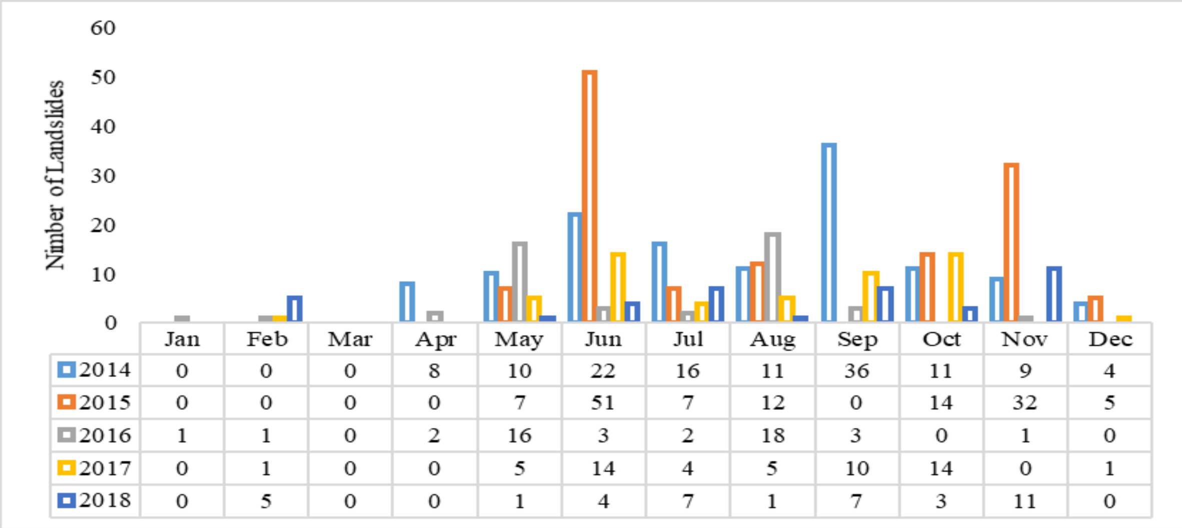


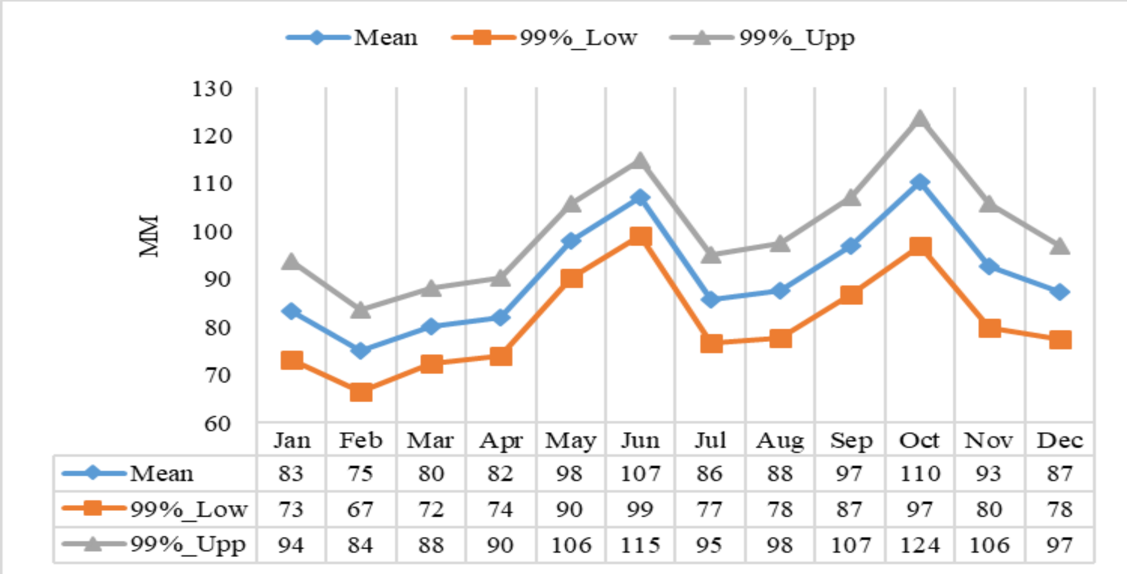
Fig. 1. Number of landslides in Georgia in different month in 2014-2018.

In fig. 1 data about number of landslides in Georgia in different month in 2014-2018 are presented. As follows from this figure, the maximum number of landslides (51) was recorded in June 2015. During the entire study period in March, no landslides were recorded. In just five years, 395 landslide cases were recorded.

Table 1. Statistical characteristics of number of landslide cases in Georgia in 2014-2018.

Parameter	Mean	Min	Max	St Dev	St Err	Sum	Rel Sum, %
Jan	0.2	0	1	0.4	0.2	1	0.3
Feb	1.4	0	5	2.1	1.0	7	1.8
Mar	no	no	no	no	no	no	no
Apr	2	0	8	3.5	1.7	10	2.5
May	7.8	1	16	5.6	2.8	39	9.9
Jun	18.8	3	51	19.6	9.8	94	23.8
Jul	7.2	2	16	5.4	2.7	36	9.1
Aug	9.4	1	18	6.6	3.3	47	11.9
Sep	11.2	0	36	14.4	7.2	56	14.2
Oct	8.4	0	14	6.5	3.3	42	10.6
Nov	10.6	0	32	12.9	6.4	53	13.4
Dec	2	0	5	2.3	1.2	10	2.5

In table 1 the statistical characteristics of number of landslide cases in Georgia in 2014-2018 are presented. In particular, as follows from Table 1, the largest number of landslides for five years (94) was observed in June, which is 23.8% of the total number of landslides for the indicated period of time. The most active period of landslides is from May to November (92.9% of all landslide cases).



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mean	83	75	80	82	98	107	86	88	97	110	93	87
99%_Low	73	67	72	74	90	99	77	78	87	97	80	78
99%_Upp	94	84	88	90	106	115	95	98	107	124	106	97

Fig. 2. Monthly variation averaged to one meteorological station of Georgia of atmospheric precipitation in 1936-2015.

Data about averaged on 39 meteorological stations of Georgia monthly values of atmospheric precipitation in 1936-2015 in fig. 2 are presented. Note that Fig. 2 shows the general picture of the intra-annual distribution of monthly precipitation totals per one weather station in Georgia. Since the data in Fig. 2 were obtained by averaging the series of observations over 80 years, the indicated distribution is quite representative for several decades both before 1936 and after 2015.

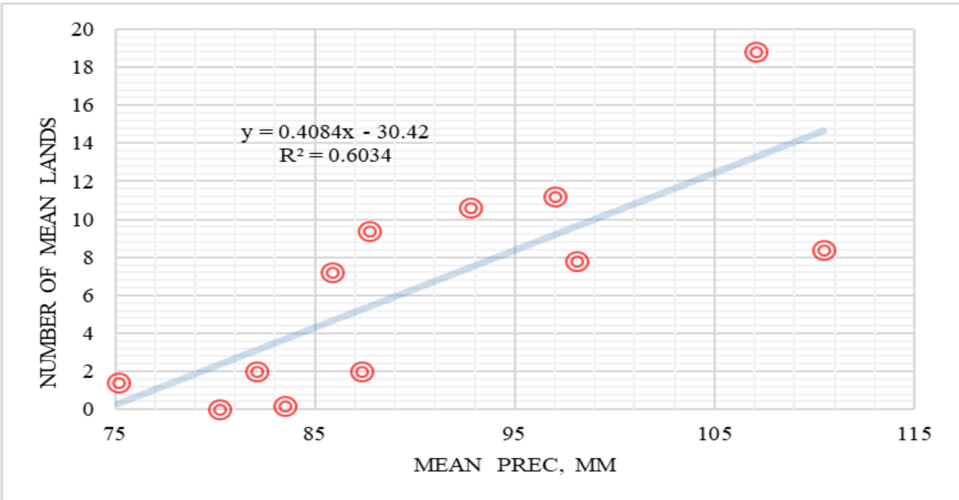


Fig. 3. Linear correlation between the monthly mean value of atmospheric precipitation averaged to one meteorological station and the mean monthly value of the number of landslides in Georgia in 2014-2018. (R = 0.78, α = 0.005).

Finally, in fig 3 data about connection between of monthly mean of atmospheric precipitation and monthly mean of landslide cases in Georgia are presented. This relationship with a high level of significance has a linear form. Note that the monthly effects of the influence of atmospheric precipitation on the number of landslides are more pronounced than the annual ones [11].

Conclusion

It is shown that with a monthly scale of averaging data on the amount of atmospheric precipitation and the number of landslides in Georgia, a clear linear tendency towards intensification of landslide processes with an increase in precipitation is noticeable**.** With this the monthly effects of the influence of atmospheric precipitation on the number of landslides are more pronounced than the annual ones [11].

These studies will be continued with a variety of scales of averaging ground-based and satellite observations in accordance with the Shota Rustaveli National Science Foundation of Georgia project FR-19-8190 “Assessment of landslide and mudflow hazards for Georgia using stationary and satellite rainfall data”

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საქართველოში საშუალო თვიური ნალექებისა და მეწყერთა შემთხვევათა შორის კავშირის შესწავლის წინასწარი შედეგები

ა. ამირანაშვილი, თ. ჭელიძე, ლ. დალაქიშვილი, დ. სვანაძე,
თ. წამალაშვილი, გ. თვაური

რეზიუმე

წარმოდგენილია საქართველოში მეწყერებზე ატმოსფერული ნალექების საშუალო თვიური რაოდენობის გავლენის შესწავლის წინასწარი შედეგები. კერძოდ, დადგენილია, რომ ატმოსფერული ნალექების თვიური რაოდენობის ზრდასთან ერთად შეიმჩნევა მეწყერთა რაოდენობის ზრდის წრფივი ტენდენცია.

Предварительные результаты исследования связи между среднемесячной суммой атмосферных осадков и случаями оползней в Грузии

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Резюме

Представлены предварительные результаты исследования влияния среднемесячного количества атмосферных осадков на оползни в Грузии. В частности, было получено, что с увеличением месячного количества атмосферных осадков наблюдается линейная тенденция увеличения количества оползней.