Improvement of classification and typification of operational conditions of wheeled vehicles in the Kyrgyz Republic

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Abstract. This article considers the issues of classification and typification of operating conditions of wheeled vehicles in the Kyrgyz Republic. The analysis of existing classification and typification of operating conditions by terrain and ambient air temperature is carried out. New information coding of administrative divisions of the Kyrgyz Republic with implementation of QR-coding has been introduced. And also the questions on improvement of the methodology of classification and typification of operational conditions of wheeled vehicles in the Kyrgyz Republic by the above-mentioned indicators are considered.
Keywords. wheeled vehicles, operational conditions, classification and typification, information code, car, terrain, ambient air temperature, road conditions

1 Introduction

The modern stage of economic development of the Kyrgyz Republic is a transitional stage to the market green economy. New economic management methods and information technologies are being introduced in all sectors of the national economy. Interrelationships are being established between sectors by means of digitalization. The paper [1] notes the need to introduce modern information technologies in the machine and tractor fleet for effective planning of wheeled vehicles and agricultural machinery.

In accordance with the plan of economic development of the Kyrgyz Republic until 2026 the section of transport provides for the active introduction of information technology and digitalization in the transport industry. This will require intensifying the development of uniform norms and standards for various operating conditions of wheeled vehicles in the Kyrgyz Republic [2].

In the conditions of trade and transport liberalization, the issues of scientifically substantiated classification and typification of operating conditions of wheeled vehicles become especially important, since the efficiency of wheeled vehicles use, production

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indicators, as well as the degree of use of potential properties of motor vehicles are determined by the adaptability of the design of vehicles to the actual working conditions. Therefore, scientific research devoted to the new direction of adaptability (suitability) of wheeled vehicles to the impact of natural and climatic factors is relevant and requires a speedy solution [3-7].

The increasing flow of interstate cargo and passenger transportation by road creates a lot of problems. Thus, the solution of this problem takes social character as well.

The process of automobile movement is directly affected by the type, quality and condition of the supporting surface on which it moves. Routes and tracks of automobile transportation, passing on paved roads, unpaved roads and directly on the terrain, are characterized by great diversity, instability of characteristics of physical and mechanical state of the movement surface. Rises and descents of roads, micro roughness of the pavement, grip of car wheels with it, curves in the road plan and other characteristics significantly affect the resulting indicators of car movement and should be taken into account in their calculation [8, 9].

2 Materials and methods

When solving the problems of classification and typification of operating conditions of wheeled vehicles (cars and tractors) for the Kyrgyz Republic, three indicators were taken as a basis: terrain, ambient air temperature and road conditions. For the convenience of research work, the Kyrgyz Republic was conditionally divided into three regions, considering their location, natural and climatic conditions, economic, trade and historical ties. The southern region included Batken, Osh and Jalal-Abad regions, the northern region included Yssyk-Kul and Naryn regions, and the central region included Chui and Talas regions [9].

In order to effectively enter the “Tunduk” digitalization system of Kyrgyzstan and simplify implementation in practice, facilitate practical calculations, the authors recommend to introduce information and QR coding of administrative districts of the Kyrgyz Republic. For this purpose the regions and districts of Kyrgyzstan have been alphabetically designated. Information and QR codes of districts are decoded and read as follows: KG – distinctive sign of Kyrgyzstan, digits 1...7 – ordinal numbering of regions, R – designation of the district, digits 1...40 – ordinal numbering of the district (see Table 3), etc. [9].

It is well known that the determining factor of ambient air temperature, road conditions and atmospheric pressure is the terrain. Therefore, the classification was made according to the methodology of the authors [10, 11]. But, considering the practical implementation of the results and small differences between the terrain reliefs, the following groups were combined: H1=P1+P2, N2=P3+P4, N3=P5+P6. When classifying and typifying operational conditions for wheeled vehicles in the regions of Kyrgyzstan by terrain relief, the main indicator is the percentage distribution of the location of territories by altitude belts, i.e. 50% prevalence of terrain elevations determines the belonging of the area to the group (flat-slightly hilly (F-SH), hilly-mountainous (H-M), mountainous-alpine (M-A)). An example of terrain distribution of the territories of Issyk-Kul and Naryn regions (northern region) of Kyrgyzstan is given in Table 1.

When classifying and typifying the operating conditions of wheeled vehicles, one of the main indicators is the ambient air temperature, which is known to depend primarily on the terrain, i.e. the lower the area is located above sea level, the higher the ambient air temperature or vice versa.

Consequently, the ambient air temperature varies widely in almost every administrative district of Kyrgyzstan because they all have territories with altitudes ranging from 1000 to

3500 m above sea level [12].

Table 1. Percentage distribution of administrative divisions of the Northern region of Kyrgyzstan.

Regions	P_1 (up to 1000)	P_2 (1000-1500)	P_3 (1500-2000)	P_4 (2000-2500)	P_5 (2500-3000)	P_6 (over 3500)	Total, %
Naryn region							
Ak-Talin district	-	-	10	30	40	20	100
At-Bashy district	-	-	2	5	23	70	100
Zhumgal district	-	10	26	25	15	24	100
Kochkor district	-	-	15	25	25	35	100
Naryn district	-	-	10	35	35	20	100
Issyk-Kul region							
Ak-Suu district	-	-	15	5	10	70	100
Djety-Oguz district	-	-	10	7	8	75	100
Issyk-Kul district	-	-	40	15	15	30	100
Ton district	-	-	35	15	10	40	100
Tyup district	-	-	51	10	19	20	100

Naturally, in some districts wheeled vehicles operate for a short period of time at different ambient air temperatures, sharply differing from each other. Change of ambient air temperature and accordingly terrain (progressive increase) sharply worsens economic indicators and efficiency of wheeled vehicles. At the same time, repeated cyclic loads during operation force to change its mode all the time, which eventually leads to partial overloading or underloading of wheeled vehicles. Consequently, in both cases, operating costs increase [13, 14]. The same operating mode also affects the technical speed of wheeled vehicles. Many gear shifts, unnecessary movements during work performance, leads to additional fuel and lubricant costs and a drop in productivity of wheeled vehicles. The same happens when wheeled vehicles are braked by the engine, i.e. even when the engine is running in idle mode, fuel and lubricant costs increase, because fuel costs even in these modes are affected by the ambient air temperature, atmospheric pressure value and forced high engine speed [15].

The average altitude of the territory of the Kyrgyz Republic is 2750 m.a.s.l., and the highest and lowest altitudes are 7439 m.a.s.l. and 395 m.a.s.l., respectively. Huge amplitudes of absolute altitudes, complex relief and other factors have caused the diversity of natural and climatic conditions. The climate of Kyrgyzstan is characterized by continentality, harmfulness, duration of sunshine period, altitudinal zonation and great spatial diversity, which is caused by comparatively southern position of the republic with vast deserts, contrasting relief and orographic isolation of the most part of the territory. The average annual temperature varies with altitude from +13°C in the foothills to -3°C in the highlands. The maximum value of the average monthly temperature reaches in July +25 +27°C, the minimum in January -2-3°C. Absolute temperature values for the zones range from -30°C to +42°C. The temperature transition through 0°C, +10°C, +15°C, +20°C is delayed by an average of 10 days with increasing altitude for every 500m [12, 16].

The main role in the implementation of sectoral and intersectoral internal and external economic relations is played by road transport, which accounts for about 97% of all goods transported in the country. The main units of wheeled vehicles (injectors, nozzles, and high-pressure fuel pumps) are manufactured and calibrated at factories for normal conditions: T=+15°C, P=760 mm.Hg. Therefore, changing these parameters in any direction leads to an increase in fuel consumption or a drop in engine power [7, 15, 17].

Wheeled vehicles in the Kyrgyz Republic operate in the following specific climatic and road conditions: in hot and very hot dry climate of some regions; in areas with mountainous highways; in the highlands, where absolute road elevations reach 3000 m a.s.l.

There are several variants of classification and typification of regions by ambient air temperature. For this purpose, maximum, average monthly and average daily temperatures are considered for the regions and for individual valleys. Given that the ambient air temperature varies over a wide range during the day, the most appropriate is to consider the average monthly temperatures and the duration of the period with temperatures above certain values. In current case, the duration of the period of ambient air temperature above + 10 ° C, + 15 ° C, +20 ° C is taken as a basis. Such data are available for each region depending on the altitude of the terrain.

3 Results

On the basis of the above-mentioned methodology and data in Table 1 the authors have plotted the regions by terrain elevation in ascending and descending order (Fig. 1-3).

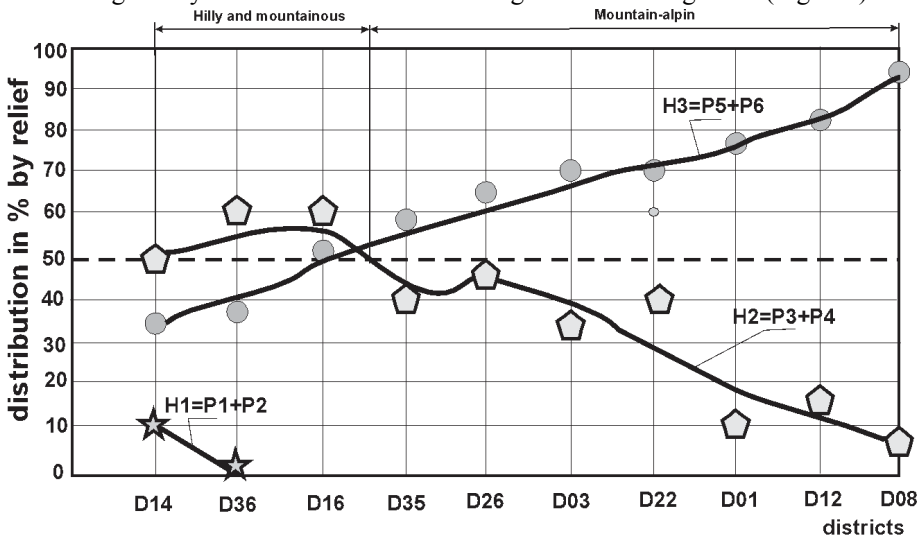

Fig. 1. Classification and typification by terrain relief of the northern region of Kyrgyzstan.

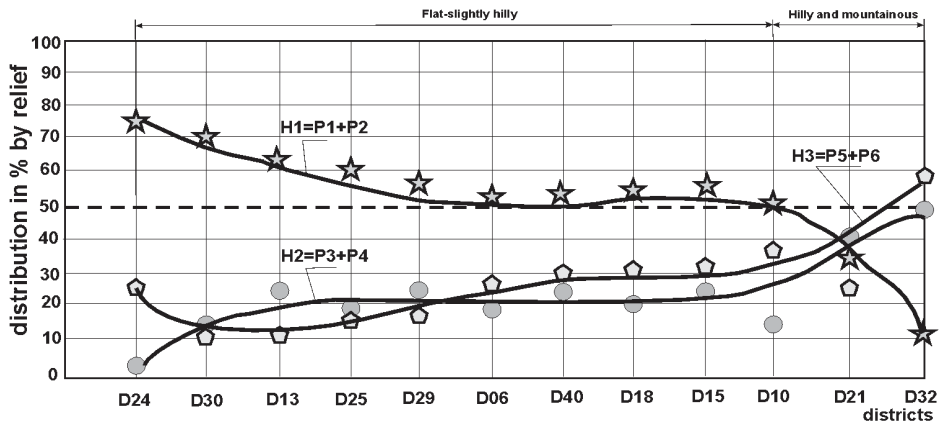

Fig. 2. Classification and typification by terrain relief of the central region of Kyrgyzstan.

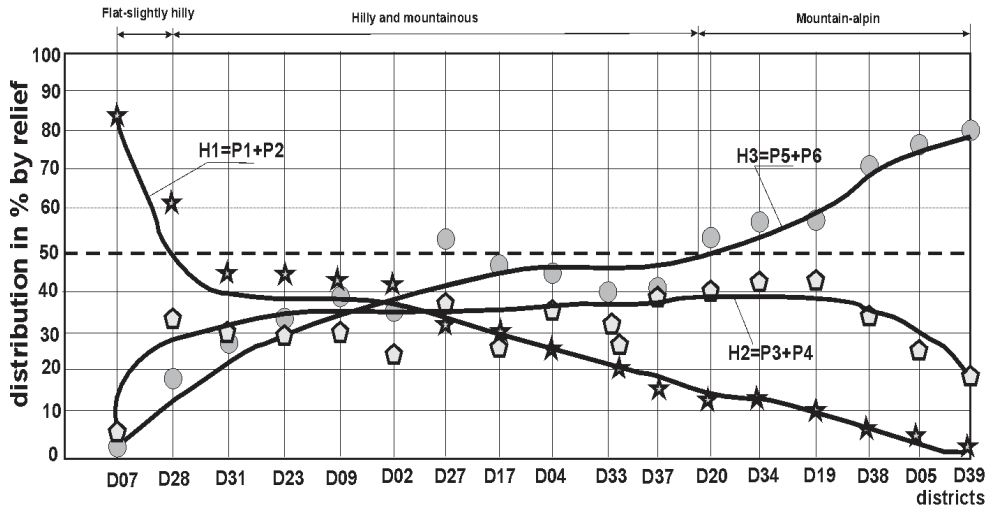

Fig. 3. Classification and typification by terrain relief of the southern region of Kyrgyzstan.

Also charts of dependence of duration of the period above +10°C, +15°C, +20°C on typical areas, in particular, plain-slightly hilly, hilly-mountain and mountain-high altitude were constructed. Classification and typification of regions by ambient air temperature were carried out using graph-analytical method. The calendar period of the summer starts from June 1 and ends on August 31, i.e. it is equal to 92 days. When classifying regions, the following principle was taken as a basis: if the temperature above +20°C is maintained for more than 60 days on the main territory of the region, it belongs to the group with very hot climate. If it is above +15°C, it belongs to the group with hot climate. The rest belong to the group with temperate climate. The data given in Table 2 [16] was used to determine the duration of the period of ambient air temperature of the terrain of a particular area. As a result, the following result was obtained (Figures 4, 5).

Table 2. Duration of the period of ambient air temperature of the area (days) [16].

Slope name	Temperature, °C	Altitude above sea level										
		1000	**1200**	**1400**	**1600**	**1800**	**2000**	**2200**	**2400**	**2600**	**2800**	**3000**
North Slope	Above +10°C	183	-	159	-	-	103	-	8	-	-	-
	Above +10°C	134	-	105	-	-	8	-	-	-	-	-
	Above +15°C	70	43	7	-	-	-	-	-	-	-	-
	Above +20°C											
South Slope	Above +10°C	150	-	130	-	-	71	-	25	-	-	-
	Above +10°C	158	-	134	-	-	82	-	22	-	-	-
	Above +15°C	96	-	42	-	-	-	-	-	-	-	-
	Above +20°C											

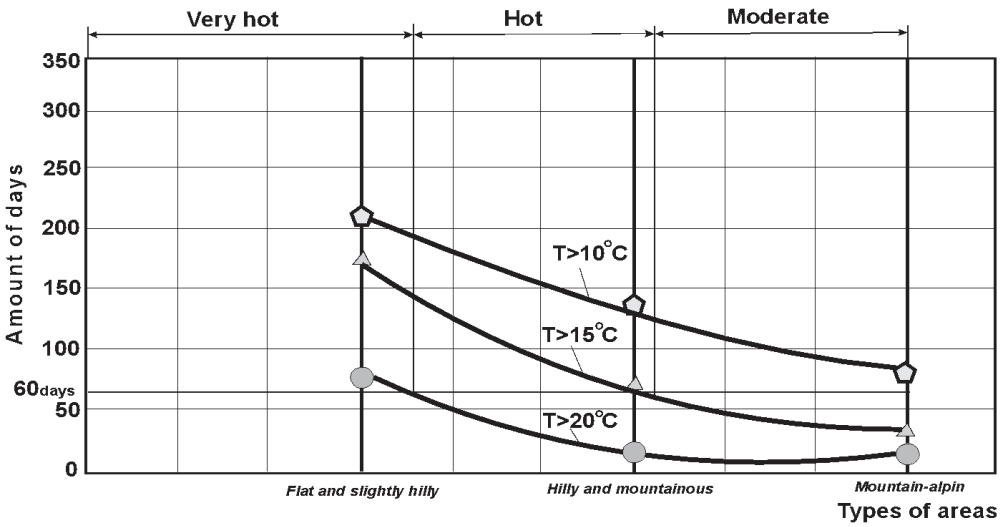

Fig. 4. Classification and typification of districts of the southern region of Kyrgyzstan by ambient air temperature.

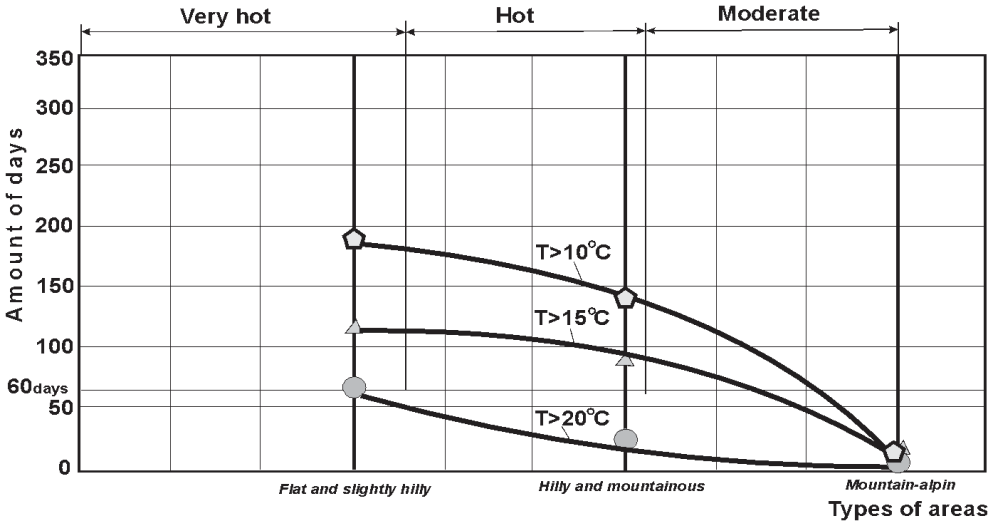

Fig. 5. Classification and typification of districts of the northern and central regions of Kyrgyzstan by ambient air temperature.

4 Discussion

The negative effect of hot conditions (high temperatures) on the operation of units and systems of wheeled vehicles has been proved by many studies. However, evaluation of the efficiency of work, as well as improvement of production indicators is impossible without a scientifically based comprehensive approach to the classification and typification of temperature conditions of the territories of the Kyrgyz Republic.

The results of the analysis of long-term data on ambient air temperature, as well as the study of wheeled vehicles performance in different conditions indicate the need for a clear gradation: temperature indicators on average annual, average monthly, average daily temperatures and the definition of the criterion for assessing the temperature conditions of

areas considering the duration of their impact, while the last factor is determinant in the range of lower temperature limits, up to above +10°C, +15°C, +20°C (moderate, hot, very hot). It should be noted that very hot conditions – include the upper limit of the temperature index to +40°C and above.

As a result of complex work on classification and typification of operating conditions of wheeled vehicles with the purpose of improvement of information and QR coding the authors suggest, in particular, to introduce additional designations by terrain and ambient air temperature after the information code of districts. For terrain abbreviated designations like H1, H2, H3 and accordingly T1, T2, T3 – for temperature classification. For example, in Table 3, information and QR codes of administrative divisions of Naryn and Issyk-Kul regions are shown.

Table 3. Improved information and QR codes of administrative divisions of Naryn and Issyk-Kul regions.

No.	Name of the district	Information code	QR-код
1	Ak-Suu	KG3R01H3T3	
2	Ak-Talinsky	KG4R03H3T3	
3	At-Bashinsky	KG4R08H3T3	
4	Djety-Oguz	KG3R11H3T3	
5	Zhumgalsky	KG4R13H2T2	
6	Issyk-Kulsky	KG3R15H2T2	
7	Kochkor	KG4R22H3T3	
8	Naryn	KG4R26H3T3	
9	Ton	KG3R35H3T3	

10	Tyup	KG3R36H2T2	

Decoding is the following: KG4R03H3T3 – Kyrgyzstan, Naryn region, Ak-Talinsky district, mountainous-high mountainous territory, temperate climate.

5 Conclusion

The research and analysis of the work on classification and typification of operating conditions for wheeled vehicles in certain areas of the Kyrgyz Republic allowed making the following main conclusions:

1. Three natural-economic zones have been created – Central, Southern and Northern Kyrgyzstan, linked historically and economically;
2. Practical bases of classification and typification of territories on conditions of operation of wheeled vehicles of the Kyrgyz Republic require enlargement of classification by terrain relief creating three groups instead of six. This simplifies future scientific substantiation of norms and standards of operating costs, amortization charges, etc.;
3. Analytical research of natural and climatic conditions of administrative districts of the Kyrgyz Republic, as well as the analysis of long-term statistical data allowed determining the number of districts by groups: flat and weakly hilly – 13, hilly and mountainous – 6, mountainous and high-mountainous – 12; districts with moderate climate – 12, with hot climate – 15, with very hot climate – 13;
4. The developed and compiled maps of zoning of the Kyrgyz Republic by groups of operating conditions for wheeled vehicles clearly confirm the natural regularities of geographical location of districts.

Thus, those districts, where it is necessary to consider the correction factors for operating costs, have been determined. The proposed QR code would ultimately simplify the creation of a data bank for the computer and its subsequent processing.

The developed methodology of classification and typification of operational conditions of Kyrgyzstan regarding the duration of the period most fully reflects the real conditions and can serve as a criterion for further development of norms and regulations on substantiation of operational costs of wheeled vehicles.

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