

# Geoenvironmental assessment of the effect of oil extraction on the landscapes of the Chechen Republic

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**Abstract.** This paper analyzes the situation connected with the effect of oil extraction on the landscapes of the Chechen Republic. This study shows that the association of the Republic's petroleum production facilities with its mountainous regions with complex geological, geomorphological, and tectonic structures and the transitional areas conditioned the high inhomogeneity of the development of landscapes. The consequence of such development is the current complicated environmental situation both within the boundaries of the Republic's particular districts (depending on the location of oil extraction facilities) and within the territory of the Republic's capital itself as an urbanized landscape.

## 1. Introduction

One of the causes of the current environmental situation in the Chechen Republic are the consequences of the petroleum extraction and processing activities that have a long history (almost two centuries). The territory of the Republic where oil extraction took place has always been characterized by specific natural and climatic conditions. Throughout the entire period of this activity, significant changes occurred in the environment that reflected in the condition of the landscapes themselves. First of all, this includes the pollution of the natural constituents and the transformation of landscapes from natural to natural and man-made to completely man-made. Oil field development was accompanied by the formation and expansion of urban landscape (this is the way the city of Grozny shaped). In the Soviet era, the current capital of the Chechen Republic used to concentrate the largest oil-producing and petrochemical enterprises of that time. The events related to the political instability and the counter-terrorism campaign at the turn of the 20th century further exacerbated the environmental situation in the Republic. At the moment, the processes of oil extraction and processing have led to the contamination of all natural constituents both within the oil extraction areas themselves and far beyond the borders of the Republic itself if one takes into account that petroleum products become the source of pollution of the Terek River during floods and are then transported into the Caspian Sea. It is hard to provide a comprehensive geoenvironmental assessment due to the lack of reliable information about the consequences of oil extraction. This is why it will be given on the basis



of the available data about the condition of the environment in the oil-producing areas.

Unlike the lowland landscapes, the mountainous landscapes are more subjected to the dynamics of nature and are less resistant to man-generated changes when scientific approaches to preserving the ecological balance are not adhered to. Oil extraction in the mountainous and foothill areas causes ground distortion, upheaval, increase in landslides and earthquakes, and is accompanied by changes in the landscape structure.

## 2. Materials and methods

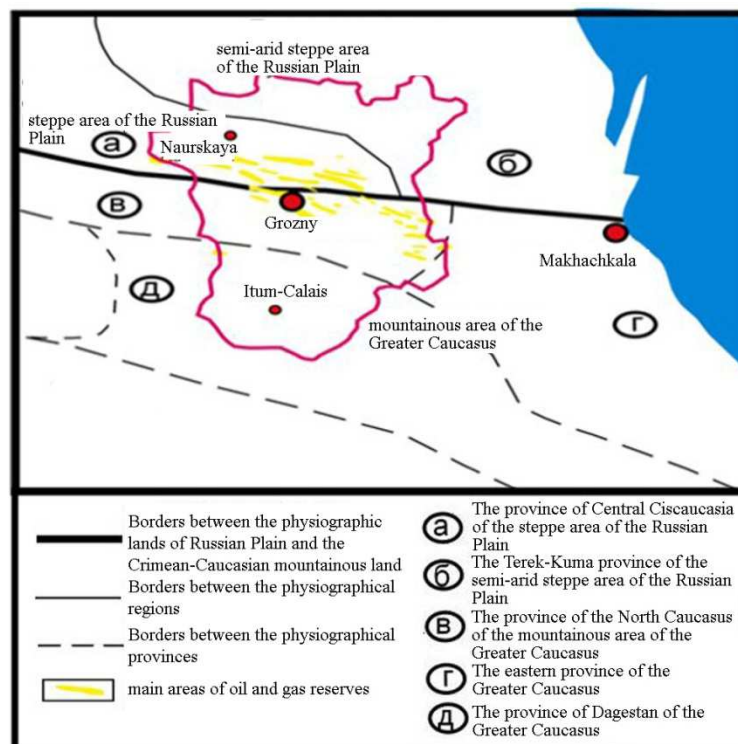
This research relies upon the results of the field studies carried out in the territory of the Chechen Republic to assess the effect of the objects of the petroleum complex on the natural environment of the city of Grozny. The work makes use of literary and statistical sources in this topic. The methods of statistical and comparative analysis were applied.

## 3. Research results and discussion.

Oil extraction in the Chechen Republic was carried out in the landscapes that coincide with geodynamically active areas. Structurally and tectonically, these areas encompass two contrasting morphological elements of the Caucasian segment of the Alpine-Himalayan mobile belt: the Terek-Caspian foreland basin and the Greater Caucasus orographic area.

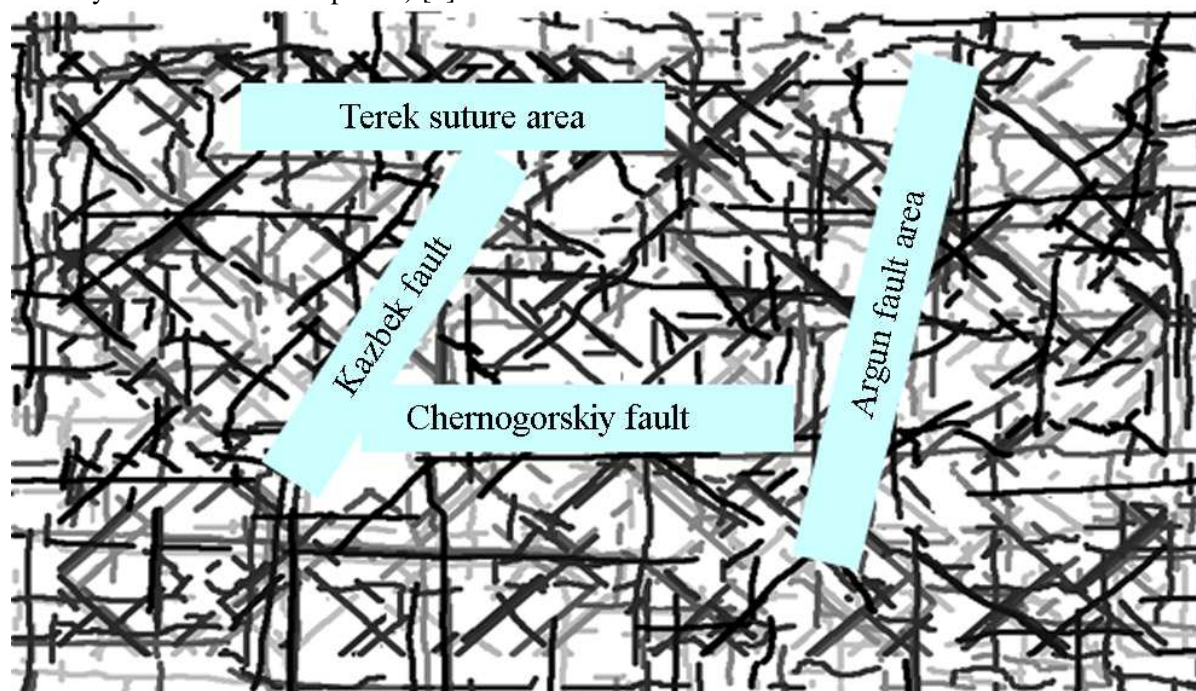
The uniqueness of the territory of the Chechen Republic as an oil-producing region lies in that large lenses of oil are located in the immediate vicinity of an active orogenic area and coincide with the "nodes" that have shaped at the joints of high-level physiographic units. The oil-bearing area within the territory of the Republic lies at the border of two tectonic formations that serve as a foundation for two physiographic lands: the East European (Russian) Plain and the Crimean-Caucasian mountainous area [3].

Superimposing the oil field data on the map of physiographic differentiation allows to make the conclusion that they are closely related and that the oil fields are associated with different types of landscape (Fig. 1).



**Figure 1.** Main oil field concentration areas in the Chechen Republic on the map of physiographic regions of the USSR, 1968

Fig. 2 highlights lineaments (or morphostructural lineaments according to Gerasimov, 1973) (based on wavelet transform) of various hierarchical levels for the terrain and the orthogonal components of the image. Very often, the identified lineaments coincide with known geological structures (this issue is yet to be studied). Lineaments were identified during the study of the landscape structure using remote sensing data (this scheme was prepared in the course of small-scale landscape mapping of the territory of the Chechen Republic) [4].



**Figure 2.** Identification of lineaments (based on wavelet transform) of various hierarchical levels for the terrain and the orthogonal components of the (space) image.

The uniqueness of the location of the Chechen Republic on the junction of mountains and foothills as well as different physiographic lands and regions imposes special requirements to the study of the effect of oil extraction on the environment. In the recent 100 years, the leading factor in the shaping and dynamics of the landscapes of the Chechen Republic has been the anthropogenic activity focused, first of all, on the extraction of oil.

The environmental consequences of such industrial influence related to extraction, transportation, storing, and processing of oil are very diverse in forms and hazard level. Exactly the same substances behave differently in different landscapes and geochemical conditions: in some cases, they are stable and even inert, while in others they may not only be subjected to quick transformations but also actively interact with the soil material. This usually concerns mountainous and foothill territories formed of coarse-grained deposits and other materials that are easily permeable by pollutants.

The association of the petroleum production facilities of the Chechen Republic to mountainous territories, ecotones, and large physiographic borders facilitated the high inhomogeneity of the conditions of the development and spatial differentiation of landscapes, which together with the development of the petroleum industry has reflected in the space-time and vertical component structures of the natural and man-made landscapes, particularly in the distribution of areas with deep transformation of natural components and the axes and zones of spread of effect. Many important regularities of the macro-level physiographic differentiation that are related to tectonic and geomorphological factors have become more convex than the influence of the long-term effect of the petroleum industry facilities. At the same time, the maximum disruptions of natural landscapes and

their transformation to natural and man-made and completely man-made can be observed in the area encompassing the city of Grozny and the adjacent territories.

The long-term development of the petroleum industry facilities has lead to the formation of a new environmental situation in the Republic that requires a comprehensive study and adoption of measures to optimize the management of natural resources.

#### 4. Conclusion

Until the early 90ies of the 20th century, The Chechen Republic used to be one of the largest petroleum industry centers of the country. The continuous oil extraction activities have delivered a highly negative impact on the environment. The natural components have in many cases been subjected to such a profound influence that the processes that followed can be characterized as irreversible. That means that the landscapes can not return to their natural condition unless new approaches to the remediation and restoration of the disturbed landscapes are applied. A new man-made landscape structure has formed with its own natural elements.

At the end of the last century, in the period of political turbulence, massive destruction of the oil extraction and processing facilities occurred across the territory of the Chechen Republic as a result of armed conflict. Accidents resulted in the disruption of settling pits and oil sludge facilities. This lead to the appearance of focal points of oil contamination of groundwater, vadose zones, and soils and to disruption of the natural balance in oil extraction sites, especially within the territory of the city of Grozny. This period is characterized as a new stage of the negative impact on the natural and man-made environment when indiscriminate interventions were made into the environment in the sites of oil extraction, transportation, storage, and processing and the environmental requirements and regulations were virtually disregarded.

Worldwide, the issue of the effect of oil extraction on the environment is no less urgent and is given sufficient attention by researchers [5-8].

This way, the long-term development of the oil industry facilities and the consequences of armed conflict have resulted in the formation of a new environmental situation on the territory of particular districts of the Chechen Republic and its capital. This situation requires a comprehensive study of the existing problems using the most advanced approaches to the assessing impact and the possibilities of restoring the disrupted environment and optimizing the management of natural resources.

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