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Landscape science potentiality for the construction of buildings on megafans

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ABSTRACT: The possibility of using the potential of landscape science for the construction of buildings is considered on the example of two unique natural formations of Kazakhstan - megafans of the Talass and Kon rivers. Landscape science as a synthetic natural science discipline can contribute to the design of foundations for buildings and structures. The presented materials testify to the variety of variants of megafans, their dissimilarity, which entails the need for an individual approach to their assessment. The megafans considered by us are complex and diverse in their structure and do not always correspond to traditional ideas about alluvial fans and inland deltas. Separate cone-shaped formations included in their composition are facultatively closed; they correspond to the time stages of mudflow or, in the case of inland deltas, flood process. The approach outlined in the article is considered by us as an addition to engineering and geological surveys, which are mandatory when designing the foundations of buildings and structures. It gives a systematic vision of the subject of research. The approach is applicable in the development of a strategy for large-scale design of the construction of buildings and structures in the volumes of the country's regions.

Synthetic physical-geographical discipline - The Science of Landscape - has been developing in Kazakhstan since the early 60s of the last centuries. Its foundations were laid in the 19th century by the outstanding Russian naturalist V.V. Dokuchaev. The subject of study of landscape science are natural formations of different hierarchical levels.

Landscape cartography serves as a source of new information about natural formations, the basis for creating thematic maps for various scientific purposes and theoretical generalizations. Two giant (more than 10^5 km^2) fan formations - alluvial fans and inland deltas in the basin of the Talass and Kon rivers were chosen by us for a closer acquaintance with the possibilities of landscape maps for the construction of buildings. These natural formations are the main arena for the life of the population in arid conditions and the objects of the construction boom that has unfolded in the country.

1 TALASS COMPOUND MEGAFAN

1.1 *Landscape map of the Talass river alluvial fans*

The landscape map of the Talass river megafan is shown in Figures 1 and 2).

a – Current lines of former water-ground flows drawn along watersheds (solid, dotted and dotted lines correspond to alluvial fans of landscape rank (Solntsev, 1948); b- corresponding to the tops of alluvial fans; c - branching nodes of current lines of former water-ground flows, corresponding to the tops of alluvial fans in the rank of morphological units of the landscape (tracts, facies) d – numbers of alluvial fans landscapes; e - the border of the Talass and Assa of alluvial fans systems; f – boundary of the Assa alluvial fans system of with fans superimposed on the Talass fans; g - boundary of the alluvial fans of the Ichkeletau mountains and the Talass system

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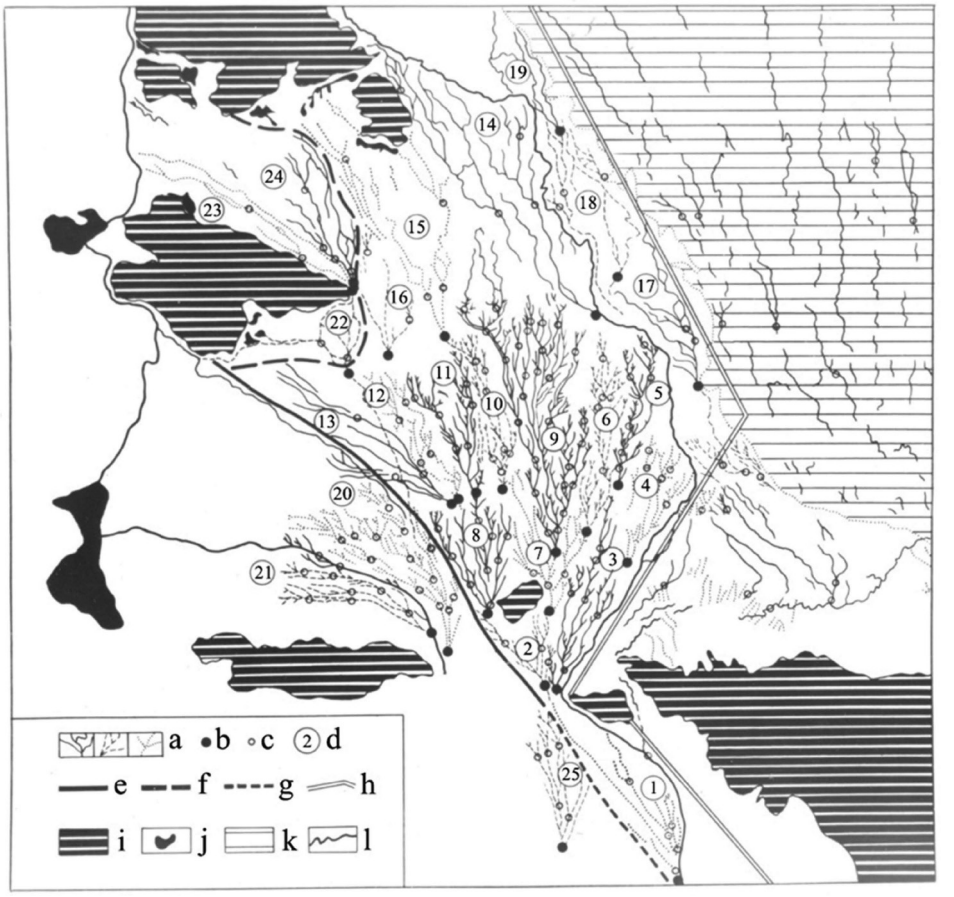

Figure 1. Talass system of alluvial fans landscapes (Ishankulov, Ropot, 1978, p.33).

of alluvial fans; h – boundary of the dead system of Talass alluvial fans, buried under eolian sediments of the Moyinkum and partially involved in the mountain uplift in the process of orogenization of the territory (restored by interpretation of aerial photographs); i - low mountains, remnant low mountain massifs and plateaus within the territory of the development of alluvial fans; j - lakes; k- sands; l – rivers-bed.

Talass alluvial fans landscapes system:

Active fans: 1 - Pokrovka, 2 - Dzhambul, 3 - Rovnoe, 4 - Karasu, 5 - Zylikha, 6 - Kosheni, 7 - Karatobekol, 8 - Zhanasaz.

Dying fans (transitional state from active to dead): 9 - Karashingil, 10 - Eshkilikbay, 11 – Kolkaynar, 12 – Shiyozek, 13 – Torangy.

Dead fans: 14 – Karabakyr, 15 – Dalazhailau, 16 – Kudeli, 17 – Upper Kokozek, 18 – Middle Kokozek, 19 – Lower Kokozek.

Assa river alluvial fans system: 20 – Karakemir, 21 – Kyrshandy.

Assa alluvial fans landscapes system superimposed on landscapes of alluvial fans of the Talass system: 22 – Karabuget, 23 – New Tasaryk, 24 – Old Tasaryk (Figure 2).

1.2 *Landscape map of the Talass river alluvial fans*

Tracts and their combinations:

1 – Delta streams, mostly sandy with a thin layer of silt, deposited during flood periods by undeveloped alluvial-meadow soils with succession changes of herbaceous communities.

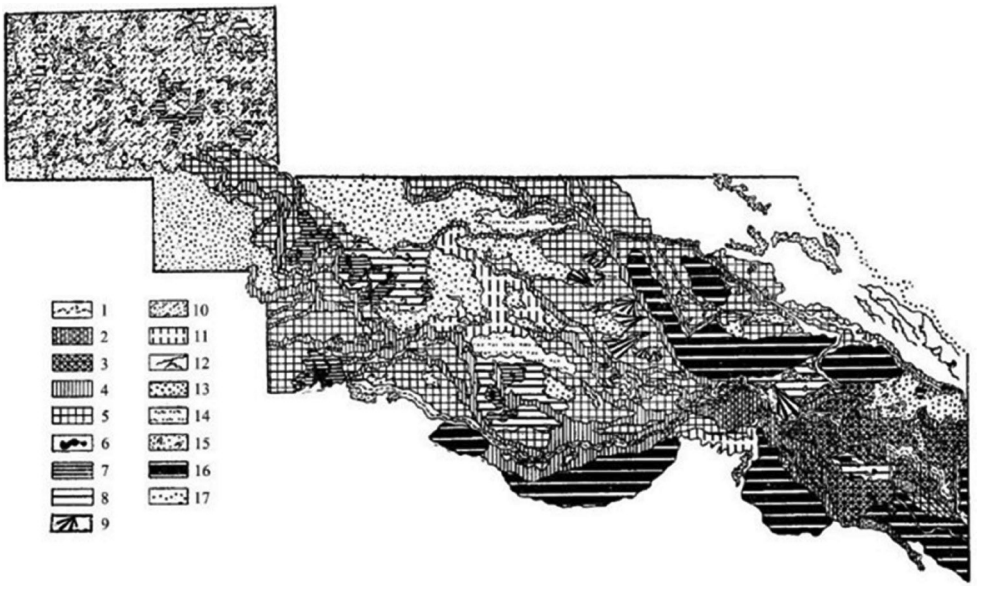

Figure 2. Landscape map of the Talass river inland deltas (Bogachev, Ishankulov, 1986, p. 22-23).
The map of inland deltas is a continuation in runoff of the map of Talass alluvial fans, presented in Figure 1.

2 – Embryonic levee, composed mainly of sands and sandy loams, washed out during floods with a multi-year periodicity; alluvial-meadow-tugai and alluvial-meadow soils under Salsola chingils.

3 – Embryonic interchannel depressions composed of medium and heavy loams during flooding for 10-40 days a year and groundwater at a depth of up to 2.5 m with meadow-bog and bog-meadow soils under reed-forb-reed, Climacopter-reed, Comba communities.

4 – Mature levee composed mainly of sandy loam and light loam when washed out during floods with annual or long-term periodicity with alluvial-meadow-tugai and alluvial-meadow soils under Elaeagnus angustifolia and Chingil tugai; in the absence of floods - with alluvial-meadow desertifying soils under Saltwort chingils, Aeluropus–limonium-Saltwort with Alhagi communis.

5-8 – Mature interchannel depressions composed of medium and heavy loams and clays (5) with year-round stagnation of waters entering the flood – deltaic lakes (6); with flooding 160-190 days a year and groundwater at a depth of up to 1 m with swamp soil under Typha angustifolia, Typha angustifolia-Phragmites communis, Aeluropus and Bolboschoenus communities (7); with flooding 100-110 days a year and groundwater at a depth of up to 2.5 m – with meadow boggy soils under Forb-read, Reed grass-Forb-Reed communities (8); with flooding 30-40 days a year and groundwater up to 5 m – with swampy-meadow and meadow-swampy decertifying soils under Elytrigia repens, Puccinellia, Tamarix and Halostachys communitis; in the absence of floods and occurrence of groundwater at depth of 5-10 m and deeper – with takyr-like soils under Artemisia-Anabasis salsa with Haloxylon aphyllum communities.

9 – Alluvial fans formed by temporary flows originating from the remnants surrounding land deltas, composed mainly of saline red-colored clays with gray-brown desert soils under Gramínea-Saltwort communities in the upper part and solonchaks along the periphery of alluvial fans.

10 – Eolian hilly-ridged sands processed by floods; with flooding 160-190 days a year and groundwater at a depth of 2.5 m with meadow boggy and swampy meadow soils under Forb-reed communities; with flooding 30-40 days a year and groundwater at a deep of 2.5-5.0 m – with alluvial-meadow soils under Forb grass-Calamagrostis communities.

11 – Runoff hollows filled with silty sands with alluvial-meadow soils under Artemisia- Puccinellia communities.

12 – Gully.
13 – Hilly-ridged sands with Agropyron fragile-Hordeum communities.
14 – Ridge sands with Artemisia-Agropyron repens-Eurotia ceratoides communities.
15 – Dune-hummocky sands with Artemisia-Agropyron repens communities.
16 – Monoclinal remnant ridges - local anticlines composed of red-colored clays, gray-brown desert soils under Artemisia pauciflora.
17 – The boundary of the sand massif Moyinkum.

2 KON COMPOUND MEGAFAN

2.1 *Proluvium of the North Kazakh Plain*

Five rivers of the basins of the Ob watershed of the Kazakh hills (Kon, Nura, Ishim, Olenty and Shiderty) created the North Kazakh plain. In the geographical literature, it is also called the Ishim plain, and sometimes the Ishim steppe. Each of the watercourses, upon exiting the drainage basin to the North Kazakh Plain, forms alluvial fans and inland deltas created by deposits of proluvial genesis (Figure 3).

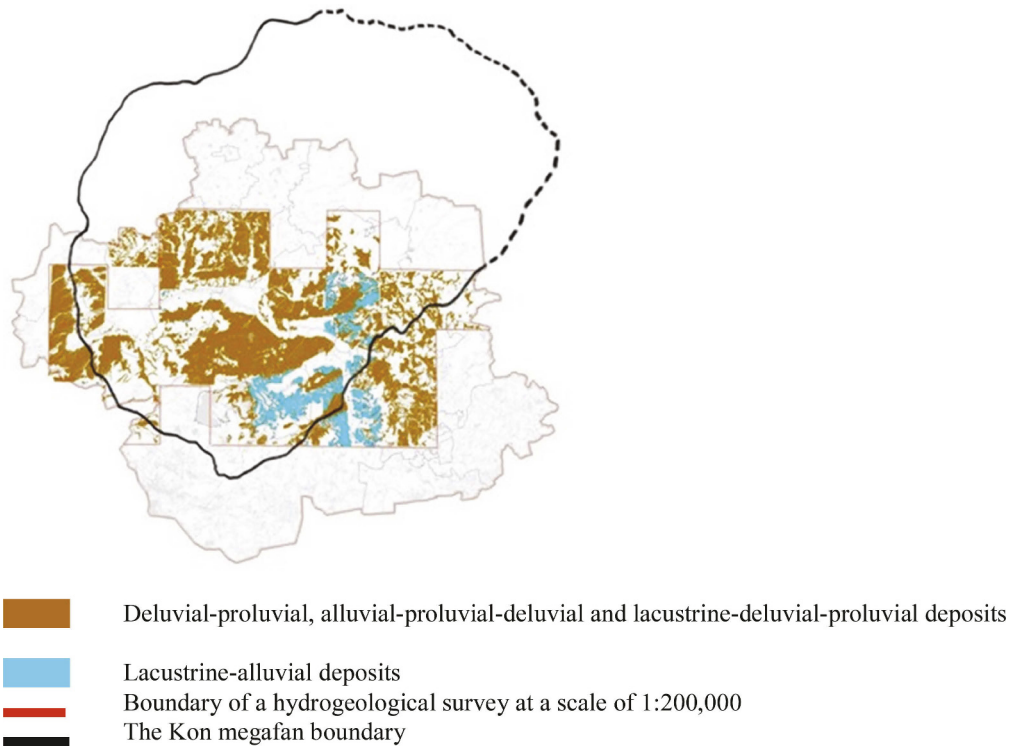

Figure 3. Proluvium of the North Kazakh Plain within the boundaries of the Akmola and Nurinsky districts of the Karaganda region (compiled by M.Sh. Ishankulov according to the hydrogeological maps of the USSR, m 1:200,000, surveyed in 1955-1979).

The alluvial fan of the Kon River stands out with gigantic dimensions against the background of all 5 alluvial fans of Kazakhstani rivers of the Ob watershed of the Kazakh hummocky terrain (Figure 4). Its area is estimated at 240,368 km^2; length from north to south – 586 km; from west to east – 587 km (Figure 4).

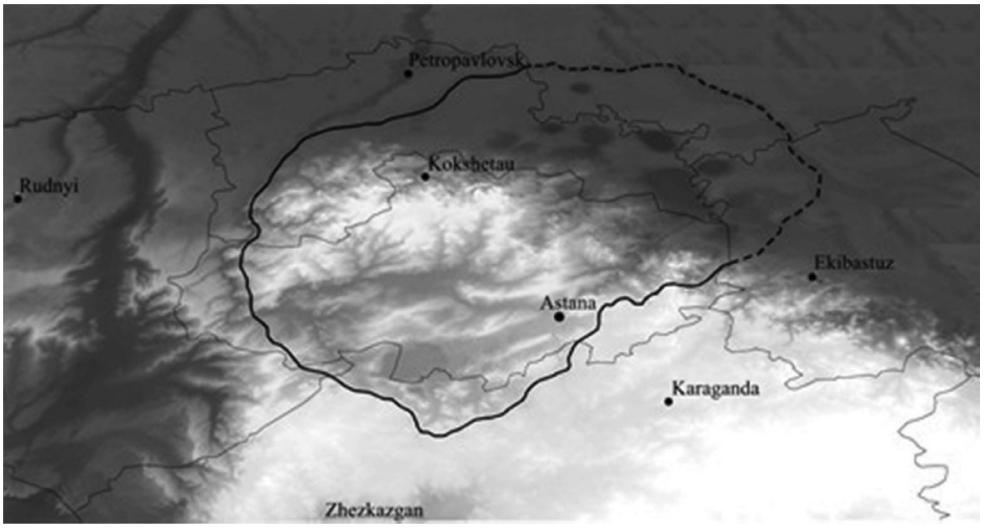

Figure 4. Proluvium of the North Kazakh Plain within the boundaries of the North-Kazakhstan, Akmola and Nura districts of the Karaganda region (compiled by M.Sh. Ishankulov according to the hydrogeological maps of the USSR, m 1:200,000, surveyed in 1955-1979). (The dotted line shows the proposed segment of the border. Thin lines inside the object of study are the boundaries of administrative regions).

The reason for such gigantism lies in the specifics of its origin and in the properties of the rocks of the catchment. The megafans arose due to the ultra-mud flow. Such flows are rare and represent one of the groups of mudflows and mudflows of the Earth, characterized by a grandiose scale of the process (Perov, 1996). As for the properties of rocks, it was found that the drainage basin of the Kon river is the only active river catchment area on the Ob watershed of the Kazakh hummocky terrain that can supply material with plastically viscous properties for in other watersheds mudflows - fatty Miocene clays. in other watersheds, such clays are absent or limited (Figure 5).

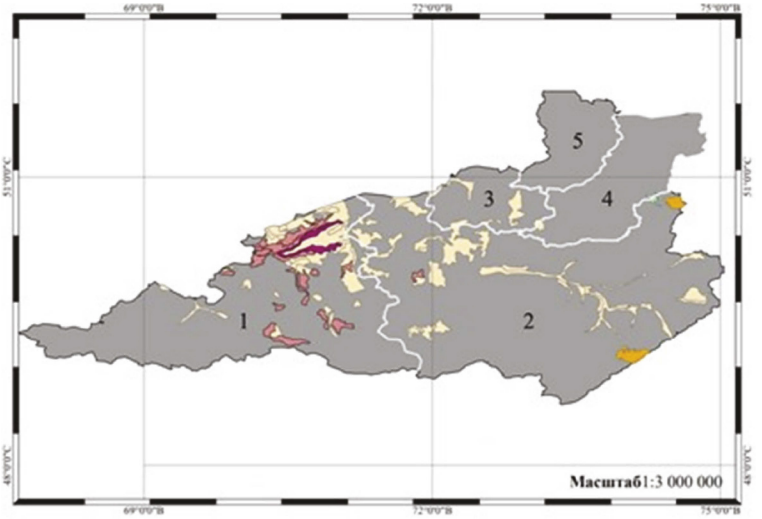

Figure 5. Resilience of rocks composing watersheds to displacement under conditions of extreme climatic situations. Drainage basins of the rivers: 1 – Kon, 2 – Nura, 3 – Ishim, 4 – Selety, 5 – Shiderty.

The object discovered in 2007 has not yet been studied with the same detail as the Talass compound megafan. However, the first results of the research say that the object is original and does not look like the Talass megafan at all. Its drainage basin is located not in the mountains, but in the hills of the Kazakh hummocky terrain.

Its top is composed not of coarse clastic material, but of red-colored saline clays, which led to the formation of saline deep-lying groundwater and soils of the saline series (Figure 6).

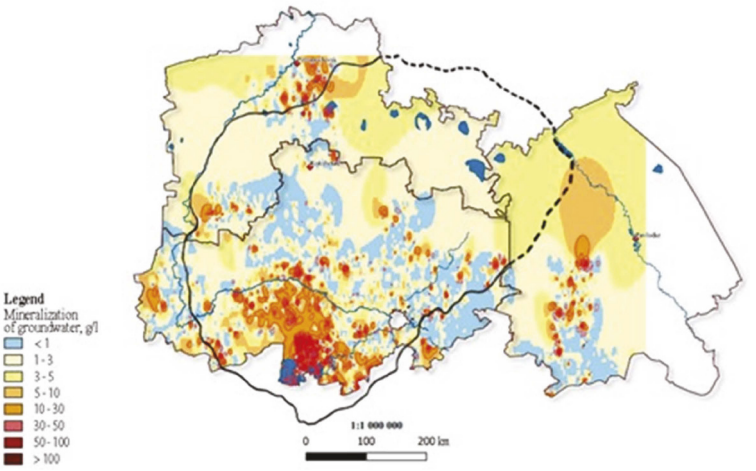

Figure 6. Mineralization of underground waters of the Kon megafan.

The issue of choosing a foundation for the construction of buildings is a key one and needs to be thoroughly considered. Construction objects in the cartographic material presented in the article are considered against a wide systemic natural background instead of the practiced point local consideration of specific objects that have little to do with the natural environment. The content of landscape maps testifies to the existence of a variety of options for megafans, their dissimilarity, optional isolation and the need for an individual approach to their assessment for construction purposes. They also contain specific detailed factual material in terms of soil characteristics, which is necessary when designing shallow foundations.

Practitioners-builders are little aware of the potential inherent in landscape maps and they are not used and for landscape specialists, familiarity with the subject of building construction can become a new area for the practical application of acquired knowledge.

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