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# INTEGRATED LANDSCAPE PLANNING OF ROADSIDE ZONES AND REST AREAS IN ARID REGIONS

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**Abstract.** Integrated landscape planning of roadside territories in arid regions plays a crucial role in improving environmental sustainability, transport safety, and the comfort of long-distance mobility. This study examines landscape planning principles for roadside zones and rest areas along the A-380 Guzar–Bukhara–Nukus–Beyneu international highway within the Republic of Karakalpakstan. The region is characterized by extreme continental climate conditions, desertification processes, soil salinity, and water scarcity, which significantly influence the design and maintenance of transport-related landscapes. The research aims to develop scientifically grounded planning solutions for roadside green infrastructure and multifunctional rest areas adapted to arid environments. Methods include spatial analysis, climatic assessment, field observation, and comparative evaluation of international arid-region practices. The results propose a hierarchical system of rest areas, drought-resistant planting schemes, and integrated landscape-architectural solutions that enhance ecological stability and user comfort. The findings may be applied in regional transport planning and sustainable infrastructure development strategies.

**Introduction.** Arid and semi-arid regions represent one of the most challenging environments for infrastructure-related landscape planning. In such territories, transport corridors are not only engineering structures but also key spatial elements shaping regional ecological balance and human perception of the landscape. The Republic of Karakalpakstan, located in the north-west of Uzbekistan, is among the regions most affected by desertification and climate stress due to the Aral Sea crisis.

The A-380 Guzar–Bukhara–Nukus–Beyneu Highway is a strategic transport corridor connecting central and western Uzbekistan with Kazakhstan. Along its Karakalpakstan section, long distances between settlements, harsh climatic conditions, and monotonous desert scenery necessitate the creation of well-planned roadside zones and rest areas. Integrated landscape planning is therefore essential to mitigate environmental impacts, reduce driver fatigue, and support sustainable regional development. [1,5]

## 1 Study area and transport context

### 1.1 Regional characteristics

The study area is located within the Republic of Karakalpakstan, characterized by flat relief, sandy and saline soils, and sparse natural vegetation. Climatic extremes and strong winds require special planning solutions for roadside spaces.

### 1.2 Role of the A-380 Highway

The A-380 Guzar–Bukhara–Nukus–Beyneu Highway is one of the most important international transport corridors connecting Uzbekistan with Kazakhstan and the Caspian region. The Karakalpakstan section includes long uninterrupted stretches without settlements, which increases the importance of well-distributed rest areas.

## 2 Landscape planning of roadside zones in arid regions

The research methodology includes:
-analysis of spatial planning documents related to transport infrastructure;
-assessment of climatic constraints affecting roadside landscapes;
-functional analysis of existing rest areas along arid highways;
-comparative study of rest area planning standards in Europe and Central Asia.

### 2.1 Roadside zones as landscape systems

Roadside zones in arid regions function as transitional landscapes between transport infrastructure and natural desert environments. Their planning must address:
-dust and sand movement control;
-visual monotony reduction;
-microclimate improvement;
-ecological stabilization.
Integrated landscape planning ensures that these functions are achieved simultaneously rather than separately.

### 2.2 Functional zoning of roadside territories

**Table 1.** Functional zoning of roadside territories

| Zone | Purpose | Planning elements |
|---|---|---|
| Protective zone | Wind and dust control | Earth berms, shrubs |
| Service zone | Rest area placement | Parking, pavilions |
| Visual zone | Orientation, identity | Landmark planting |
| Ecological zone | Soil stabilization | Native vegetation |

## 3 Current absence of organized rest areas along the A-380 Highway and the need for a scientific planning approach

Despite the strategic importance of the A-380 Guzar–Bukhara–Nukus–Beyneu Highway, field observations and analysis of existing infrastructure indicate that fully organized, landscape-integrated rest areas are currently absent along significant sections of the highway within the territory of the Republic of Karakalpakstan. [1,5]

At present, roadside stopping points are largely informal, unplanned, and lack essential facilities such as structured parking, shaded recreational spaces, and landscape buffering. These

spontaneous stop locations do not meet modern requirements for traffic safety, environmental protection, or user comfort, particularly under the extreme climatic conditions of arid regions.


**Fig. 1.** Section of the A-380 Highway crossing the desert territory of the Republic of Karakalpakstan.

### 3.1 Scientific justification for the planned organization of rest areas

Given the current absence of properly planned rest areas, this research adopts a forward-looking, design-oriented scientific approach. Within the framework of the present PhD dissertation, roadside rest areas are not analyzed as existing objects, but rather as planned landscape–infrastructure elements based on scientifically grounded principles.

The proposed approach is justified by:

-increasing long-distance traffic volumes along the A-380 corridor;

-elevated risks of driver fatigue in monotonous desert environments;

-the lack of ecological and spatial organization in roadside zones;

-international recommendations for rest area spacing on arid highways.

Thus, the dissertation introduces a new planning concept aimed at the systematic organization of roadside rest areas as part of an integrated highway landscape system**.**

### 3.2 Scientific novelty of the proposed concept

The scientific novelty of this study lies in the formulation of a previously non-existent planning and design model for the A-380 Highway corridor within the Republic of Karakalpakstan. Unlike descriptive studies of existing infrastructure, this research introduces a forward-looking landscape–architectural solution**,** intended for future realization. [4]

The novelty is defined by the following aspects:

-development of extended rest areas with integrated parking facilities**,** located at a controlled distance from the roadway;

-application of landscape buffer zones as primary design elements rather than auxiliary features;

-creation of a new spatial typology for arid-region highways, adapted specifically to Karakalpakstan's climatic and ecological conditions;

-integration of transport infrastructure planning with landscape architecture and environmental design.

This approach represents a new design paradigm for highway rest areas in Uzbekistan, particularly in regions where such facilities have not previously existed.

### 3.3 Conceptual "Before and after" design model (existing vs. proposed condition)

To clearly illustrate the proposed innovation, the study applies a "Before–After" conceptual model, demonstrating the transformation of the roadside environment along the A-380 Guzar–Bukhara–Nukus–Beyneu highway within the Karakalpakstan.

**Before (current situation)**

- no designated rest areas;
- uncontrolled roadside stopping;
- absence of parking organization;
- lack of shading, greenery, and microclimatic protection;
- increased safety and environmental risks.

**After (proposed design concept)**

- planned off-road rest areas at a distance of 150–400 m from the highway;
- structured parking zones for cars, buses, and trucks;
- landscaped buffer zones reducing dust, noise, and visual impact;
- shaded recreational spaces designed as micro-landscape environments;
- improved safety, comfort, and ecological stability.

**Fig. 2.** Conceptual "after" scenario: proposed landscape-integrated rest area with parking facilities (3D-like visualization).

### 3.4 Necessity of scientific implementation and future realization

The proposed rest area system is not presented as a theoretical abstraction, but as a scientifically grounded concept intended for implementation. The dissertation argues that the introduction of this new design model is necessary due to:

-the strategic importance of the A-380 highway as an international transport corridor;
-the absence of existing rest area infrastructure in Karakalpakstan;
-the specific environmental vulnerability of arid landscapes;
-international transport safety recommendations regarding driver rest intervals. [2,6]

The research therefore positions the proposed design as a pilot innovation, which can be gradually implemented in future development programs and replicated along other arid-region highways in Uzbekistan.

**Conclusion.** This study demonstrates that integrated landscape planning of roadside zones is a key factor in ensuring sustainable transport infrastructure in arid regions. The case of the A-380 Guzar–Bukhara–Nukus–Beyneu Highway in the Republic of Karakalpakstan highlights how extreme climatic conditions, desertification, soil salinity, and water scarcity influence the spatial organization and functionality of transport-related landscapes. The analysis confirms that, despite the strategic importance of the corridor, organized and landscape-integrated roadside rest areas are currently absent, which negatively affects driver comfort, road safety, and environmental resilience.

In response to this identified gap, the research proposes a scientifically grounded planning approach for the future organization of roadside zones and multifunctional rest areas adapted to arid environments. The scientific novelty lies in the introduction of a new landscape–transport planning model, in which extended rest areas with integrated parking facilities are designed as off-road landscape complexes separated from the roadway by buffer zones. The proposed solutions have practical significance for regional transport planning and may serve as a pilot model for sustainable highway development in Karakalpakstan and other arid regions.

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