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The challenges of desertification in Kazakhstan: Current Status and Tendencies

ABSTRACT

The context of this paper is about the challenges of desertification in Kazakhstan. Overall, about 66% of the country is prone to desertification and land degradation in one form or another. The main types of desertification in Kazakhstan determined in accordance with the criteria adopted in the Convention to Combat Desertification such as: vegetation degradation; water and wind erosion; soil salinization and dehumidification; chemical pollution of soil, groundwater and surface water; anthropogenic land disturbance and hydrological regime.

The study was conducted on the basis of the ecosystem approach as follows: “identification of threats - impact - the current state of natural and economic systems - trends - management.” In particular attention is paid to trends in climate change, the type and extent of human influence.

The significance of the paper is that created assessment and mapping unit, identifying the main natural and anthropogenic factors of occurrence and development of desertification as the identification of threats to sustainable development of land. There has been done the zoning of the territory of Kazakhstan under the terms of the formation and the level of risk of desertification. Moreover, applied science foundations of natural risks associated with the exposure to natural and socio-environmental sites on desertification, in order to prevent and reduce damage from desertification.

Developed a set of measures to reduce the rate, risk and damage from the impact of desertification on the natural and economic system of Kazakhstan. Assessment and mapping of degree types, rates, and the risk of desertification is one of the complex criteria state territory and may be the basis for the formation of a rational organization of the territory.

INTRODUCTION

The Republic of Kazakhstan is the tenth largest country in the world because of its territory. The country is characterized by desert, semi-desert and steppe, which in combination with the arid and continental climate causes the vulnerability of ecosystems to desertification and land degradation. Another factor influencing the growing problem is the anthropogenous activities. So far, the problems of desertification and land degradation are particularly relevant in the Aral Sea, Balkhash, as well as areas where those there have been with an intense of oil and gas in the Western and Southern of Kazakhstan. Overall, about 66% of the country is prone to desertification and land degradation in one form or another.

The objective of this thematic review is to conduct a situational analysis on the problem of desertification and land degradation. The basis of it went to legal materials, experience of government agencies on this issue, as well as research and development projects relating to desertification and land degradation.

The Convention to Combat Desertification was signed in 1994 and ratified in 1997, where Kazakhstan took a number of obligations, such as an integrated approach to the planning and implementation of activities to combat desertification and its relationship to the fight against poverty, promote awareness and participation of the local population to promote the exchange of information, transfer, acquisition and adaptation of technologies to combat desertification.

The problem of desertification in Kazakhstan

The problem of desertification and land degradation is a complex and multifaceted. It is associated with water supply and water management, with agricultural practices, the quality of soil and vegetation, climate change and biodiversity conservation. The complexity of the situation is recognized in the Convention itself, where attention is paid to its synergies with other international conventions that are due to communication problems of desertification and land degradation to poverty is creation of new jobs, increasing employment, improving education and training, along with the development of resource-saving technologies and the introduction of the principle of resource conservation in the legislation that led to the movement in the right direction.

Relevance. The desertification scale of negative manifestations and implications highlighted by the international community as the global environmental problems threatening the sustainable development of individual countries and territories. Regarding the recommendation of UNEP current decade of 2010- 2020 proclaimed as "United Nations Decade for Deserts and Desertification". The most affected by desertification, drylands, which includes 45% of the land area and is populated by 33.8% of people of the universe, they hold 46% of all carbon stocks and 50% of fed cattle, which are concentrated in 44% of all cultivated areas of the planet¹.

In the United Nations Convention to Combat Desertification the “desertification” term is defined as “the land degradation in arid, semi-arid and dry sub-humid areas resulting from various factors, including climatic variations and human activities.” Land degradation in drylands is defined as the reduction or loss of biological or economic productivity of drylands. Degradation affects a third of the Earth's surface, which consequently affects the lives of more than 1 billion².

According to Karibayeva K.N. (1991), anthropogenic factors leading to the emergence and development of desertification processes in Kazakhstan are connected mainly with such economic activities as: grazing; agriculture; development of mineral resources; construction and operation of industrial, military and civilian facilities, irrigation and linear structures. Desertification is also the result of illegal logging, uprooting shrubs and dwarf shrubs for fodder and fuel, forest and steppe fires, haphazard recreation organization dumps around settlements, pollution of soil and groundwater with toxic substance and the impact of transport.

The main types of desertification in Kazakhstan determined in accordance with the criteria adopted in the Convention to Combat Desertification such as: vegetation degradation; water and wind erosion; soil salinization and dehumidification; chemical pollution of soil, groundwater and surface water; anthropogenic land disturbance and hydrological regime.

¹ <http://www.unccd.int/Lists/SiteDocumentLibrary/Publications/DesertificationVisualSynthesisRussian.pdf,2013>.

² <http://www.un.org/ru/development/sustainable/desertification/>

Vegetation degradation is one of the most common and visually defines the process of desertification, manifested in the form of degradation of forests, rangelands and hayfields.

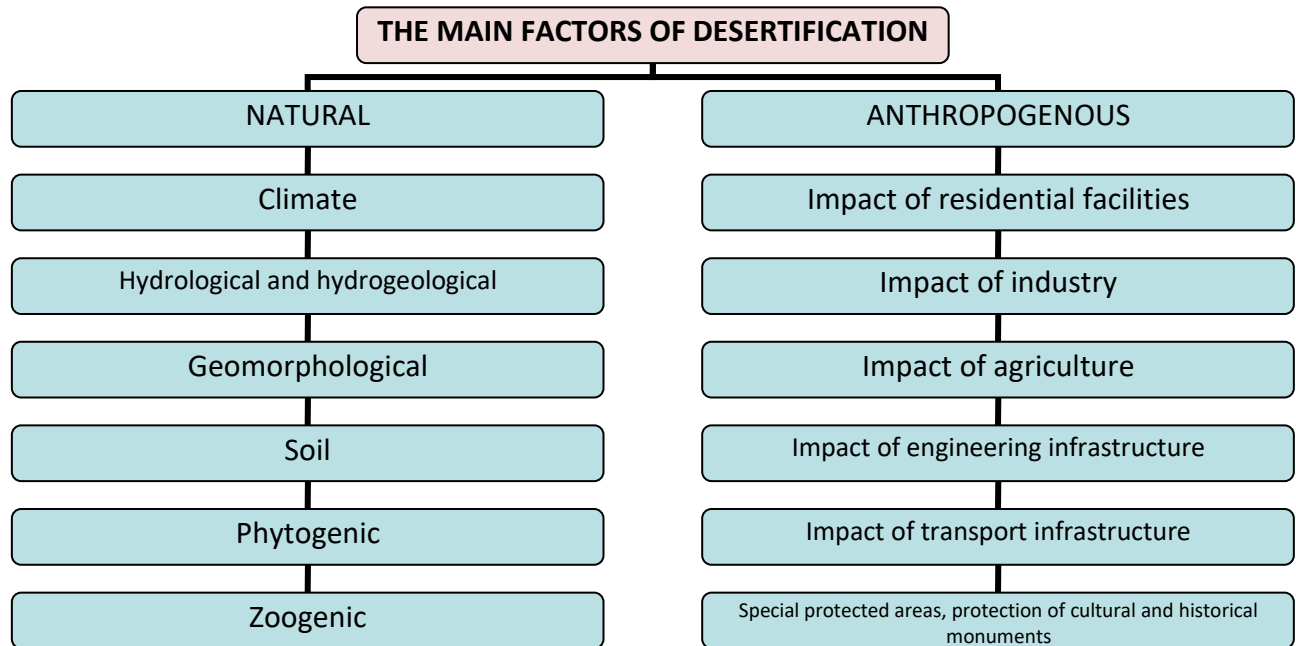
Desertification - soil degradation in arid, semi-arid and dry/sub-humid areas due to the action of various factors, including climate change and human impacts (UNEP, 1994). The most common concept relates to the desertification not only with the changes brought by climate, but also to changes caused by human activities. Among the causes of degradation caused by human activities can result in improper cultivation areas, overgrazing on pastures, deforestation and inappropriate methods of irrigation. Intensification of these actions resulted in the loss of resilience in dryland ecosystems (Enne and Zucca, 2000).

The study of the origin and development of the prerequisites of desertification, the development of methods to combat and prevent it involved scientists from all over the world, the International Conference on Combating Desertification (1977) suggested that “because of the 45 causes the desertification, which is 87%, it is due to the anthropogenic factors.” Many researchers also noted that the pace of spatial and temporal spread of desertification in most cases were directly related to the irrational and the mismanagement of human activities (Babayeva A.G., 1995).

The problem of desertification is very important challenge to Kazakhstan, 62.2% of which is occupied by natural desert and semidesert. It is observed the process of degradation of natural complexes, dry steppe subzone and dry sub-humid areas, such as forest and meadow steppes. Due to the fact that drylands are widely used in agriculture, industry and the accompanying engineering and transport infrastructure, which are widespread the anthropogenic desertification processes. From 93 428,2 thousand hectares of agriculture(31.1%) is in varying degrees, it subjects to the processes of deflation, 6.1% - erosion, including the territory of the steppe and forest steppe. Since the dry and arid regions produced the bulk of agricultural production in Kazakhstan, desertification in these regions endangers food security of the state.

Government of Kazakhstan signed a number of fundamental documents of national and international levels, which are directly or indirectly address the natural problem of desertification and economic systems. The strategic goal of the state policy of the Republic are to provide and maintain at an optimum level conducive to human habitats based on the progressive development of production, natural resource management and environmental protection. One of the major challenges in achieving this goal is to combat desertification and land degradation, which primarily should be based on the results of scientifically research.

The starting materials. There has been analyzed a large block of domestic and foreign publications on the conceptual, methodological and scientific applied on the aspects of desertification. The study is based on the experience of large and complex research of the Institute of Geography, Institute of Ecology and Sustainable Development in the last quarter of a century on the instructions of the central and local executive bodies, which are held with the participation of prominent scientists of Kazakhstan. In order to investigate, there was necessary to use considerable material on the current state of the main components of the natural environment at various levels, from local, regional to the country, including the authors of the study conducted in 1970, 1975-78, 1995-2000 and 2007-2011 years.



the ecosystem approach as follows: “identification of threats - impact - the current state of natural and economic systems - trends - management.” In particular attention is paid to trends in climate change, the type and extent of human influence. Conditional division of desertification on the components has allowed a deeper understanding of the causes and consequences, to determine the extent and intensity of the process and the possibility of forecasting. In line with the theoretical and methodological foundations with a detailed analysis of natural (relatively natural) and anthropogenic factors exploded to determine the degree and type of exposure (Figure 1).

Figure 1. The main factors of desertification

To assess desertification’s main component of natural and economic system defined input parameters, indicators which held their ranking.

An overview. Indicators - a statistic or measure related to the conditions, changes in the quality or condition of the object or thing of value (Dumanski and Pieri, 1996). They provide information and describe specific condition effects and are useful for monitoring changes, allow comparing trends and progress over a long period of time. The main challenge in identifying indicators is that it is necessary to select those that are reasonably representative but at the same time easy to understand and simple to measure on a regular basis (LADA, 2002).

Indicators should be SMART (specific, measurable, achievable, relevant and time-urgent). (Shomaker, 1997). Snel and Bot (2002) provide explanation on indicators which are SMART and it is as following:

S or Specific: A good indicator is one that does not allow for ambiguity and clearly defined.

M or Measurable: Indicators give planners and analysts to assess a specific problem qualitatively or quantitatively. Measurement methods used to collect data for indicators (from a scientific assessment to joint reviews) depends on the quality and scale (spatial and temporal) of data requirement.

A or Achievable: Since resources are limited, it is necessary to have the right set of indicators, cost-effective in monitoring.

R or Relevant: The set of indicators should clearly reflect the goals and objectives of the project / problem (for example, in this case, soil degradation) must be appropriate for those who make decisions and preparation of information should be linked to the information users. In some cases, the policy may already be interested in using this indicator (if available), in other cases indicators can be used to raise awareness on a specific issue.

T or Time-urgent: Good indicators are sensitive to important changes, such as changes in policies, programmes and institutions.

Biophysical indicators. Although the underlying causes of land degradation are poverty and lack of food security guarantees combined with the sharp of fluctuations in climate, the immediate causes of land degradation are inappropriate land use (such as overgrazing, excessive irrigation, extensive agriculture and deforestation), degradation of soil, water and vegetation and the loss of soil and plant biodiversity that affect the structure and function of ecosystems. Among the biophysical impacts of land degradation, leading to loss of productivity of the soil, such as water and wind erosion, salinization and chemical alkalization, physical and biological degradation. Distribution of soil degradation lowers the actual and/or potential ability of the soil to produce goods or services, while land degradation leads to the loss of intrinsic qualities required for a particular type of land use. Biophysical indicators of land degradation are described with the respect to the properties of the soil (e.g. soil fertility, soil productivity, soil compaction and loss of top and subsoil), erosion (e.g. sand on fertile soil, water turbidity and sedimentation, soil loss and washouts cases of formation), land cover (e.g. land cover change and intensive agriculture and grazing) and terrain (e.g. topography) (Snel and Bot, 2002).

Kuhlmann (2002) identified biophysical indicators as a soil and terrain, vegetation and land cover, climate and water. Soil quality is of paramount importance for the degradation because ultimately degradation leads to deterioration of soil quality. For more details on indicators of land quality is said in Kirkby and others publications (2000).

Socio-economic indicators related to the human factors causing land degradation, as well as the impact of land degradation on people (Kuhlmann, 2002). At the same time root causes the consequences of land degradation and desertification are often related to poverty and lack of guarantee on food security, coupled with the abrupt climatic changes such as drought, whether natural or artificial. Options are available to poor farmers and land users (land managers) to reclaim their land are much more limited than those available to richer farmers. Poor land managers are often forced to degrade the earth to give yourself daily survival (e.g. to ensure receipt of food); they have lack access to land, credit, cash, labor and livestock; and that in the absence of infrastructure, information and technology to help increase crop yields. When you try

to improve their lives, they face political marginalization. In the center of the main problems is poverty as the root cause and it is also a consequence of land degradation. At the same time cause and consequence of land degradation are more pronounced among the poorest segments of the population of the globe. Thus, socio-economic indicators are grouped around the key characteristics of poverty - lack of opportunities (e.g. lack of income, credit, land and other assets necessary to meet basic needs such as food, clothing and shelter); lack of security (e.g. vulnerability to adverse shocks and limited ability to cope with these attacks); and the lack of rights and opportunities (e.g. lack of voice and power to influence the decision-making process) (Snel and Bot, 2002).

It should be noted that in assessing the impact of processes of erosion, deflation and soil salinization, vegetation degradation, anthropogenic impact into account the percentage of the affected areas and the intensity of their manifestation. For example, when considering the territory of the Caspian Sea region of Kazakhstan to the geological and geomorphological assumptions the desertification attributed tectonic movements positive sign, creating areas of enhanced denudation³, prevents the development of soil that is especially true for the vaults of active salt domes.

One of the main methods for mapping the types and degree (class) of desertification was the interpretation of remote sensing data. For a comprehensive analysis and assessment of human impact on desertification of natural systems, pollution of the environment, including oil and gas industry were the most informative digital multispectral satellite images for the summer in 1982, 1987, 1998, 2000 and 2013. Satellite image of interpretation in geoinformative programme will allow a comparative analysis of changes in the damaged area (Kurochkina L.Y., Karibayeva K.N., 1973).

For example, the most significant transformation over the last 25 years has experienced low marine accumulation plains of the Northern Caspian Sea. This is mostly flat, sometimes weak partition of plains, the development of the modern coastline (sea-level 27 m) to an average of absolute elevations of 50 meters. The total area of their development, which is a 1982- 18043 km² decreased by 1998 to 11970 km² (33.6%) due to modern transgression of the Caspian Sea. Comparative analysis of regional data suggests that high and very high degree of desertification areas are characterized by intensive economic development. These primarily include oil and gas exploration areas from mining, hydrocarbons transportation to the places of their processing. An increase in the percentage of areas can be seen in 1982 and 1998. Areas of high (from 35.9% to 37.3%, respectively) and very high (from 11.8% to 13.5%) degree of desertification is entirely due to the active development of oil and gas resources in the region. With the most rapid effect has technogenic desertification on soil, vegetation and the animal world.

Analysis of the state of the main components of the environment, land use data, factors, types and degree of desertification by taking into account their dynamics are allowed mapping risk of desertification. The mapping allowed as medium and long term plans for socio-economic development of Kazakhstan and its regions.

³ Denudation - from the Latin is a biological term: wastage, detritions.

Allocation of areas with varying degrees of risk of desertification allows identifying areas in which it is first necessary to carry out actions to mitigate and neutralize desertification processes.

A comprehensive study of the current state of the natural and territorial systems, factors of desertification, the internal danger of desertification areas allowed a preliminary environmental zoning characterized by varying degrees of risk of desertification. Zoning will allow rational organization to plan ways of nature, limit human pressures, create favorable conditions for the stable functioning of natural-territorial systems with regard to their ecological capacity.

In assessing the extent of desertification of the integral component used by qualimetric approach. By experts percentage calculated as a “contribution” of each of the factors in desertification (Akiyanova, Abitbayeva and others, 2014).

The total sum of the classification of all factors will create an algorithm for estimating type, extent and rate of desertification. In this case, attention has been paid to desertification transition areas of natural areas that are rapidly destroyed and worse restored.

Taking into account the values obtained by methods of geoinformation mapping created integral of the “Map of desertification of natural systems” and “Map of desertification due to human activity” in the scale of 1: 5 000 000 and the resulting map of the “Desertification in the Republic of Kazakhstan” in the scale of 1: 1 500 000.

The main results of the assessment and mapping of desertification in Kazakhstan. Mapping integral indicator and analysis of the results revealed some patterns in the spread of the territories subject to varying degrees of desertification caused by natural and anthropogenic factors.

Analysis of the “Maps of desertification of natural systems” show that almost “conditionally natural” form of the territory of special protected areas (SPA) and hard of undeveloped and underdeveloped mountainous regions of south-east constituting 5.2% of the territory of Kazakhstan. Areas affected by desertification to a small extent of amounts is almost one-fourth of the country (18.3%). These include the areas of lowland forest-steppe landscapes of the north of the republic and the steppe, dry steppe, semi-desert landscapes basement of plains denudation and low hills of the eastern slope of Sary-Arka, small areas of the intermountain plains of the south-east of Kazakhstan.

Most of the territory of the country affected by desertification of the natural complexes in a moderate is 37.4%. Plots of land are present in the forest-steppe and steppe zones, but most of the dedicated to the semi-desert and desert regions. 28.3% of the territory of Kazakhstan is largely prone to desertification, to them are attributed the territory of the sandy deserts of the Caspian, Aral and Pribalkashya. High degree of desertification (10.8%) are affected the areas of shifting sands and sors-suffusion plains.

Analysis of the “Maps of desertification areas under the influence of anthropogenic factors” showed that desertification is absent or developed to a lesser degree by 3.4% of the country. These above all are sparsely populated and poorly developed areas. Marginally is affected by desertification and semi-desert areas within the least developed areas of the south-east of Atyrau, Aktobe south, south Mangistau, the western part of Kyzylorda and Zhambyl regions making up

almost one-fourth of Kazakhstan (26.0%). Desertification processes moderately susceptible to the northern part of Western Kazakhstan, the central latitude of the Mangistau region, the northern and south-eastern parts of the South Kazakhstan region. The area of moderate impact of anthropogenic factors is 24.5% of the territory of Kazakhstan.

Particular attention should be paid to areas affected by desertification in large and strong powers, which together occupy more than half of the territory of the republic and make up 38.4%. Strong degree of desertification is typical for areas of active industrial development in Karaganda, Pavlodar and East Kazakhstan oblasts. It is planned to increase the impact of certain vector anthropogenic factors helped to create a summary map of natural and anthropogenic desertification in Kazakhstan in scale of 1: 1 500 000. The materials suggest that a moderate, significant and severe desertification is subject to more than 76.2% of the territory of Kazakhstan. Of these, 105.4 thousand grade-strong (3.9%) km² in the 432 km² significantly - (15.8%), moderate - 1539.3 km² (56.5%). And most of the territory with a considerable degree is desertification, which is not characteristic of natural desert, dry steppe and steppe for zones through the development of negative processes (deflation, erosion and salinity) within the arable land. Strong degree of desertification is observed in areas of active development of the resources of the fuel and energy complex (oil and gas producing of the Caspian Sea, Karaganda coal and etc.). Leading type of desertification occupies 464.0 thousand km² of the territory of the Republic, which is a complex type, including the technological impact of degradation or complete destruction of soil and vegetation layer.

The main types of desertification in Kazakhstan are vegetation degradation, erosion, deflation, salinization, dehumidification, chemical contamination of soils and anthropogenic land disturbance.

On the map of the “Desertification in the Republic of Kazakhstan” with the scale of 1:1 500 000 created in geoinformation systems, background color shows the degree of natural-anthropogenic desertification and desertification of shading- types (Figure 2).

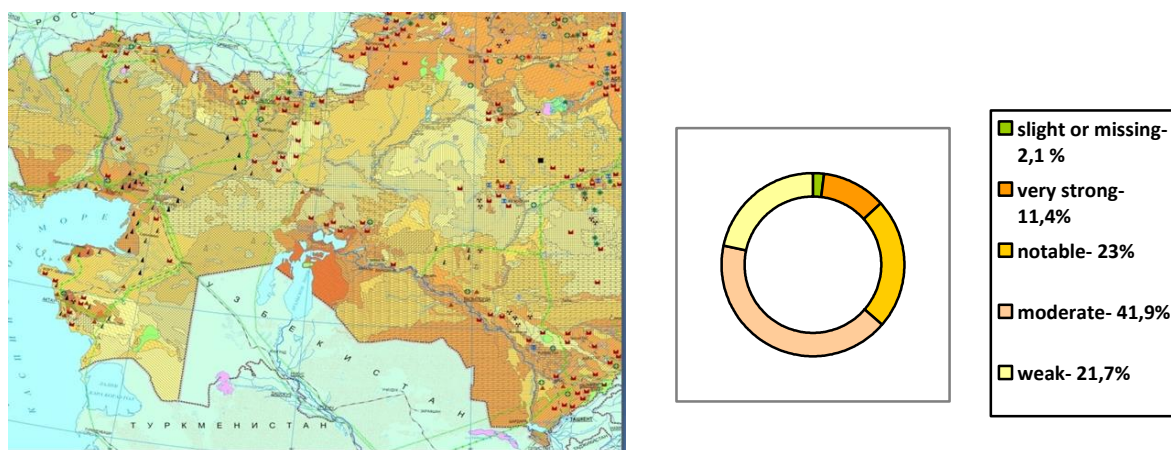


Figure 2. The degree of natural-anthropogenic desertification and desertification of shading-types

The first attempt to assess and map projection (trends) of desertification in Kazakhstan till 2030 on favorable and unfavorable development scenarios. Prediction of desertification of the environmental components was carried out on the basis of studying the main trends and the pace of development of natural processes in two (2005, 2010) years or more time slices. The basic approach in risk assessment was a comparative analysis of the extent of desertification for the periods was indicated. Risk analysis of desertification and its mapping allowed for zoning risk of

desertification with the release of the zone of low, moderate and high risks. Zones of low-risk characteristic of the plains arid landscapes of the North-East, the desert and semi-desert landscapes of South-Western Kazakhstan. The zones of moderate risk assigned regions of Central and South-East Kazakhstan, largely confined to the hummocky and mountain regions. The central areas of moderate risk areas tend high-risk areas, which account for almost a third of Kazakhstan and connected to a greater extent with the active sites of human impact.

Anthropogenic, including man-made impact on the type, degree and pace of desertification based on different levels of effectiveness of the implementation of environmental technologies. The basis for making the prediction maps of industrial and agricultural pressures on the environment was to analyze the development of industry and agriculture for the 1997-2010 biennium and accounting for changes in the future in accordance with the development strategies of the Republic of Kazakhstan and the General scheme of the organization of the territory of the Republic of Kazakhstan (Decree of the President of the Republic of Kazakhstan).

Conclusion. Through the development of integrated approaches to evaluation of natural and anthropogenic desertification and degradation of natural and economic systems created information and cartographic support for the fight against desertification, including assessment of the current state of the extent and types of desertification, the risk of natural and anthropogenic desertification through the application of geo-information technologies, and the development of a set of measures to reduce the rate and extent of desertification.

Created assessment and mapping unit, identifying the main natural and anthropogenic factors of occurrence and development of desertification as the identification of threats to sustainable development of land. There has been done the zoning of the territory of Kazakhstan under the terms of the formation and the level of risk of desertification. Moreover, applied science foundations of natural risks associated with the exposure to natural and socio-environmental sites on desertification, in order to prevent and reduce damage from desertification.

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