

SPATIAL ANALYTICS: THE EVOLUTION OF PUBLIC ADMINISTRATION FROM MONITORING AND CONTROL TO FORECASTING AND PLANNING

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Abstract. Many of the traditional ideas that the state, thanks to space satellites, has an “all-seeing eye” to monitor field activities remain relevant to this day. However, along with this, remote sensing of the earth has functions that, according to the authors, should become an integral part of the routine practice of the state bodies of Kazakhstan. Remote sensing should be used not only in matters of monitoring and controlling economic activities, respecting the rule of law, and so on in the territory, but also forecasting and planning its development, assessing resources, opportunities and risks, including the prevention of natural and man-made emergencies, and even identifying social prerequisites tensions.

Keywords: remote sensing, spatial analytics, public administration, Kazakhstan.

JEL codes: H83

Андатпа. Мемлекет ғарыштық спутниктердің арқасында далалық іс-шараларды бақылау үшін «бәрін көретін көзге» ие деген көптеген дәстүрлі идеялар осы күнге дейін өзектілігін жоғалтпайды. Сонымен бірге, жерді қашықтықтан зондтау функциялары да бар, олар авторлардың пікірінше, Қазақстанның мемлекеттік органдарының күнделікті тәжірибесінің ажырамас бөлігі болуы керек. Қашықтан зондтау тек аумақтағы экономикалық қызметті бақылау және бақылау мәселелерінде, заңдылықты құрметтеуде және т.б. мәселелерде ғана емес, сонымен қатар оның дамуын болжау мен жоспарлау, ресурстарды, мүмкіндіктер мен тәуекелдерді бағалау, соның ішінде табиғи және техногендік сипаттағы төтенше жағдайлар, тіпті шиеленістің әлеуметтік алғышарттарын анықтау.

Түйін сөздер: қашықтықтан зондтау, кеңістіктік аналитика, мемлекеттік басқару, Қазақстан.

JEL кодтары: H83

Аннотация. Многие традиционные представления о том, что государство, благодаря космическим спутникам, имеет «всевидящее око» для наблюдения за деятельностью на местах, остаются актуальными и по сей день. Однако наряду с этим дистанционное зондирование Земли имеет функции, которые, по мнению авторов, должны стать неотъемлемой частью повседневной практики государственных органов Казахстана. Дистанционное зондирование следует использовать не только в вопросах мониторинга и контроля экономической деятельности, соблюдения законности и т.д. на территории, но также для прогнозирования и планирования ее развития, оценки ресурсов, возможностей и рисков, включая предотвращение природных и антропогенных чрезвычайных ситуаций, и даже выявление социальных предпосылок напряженности.

Ключевые слова: дистанционное зондирование, пространственная аналитика, государственное управление, Казахстан.

JEL коды: H83

Introduction

At the end of the 1970s, a series of criminal cases were initiated on economic and corruption abuses in the Uzbek SSR, which later became known as the “Cotton Case”. The investigation revealed a long-term large-scale distorted accounting of cotton collection. One of the triggers of criminal proceedings was the use of data from remote (satellite) sensing of the earth (*Ulrika iz proshlogo, 2018*).

Many of the traditional views on state control are based, as Foucault describes, on the conception of ‘all-seeing eye’ or panopticon which enables authorities to monitor citizens without being seen. This concept of seeing without been seen remains relevant to these days due to the development of space satellites. “Side by side with the major technology of the telescope, the lens and the light beam, which were an integral part of the new physics and physics and cosmology, there were the

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minor techniques of multiple and intersecting observations, of eyes that must see without being seen..." (Foucault, 1975: 171).

Remarkable, that the same concept of 'all-seeing eye' is used in 2018 by the developer of a mobile application for civil environmental control, called «Oko» KZ (The Eye KZ)¹. The application's users are invited to report about cutting down trees, fire, trash and other environmental violations through their mobile phones. The application developer is a *National Company 'Kazakhstan Gharysh Sapary'* (Kazakhstan Space Mission) who operates the National system of Remote Sensing.

However, the remote sensing has been used by authorities not only in matters of monitoring and controlling social and economic activities, respecting the rule of law, but also forecasting and planning for development, assessing resources, opportunities, and risks, including the prevention of natural and man-made emergencies, and even identifying social prerequisites tensions. Kazakhstan has developed infrastructure and facilities to operate a national system of remote sensing and began to adapt its functions and accumulated data for socioeconomic needs of society. The main issue of the paper is to consider the ways how spatial data have been incorporated in the system of public administration and what kind of issues spatial analysis faces to become a routine administrative practice in Kazakhstan.

From control and monitoring to forecasting and planning

Limited access to data has been a traditional obstacle to the widespread use of the remote sensing. In the recent decades, however, the situation has changed in Kazakhstan as well as throughout the world.

Kazakhstan, for example, has the most sophisticated technical complex for collecting and analyzing spatially related data in the Central Asia. The territory of the country is covered by the National Global Navigation Satellite System (GNSS)

¹ "Oko KZ". News of the National Company 'Kazakhstan Garysh. Sapary' https://www.gharysh.kz/novosti/novostdetalnoz_4_12_92/

stations network, which allows obtaining geo-referenced measurements with sub-centimeter accuracy. Kazakhstan, represented by *Kazakhstan Gharysh Sapary*, has a full-operation space system consisting of two satellites: KazEOSat-1 and KazEOSat-2 operated by a modern ground complex located in the city of Nur-Sultan. In addition, the state-run companies such as the Republican State Enterprise 'Kazhydromet'², the Republican State Enterprise 'KazGeodesy'³, the Joint Stock Company 'KazGeology'⁴ have at their disposal modern digital aerial survey complexes, a network of automated for hydro-meteorological stations as well the system for collecting and analyzing statistical data.

Worldwide, the data collection and transfer process are becoming increasingly decentralized. It is facilitated by the international competition on the market of remote sensing services among such companies like *Maxar*⁵, *Planet Labs*⁶, and *UrtheCast*⁷. The strong competition leads to an increasing supply and reduced delivered costs. On this background, *Kazakhstan Gharysh Sapary* directly offers its data and analytical services to government agencies at all levels with no cost⁸. At the same time, *Kazakhstan Gharysh Sapary* offers its products to non-government organizations and individuals for money. Kazakhstan's geo-services are available in the field of agricultural monitoring, emergency situations, forest monitoring, and unauthorized land use.

The effectiveness of spatial data using depends on its continuous accumulation and systematization according to the territory and time. In Kazakhstan the government in collaboration with national operators is responsible not only for getting spatial data but in cooperation with state bodies for it delivering to end-users. At the regional levels, since 2018, geoportals have been developed by local authorities where

² <https://www.kazhydromet.kz/en>

³ <http://www.kazgeodeziya.kz/ru/>

⁴ <https://qazgeology.kz/?lang=en>

⁵ <https://www.maxar.com/>

⁶ <https://www.planet.com/>

⁷ <https://www.urthecast.com/>

⁸ "6 years of KazEOSat-1 satellite operation". News of the National Company 'Kazakhstan Garysh Sapary'. https://www.gharysh.kz/novosti/novostdetalnoz_4_89_0/

current spatial data on region are displayed (*Tumashova, 2018*). On the central level, there are ongoing projects based on geographical information systems for state services of sub-soil licensing⁹ and the State Land Cadaster which are publicly available¹⁰.

However, to embrace data driven decision making, the state needs more than just maintaining GIS systems, it should also develop an interdisciplinary approach to interpreting spatial data. Second, the state should incorporate knowledge of GIS data, infrastructure, and ways of interpretation into the system of professional training of civil servants. In future, curriculums in public administration and public policy graduate programs. In general, these measures will likely to expand competences and skills of civil servants in using remote sensing data. As a result, spatial econometrics could be a new and applicable scientific-based methodology for the public administration in Kazakhstan.

Spatial analysis methods and approaches

Geographical studies and their descriptions related to socioeconomic, natural and technogenic factors have been known for a long time, but the spatial econometrics are formed as a scientific discipline during the last 20 years. The term 'spatial econometrics' was used to describe a methodology for studying interdependencies in interregional economic processes (*Anselin, 2012*). The methods of spatial econometrics trace back to the problem of external influences in cross-country and cross-regional studies (*Galton, 1886*). Since that moment, geospatial analysis has developed into an interdisciplinary field with large contributions from econometrics, ecology, computer science, sociology and many other social and natural sciences (*Grekousis, 2020*). Conditioned on this lasting scientific interest in spatial analysis has been the development of various analytical tools both proprietary (ESRI¹¹ or Arc GIS¹²) and open source (QGIS or many spatial analysis

libraries in programming languages like Python or R).

Obviously, the advantages of map analysis tools and spatial analytics for territorial vast spread counties are a reasonable basis for the implementation of the GIS tools as special courses in management and public administration educational and professional development programs. In this frame, it should be noted that there are some training programs and courses initiated in Russian Federation nowadays. St. Petersburg University has a master's degree program in Economic Geography and Digital Spatial Analytics¹³; Geographical Department of Lomonosov Moscow State University has developed a training program for undergraduate and master's degree¹⁴ as well. Due to the historical, socio-economical, and academic bounds of Kazakhstan with the Russian Federation, it is quite possible to co-working in methodology and adapting the algorithms to local conditions.

The development of digital technology has transformed geography and regional studies into geographic information systems and made it possible to combine spatial data with statistical data and economic indicators. As a result, spatial econometrics as an independent scientific discipline were formed (*Anselin, Rey, 1997*). Methods of geospatial analysis make it clear the causal relationships of events and their pattern of occurrence in certain local conditions and on a single territory. A study of the geographical conditions of the territories and an understanding of the potential threats taking place in the given territory help to develop measures to prevent their occurrence or to carry out preparatory measures to minimize material damage and human casualties.

A research at the initial stage starts by collecting open official data or obtaining data on request. The result of data collecting is different types of figures because of the diversity of the approaches to data collection, sorting and storing. Exploring this dataset requires adapting of mathematical-statistical methods of

⁹ <https://gis.geology.gov.kz/geo/>

¹⁰ <http://www.aisgzk.kz/aisgzk/ru/content/maps/>

¹¹ <https://www.esri.com/>

¹² <https://www.arcgis.com/>

¹³ <https://spbu.ru/postupayushchim/programms/magistratura/ekonomicheskaya-geografiya-i-cifrovaya-prostranstvennaya>

¹⁴ <https://www.msu.ru/dopobr/programs/program/87657/>

analysis, cartography methods, methods of econometrics, spatial econometrics, methods of financial modeling and economic calculations and forecasts. The research results in descriptions of spatial and statistical data; found correlation dependencies between spatial location, geographical parameters of the territory and certain risk factors and events; and regressions of statistical data and socioeconomic indicators.

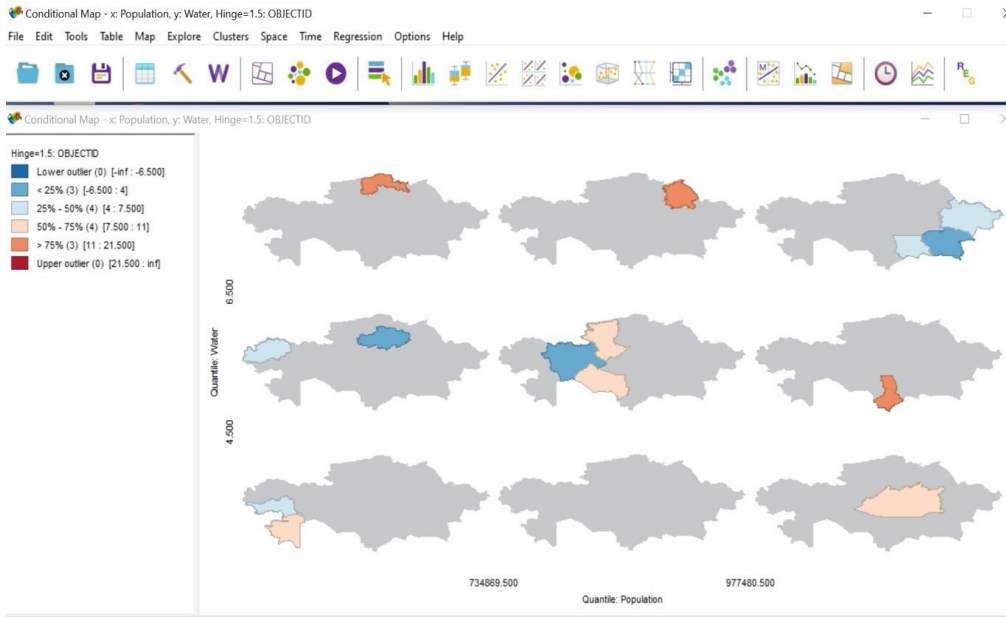
Experimental observations must comply with various variables on real events and the sequence of actions with data: collection, generalization, sampling, unification, calibration, loading onto GIS tools, and analysis. Because the spatial relationships between the studied objects may differ in their origin, there are three reasons for spatial relationships. First, common exposure – similar exogenous effects on the studied objects cause the similarity of the results obtained. Second, interdependence – the processes occurring in the same objects cause some related processes in neighboring objects. Third, endogenous selection – the intended response affects the process of clustering objects. Spatial-econometric modeling is based on the concept of a spatial weight matrix – W , which describes the degree of interdependence between the studied objects and considers the possible interaction between the studied objects in space. The weight matrix (W) is designed to determine which of the observations is spatially dependent on each other to what extent. To construct the matrix of spatial weights, GIS data and cartographic data are most often used.

Figure 1

Dependence of regional surface water availability and population quantity

Researches in the field of socioeconomic geography in Kazakhstan have mainly focused on educational goals (Akhmetov, 2007; Dzhanaleyeva, 2008; Saipov, 2015). Analytical researches based on spatial referenced data were not developed in the country until spatial data became available in digital form. Since the practical aspects of the implementation of spatial analyses have become available in public administration, the possibilities of access to planning the development of territories should be considered. This aspect is very valuable from a practical point of view because one of the big challenges for local administrations in Kazakhstan is to prove the economic efficiency of state funding and budget allocations. These needs became as results of various fails in investment revenue and state funding during Kazakhstan's independent period. So, what makes spatial analysis useful from the governance perspective?

At Figure 1 it is mapped the dependences of regional surface water availability and population quantity. It shows the correlation between the surface water scarcity in the West Kazakhstan region with the low population density there. At the same time there are both parameters up in East-South-East regions of the country. These results can give some assumptions that for example the West Kazakhstan region is surface water-sensitive and presumable has some arid and semiarid regions and water supplying vulnerability. So, the main prospects of local administration must deeply warn the water supply risk intentions.

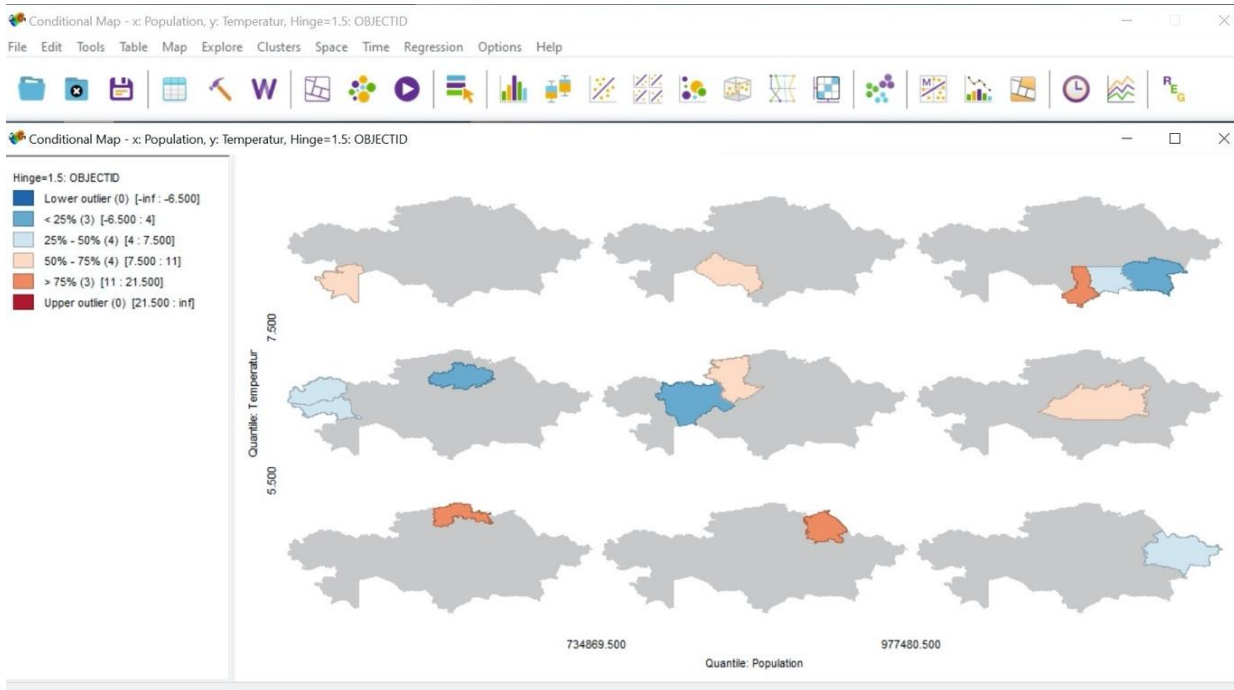


Note. Rakhimzhanov, GeoDA Software.

Figure 2 shows the regional climatic conditions and population density with some heteroscedasticity of parameters. There are a few historical and geographical reasons for this. The historical reason is that most of the settlements as district centers, towns, and cities in Kazakhstan arise during the industrialization period started in the 20s of

the XX century (Mustafayev, 2019), when central heating supply and fossil fuels delivering became available. This can be clearly seen in the presence of relatively large cities in the north-west of the country (Kostanay and Aktobe regions) and small ones in the south-west (Aktau and Zhanaozen).

Figure 2
Dependence of regional climatic conditions and population quantity



Note. Rakhimzhanov, GeoDA Software.

The climatic conditions indicated on the map are calculated by the number of

months with positive temperatures (the degree Celsius) during the year. According

to geographical aspects, in the Mangystau region in western Kazakhstan there are a high number of positive months as well as the plenty availability of oil resources for heating system supply but the low density of population. This means that there is another stronger factor influencing the situation, which is indicated in Figure 1, and this is the availability of surface water.

Along with planning and forecasting, another equally important trend in increasing the efficiency of state and local

government is to eliminate corruption risks through the transition to digital technologies and reduce human interaction in providing public services. In this frame, for the realities of Kazakhstan, the spatial analytical tools are very useful both for getting much more instrumental measured data collection and reducing the human factor.

The illustration of the case corresponding to the idea is shown at Figure 3 below.

Figure 3

A case of land abuse near Nur-Sultan city in 2015



Note. The KazEOSat-1 image in the left side and photo fixation on the ground in the right side.

Figure 1 refers to a real case of land abuse in the vicinity of Nur-Sultan city in 2015. A leaseholder violated the land use rules and polluted the subsoil surface with solid waste. Thanks to the measures taken by the state authorities responsible for the land use, this and similar cases have been prevented at an early stage. That and other related cases have been discovered with remote sensing and image analysis, and then reported to local authorities who are responsible for monitoring the sites.

The technologies of space monitoring in land resources management, agriculture, environmental safety is not new in Kazakhstan. *Kazakhstan Gharysh Sapary* has the very developed, experimentally proven, and ground calibrated methodologies. But there is a gap between data aggregation and providing the spatial analytical data to the decision-making level officials in the form of technical and analytical support.

Current tasks of public administration in Kazakhstan

Kazakhstan is facing a paradoxical situation. There are modern technical facilities, the accumulated amount of data, and experienced specialists from different areas related to spatial analysis. But spatial analysis itself as a subject of agenda activities remains a matter of purely specialized organizations and does not find a wide application in the territorial management of state bodies around the country.

Nowadays, it is becoming a very urgent task to develop methodological instructions for managerial personnel of middle and senior levels of the government of Kazakhstan on the use of geospatial analysis tools. The fact that this practice still does not have a systematic application in Kazakhstan is confirmed by several high-profile manifestations of irrational managerial decisions that led to human victims and significant material costs.

Among which is the most famous, for example, the tragedy in the village of Kyzylagash which happened on March 11, 2010. As a result of the damp burst a part of the village was washed away with water. One of the main reasons for the occurrence of this event was the village's location at the mouth of the river in the foothills which was compounded by the construction of the reservoir in the upper reaches. Incorrect territory planning ultimately led to an extraordinary event. Currently, in Kazakhstan there are other settlements of potential risks. The assessment and measures to reduce them require using geospatial analytics tools in addition to the existing mathematical models (*Mazkov, Kisanova, Jomartova, 2020*).

On July 14, 2006 an attempt by the authorities to demolish illegally built residential buildings in the 'Shanyrak' micro district led to a tragedy that caused strong social tension in the entire Kazakhstan society (*Tragediya v Shanyrake, 2016*). This event was the result of ineffective urban development management, during which for ten years the Almaty city administration did not pay attention to issues of unauthorized land use, this fact illustrates the neglect or lack of information on the situation in the territory.

However, the situation repeats itself. At the beginning it was a land issues manifests in 2016 throughout the country which had a resonance around the world and great social tension within the country (*Klevtsova, 2016*). People's protests against the Government's plans for land reforms happened due to the lack of mechanisms for planning and managing the territory. Then it was an explosion of ammunition depots on June 24, 2019, which caused significant damage to the city of Arys. The event showed incorrect planning of the city territory development towards the placement of explosive materials. Also, in the country annually, there are numerous floods with great material damage and human casualties (*Tukpiyev, 2018*), these events are associated with the construction of water protection zones and the incorrect planning of water protection measures.

All these events were geospatially linked, that is, they occurred in a certain territory or area where the geographical location and local conditions contributing to

the occurrence of these events were important. Modern GIS, Earth remote sensing systems and spatial analytics allow a timely detection of the appearance of self-construction points, and as a result help to prevent such events. However, at present, the legal regulations for monitoring territories have not been adopted. In this regard, each of the regions develops its own geoportals without a single scientifically based analysis technique.

The initiatives for regulating the state services having the spatial referenced information in the frame of the National Spatial Data Infrastructure project are undertaken by Kazakhstan's Government¹⁵. But the elaboration of technical issues of standardization and unification of spatial data and interagency exchange of spatial data in direct reading mode can take much more time and effort to implement.

Conclusion

For the realities of the Republic of Kazakhstan, there are various ways and solutions of using the spatial analyses. The combination of spatial information and its analytical interpretation with the use of statistical and other data in the form of multi-layered mapping of territories becomes the most popular direction for evidence-based decision-making. It requires the interaction of private and state-run companies, authorities and scientific circles. As a result, there should be coordination and interaction in which the initial raw data after passing through a series of processing, unification, and aggregation can be used in the decision support systems. All these initiatives as a pilot project can be launched at *Academy of Public Administration under the President of the Republic of Kazakhstan* in collaboration with the National company *Kazakhstan Gharysh*

¹⁵ Prikaz Ministra tsifrovogo razvitiia, innovatsii i aerokosmicheskoi promyshlennosti Respubliki Kazahstan ot 29 aprelya 2020 goda № 163/NQ "Ob ýtverjdenii instrýktsii, pravil, reglamentirýiyih poriadok sozdaniia, obnovleniia, ispolzovaniia Natsionalnoi infrastrýktýry prostranstvennyh danyih" [The order of the Minister of Digital Development, Innovation and Aerospace Industry of the Republic of Kazakhstan dated April 29, 2020 No.163/NQ." On the approval of instructions, rules governing the procedure for creating, updating, using the National Spatial Data Infrastructure"]. <http://adilet.zan.kz/rus/docs/V2000020535>

Sapary. Adapted to Kazakhstan's conditions spatial analysis and modeling courses can be firstly offered to the students of short training educational programs and after receiving feedback and making necessary corrections to suggest these innovative courses for teaching to post-graduate students.

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КЕҢІСТІК ТАЛДАУ: МЕМЛЕКЕТТІК ӘКІМШІЛІКТІҢ МОНИТОРИНГ ПЕН БАҚЫЛАУДАН БОЛЖАУ МЕН ЖОСПАРЛАУҒА ДЕЙІНГІ ЭВОЛЮЦИЯСЫ

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ПРОСТРАНСТВЕННАЯ АНАЛИТИКА: ЭВОЛЮЦИЯ ГОСУДАРСТВЕННОГО УПРАВЛЕНИЯ ОТ МОНИТОРИНГА И КОНТРОЛЯ К ПРОГНОЗИРОВАНИЮ И ПЛАНИРОВАНИЮ

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