

Study of Local Wind Field in Georgia

**Marika R. Tatishvili, Zurab V. Khvedelidze, Inga G. Samkharadze,
Ana M. Palavandishili**

Institute of Hydrometeorology of Georgian Technical University

marika.tatishvili@yahoo.com

ABSTRACT

The complex relief of Georgian territory has definite influence on air masses motion in atmosphere lower layers. Mainly west and eastern atmospheric processes prevailed over Georgian territory. Current geodynamics and orographic properties of Georgia play an important role in formation of weather various patterns. Such complex relief conditions the formation and evolution of various scaled circulation systems and heterogeneous spatial distribution of meteorological elements. This is verified by the fact, that such important parameter as wind annual distribution has diverse type, with sharply expressed spatial inhomogeneities.

The wind is one of most important meteorological element used both in science and energetic industry. However, its origin and nature isn't well understood yet. Wind direction and value in atmosphere surface layer is depending on local geographic conditions. Meteorological observation 1960-2017 data is used to carry out investigation.

Keywords: local wind field, renewable energy, wind velocity repeatability.

Introduction

The renewable solar, wind and bio energies became more and more actual and applicable in the World. Many studies have been devoted to study their application ways and develop equipments and devices to produce energy supply. The research of their possible energy potential is crucial for energy sector and state economics that are preconditions for sustainable development. The application of wind energy is important for Georgia. However, the wind phenomenon is still under persistent scientific investigation its nature is still unknown. There are many reasons of its genesis.

The wind is one of most important meteorological element used both in science and energetic industry. However, its origin and nature isn't well understood yet. It is especially remarkable the transformation of wind kinetic energy into electricity, which makes its value in energetic supply more and more significant. To identify the wind nature is especially important for energy sector as it makes possible to precisely determine its loading potential and share in total energetic balance of state.

Study area and methods

In Georgia due to complex orographic conditions and influence of the black Sea there exist most of Earths climatic types, from marine wet subtropical climate in west Georgia and steppe continental climate in east Georgia up to eternal snow and glaciers in high mountain zone of Great Caucasus, and also approximately 40% of observed landscapes. The Georgian relief may be characterized by three sharply expressed orographic elements: Caucasus- in north, in south – Georgian south upland and lowland or intermountain depression located between those two risings.

This one begins from The Black Sea shore namely Colchis Lowland triangle and spreads up to eastern Georgia like a narrow strip. Between those two uplands small scaled orographic elements can be allocated. Such complicated relief has definite influence on air masses motion in atmosphere lower layers. Mainly west and eastern atmospheric processes prevailed over Georgian territory. Current geodynamics and orographic properties of Georgia play an important role in formation of weather various patterns. Such complex relief conditions the formation and evolution of various scaled circulation systems and heterogeneous spatial distribution of meteorological elements. This is verified by the fact, that such important parameter as wind annual distribution has diverse type, with sharply expressed spatial inhomogeneities.

The weather and climate driven factor is solar irradiance. The variations in the Sun's magnetic flux control the amount of cosmic rays impinging on the atmosphere. Cosmic rays produce ionizations and the ions form nuclei for cloud formation. Cloud cover has a great effect on global temperature, but this area is still poorly understood and not addressed in climate models. Meteorological effects resulting from fluctuations in the solar wind are presently poorly represented in weather and climate models. Geomagnetic storm is a major disturbance of Earth's magnetosphere that occurs when there is a very efficient exchange of energy from the solar wind into the space environment surrounding Earth. These storms result from variations in the solar wind that produces major changes in atmosphere circulation on the Earth

Wind velocity repeatability is presented on map 1 [3]. As it is evident from the map there exist some local areas with strong winds.

One of such area is near Gori and this location has been chosen for construction first wind power plant. The station works smoothly and its efficiency is 54%, which is a high rate for such a station. Since the Kartli wind power station has been moving from the test drive to electricity generation regime, it has never stopped functioning, the energy generated by the power plant has been fully delivered to Georgia's electricity system (5.5 million kW) since December 1, and it provided 10 572 kilowatt hours energy. The wind power is the essential and most important precondition for producing electricity. The power plant requires a wind speed of at least 3 m / sec to start generating energy, and its further development is directly proportionate to the wind speed. According to the current year December data, the efficiency of Kartli wind power generation is 54%, which is one of the best indicators in the world

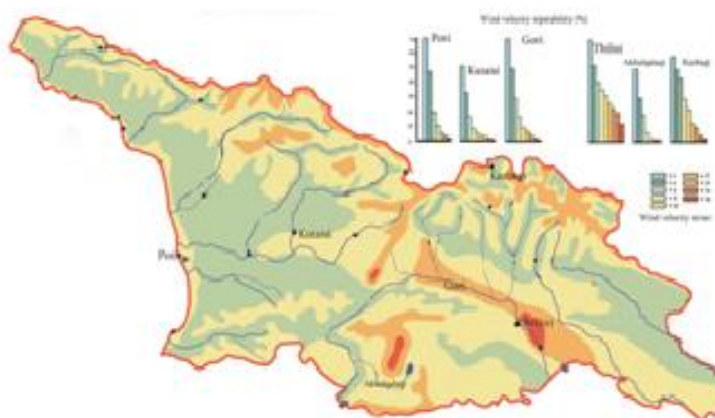


Fig.1. Wind field distribution in Georgia

Particularly wind is air masses horizontal and vertical motion caused by temperature and pressure gradient. Due to Earth motion wind is enforced by Coriolis force. In middle latitudes dominate motion caused by pressure gradient, parallel to isobars. The influence of friction and orography on air masses motion is important, as they resist motion and force it to replace toward low pressure area. Wind direction and velocity at atmosphere surface layer depends on local geographical conditions.

Except Gori there are a lot of windy regions in Georgia such as: Kutaisi, Tbilisi and Telavi, the notable is that those regions have different thermal and dynamical conditions. Wind observation 50 year period (1960-2014) data for Kutaisi have been processed and divided by 5m/sec interval gradation beyond 15m/sec. It may be concluded that 1 gradation wind occurs mainly in February-March and second gradation occurs mainly in January-March.

Wind maximal velocity variability by month has sinusoidal character; wind maximal values were detected in February-March and minimal in July (Fig.3, 4,5)

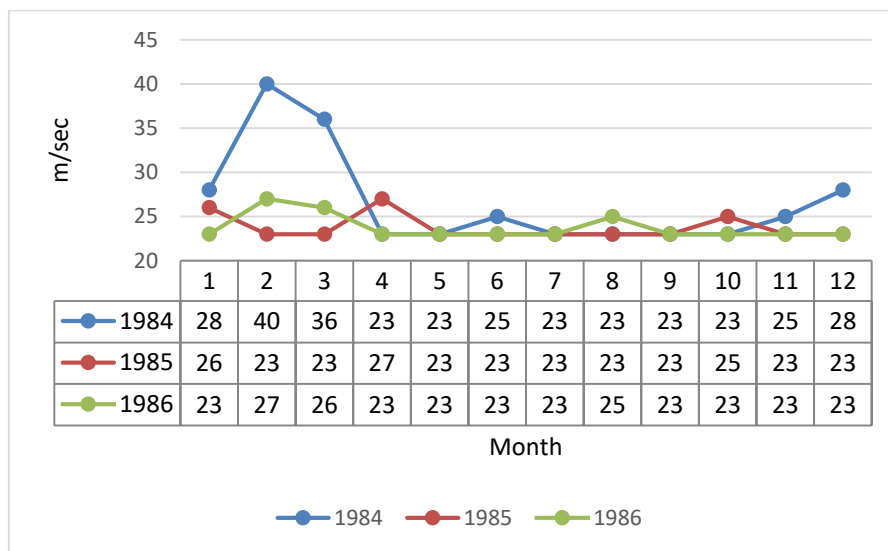


Fig.3. Wind maximal velocity distribution by years (1984-1986).

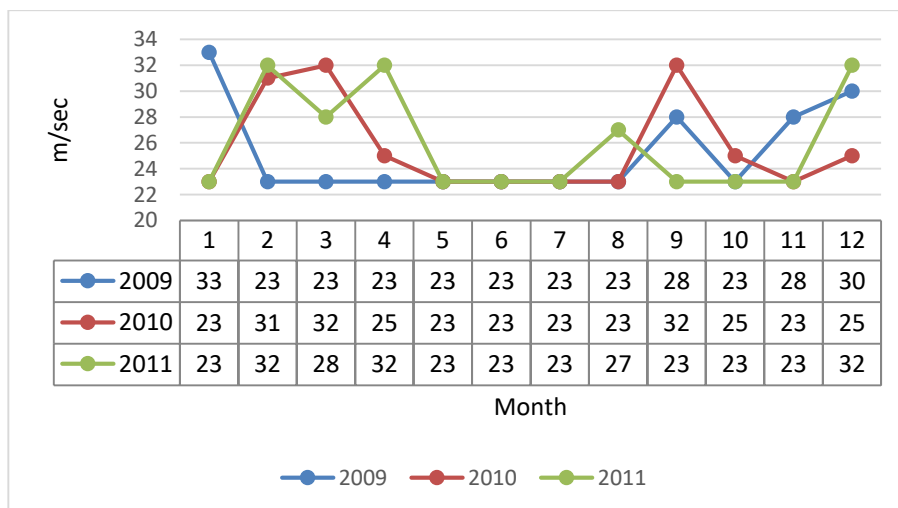


Fig.4. Wind maximal velocity distribution by years (2009-2011).

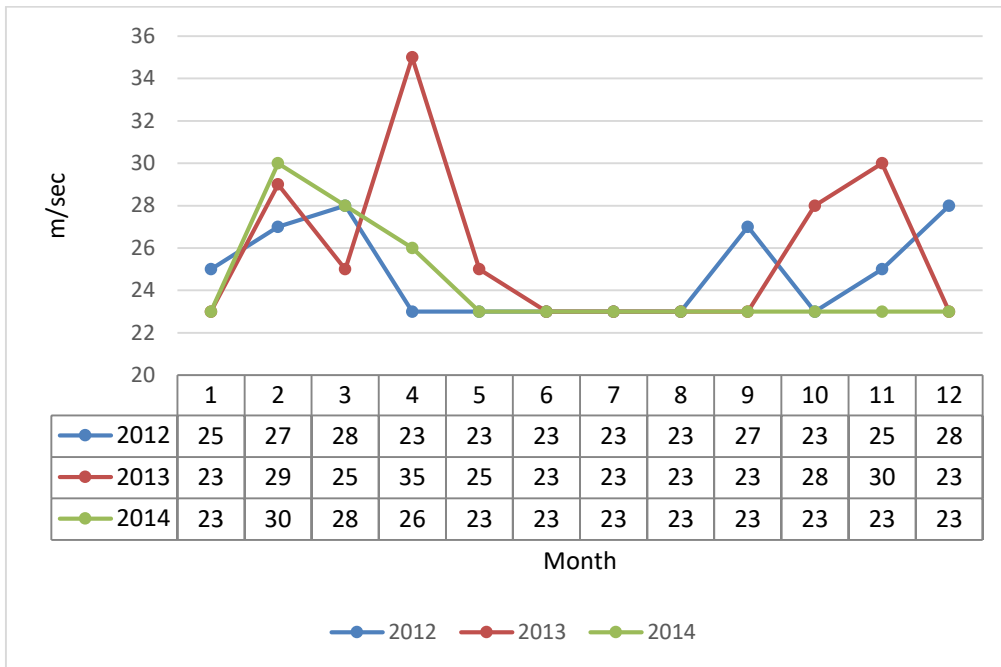


Fig.5. Wind maximal velocity distribution by years (2012-2014).

To understand wind extreme velocity character 1984-2014 data had been treated and results are presented.

The wind velocity has sinusoidal character and its maximal value reaches 40m/sec. It is remarkable that wind extremes lower threshold for last years has been increased.

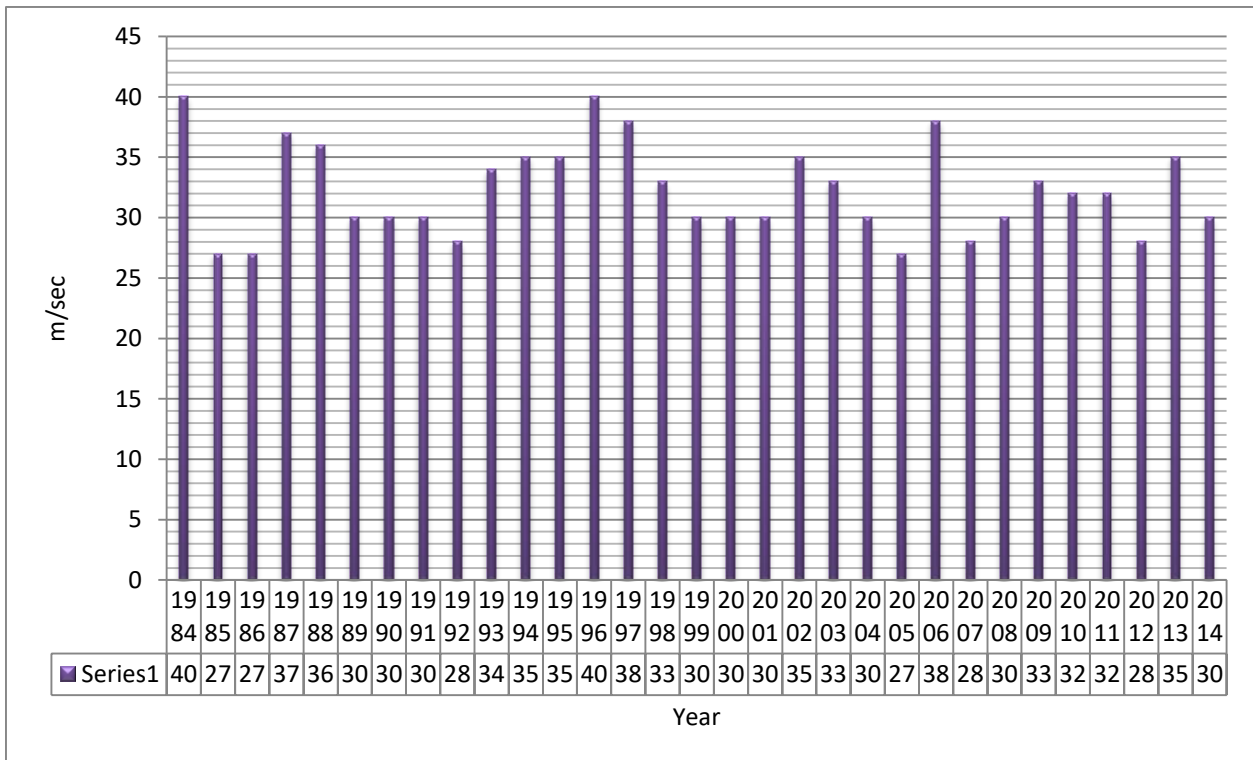


Fig.6. Wind maximal velocity (>25m/sec) distribution for Kutaisi region (1984-2014).

Table 1. Possible wind velocity_{max} (m/sec) occurred once in 1- 2-5-10- 15- 20- 50- 100 year

Station	Possible wind velocity _{max} (m/sec) occurred once in 1- 2-5-10- 15- 20- 50- 100 year							
	1	2	5	10	15	20	50	100
Batumi	19	27	31	34	36	38	42	45
Bakuriani	17	23	26	30	31	33	38	42
Bakhmaro	16	30	35	38	40	40	43	44
Borjomi	8	17	23	27	30	31	37	41
Gardabanio	8	20	25	27	28	29	31	32
Gori	18	26	29	32	33	34	36	38
Gudauta	16	20	22	23	23	24	25	26
Gurjaani	13	20	25	28	30	32	37	41
Dedoplistskaro	23	31	35	37	38	39	40	41
Dusheti	19	23	25	26	26	27	28	28
Zestaphoni	12	24	29	31	32	32	34	35
Zugdidi	17	21	25	29	32	34	41	48
Tbilisi	23	30	32	33	33	33	34	34
Tetritskaro	16	24	29	33	34	36	40	43
Telavi	15	24	27	29	30	30	32	32
Lagodekhi	8	23	27	28	29	29	30	30
Lanchkhuti	24	31	35	36	37	38	40	41
Martvili	12	29	35	39	40	41	44	45
Mestia	11	19	24	27	28	30	33	36
Mta-Sabuati	17	33	39	41	42	42	44	45
Mukhrani	18	31	37	39	41	41	44	45
Sagarejo	17	26	29	30	30	30	31	31
Samtredia	22	28	32	34	35	36	39	40
Stepantsminda	17	22	26	30	33	35	44	52
Tkibuli	19	29	34	37	39	40	43	46
Paravani	24	35	40	43	45	46	48	50
Pasanauri	12	18	23	28	30	32	39	46
Poti	22	27	30	32	33	34	36	37
Kutaisi	26	33	37	40	42	43	48	51
Khashuri	18	20	22	25	26	27	32	37

All possible wind maximal velocity repeatability over 1-2-5-10-15-20-5-100 years is presented in Table 1.

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ლოკალური ქარის გამოკვლევა საქართველოში

მ. ტატიშვილი, ზ. ხვედელიძე, ი. სამხარაძე, ა. ფალავანდიშვილი

რეზიუმე

საქართველოს ტერიტორიის რთული რელიეფი გარკვეულ გავლენას ახდენს ატმოსფეროს ქვედა ფენებში ჰაერის მასის მოძრაობაზე. ძირითადად, დასავლეთის და აღმოსავლეთის ატმოსფერული პროცესები პრევალირებს საქართველოს ტერიტორიაზე. საქართველოს ამჟამინდელი გეოდინამიკა და ოროგრაფიული თვისებები მნიშვნელოვან როლს თამაშობენ ამინდის სხვადასხვა ტიპების ჩამოყალიბებაში. ასეთი რთული რელიეფი განაპირობებს სხვადასხვა მასშტაბის ცირკულაციური პროცესების ფორმირებას და განვითარებას და მეტეოროლოგიური ელემენტების ჰეტეროგენულ სივრცითი განაწილებას. ამას ადასტურებს ის ფაქტი, რომ ასეთი მნიშვნელოვანი პარამეტრი, როგორც ქარის წლიური განაწილება, მრავალფეროვანია, მკვეთრად გამოხატული სივრცითი არაჰომოგენურობით.

ქარი წარმოადგენს ერთ-ერთ ყველაზე მნიშვნელოვან მეტეოროლოგიურ ელემენტს როგორც მეცნიერების, ასევე ენერგეტიკის სფეროში. თუმცა მისი წარმქმნის მექანიზმი და ბუნება ჯერჯერობით კარგად არ არის შესწავლილი. ქარის მიმართულება და სიდიდე ატმოსფეროში მიწისპირა ფენაში დამოკიდებულია ადგილობრივ გეოგრაფიულ პირობებზე. კვლევის ჩატარების მიზნით გამოყენებული იქნა 1960-2017 წლის მეტეოროლოგიური დაკვირვებების მონაცემები.

Изучение местного ветрового поля в Грузии

**М. Р. Татишвили, З.В. Хведелидзе, И.Г. Самхарадзе,
А. М. Палавандишили**

Резюме

Сложный рельеф территории Грузии оказывает определенное влияние на движение воздушных масс в нижних слоях атмосферы. В основном над территорией Грузии преобладают западные и восточные атмосферные процессы. Современная геодинамика и орографические свойства Грузии играют важную роль в формировании погодных условий. Такой сложный рельеф обуславливает формирование и эволюцию различных масштабных циркуляционных систем и неоднородное пространственное распределение метеорологических элементов. Это подтверждается тем фактом, что такой важный параметр, как годовое распределение ветра, имеет неодинаковый вид с резко выраженными пространственными неоднородностями.

Ветер является одним из важнейших метеорологических элементов, используемых как в науке, так и в энергетике. Однако происхождение и природа ветра еще не совсем понятны. Направление и значение ветра в приземном слое атмосферы зависит от местных географических условий. Данные метеорологических наблюдений 1960-2017 гг. используются для проведения исследований.