

INTRODUCTION

- The coordination between the pavement structure and the regional environment should be developed to avoid early deterioration of asphalt pavement performance.
- Climate-based performance zoning can adapt the design of asphalt pavement structure to the local environment of a region.
- However, most climate zoning methods only considered the individual effects of temperature and precipitation, the correlations between complex environmental factors, such as temperature, precipitation, frozen soil and freeze-thaw cycles have not been considered.
- Performance zoning method of asphalt pavement that can link the applicability of vulnerability assessment to zoning schemes need to be studied.

OBJECTIVES

- To propose the performance zoning index system of asphalt pavement in Inner Mongolia.
- To establish performance zoning scheme of asphalt pavement in Inner Mongolia.
- To propose a performance zoning method for asphalt pavement in cold regions.

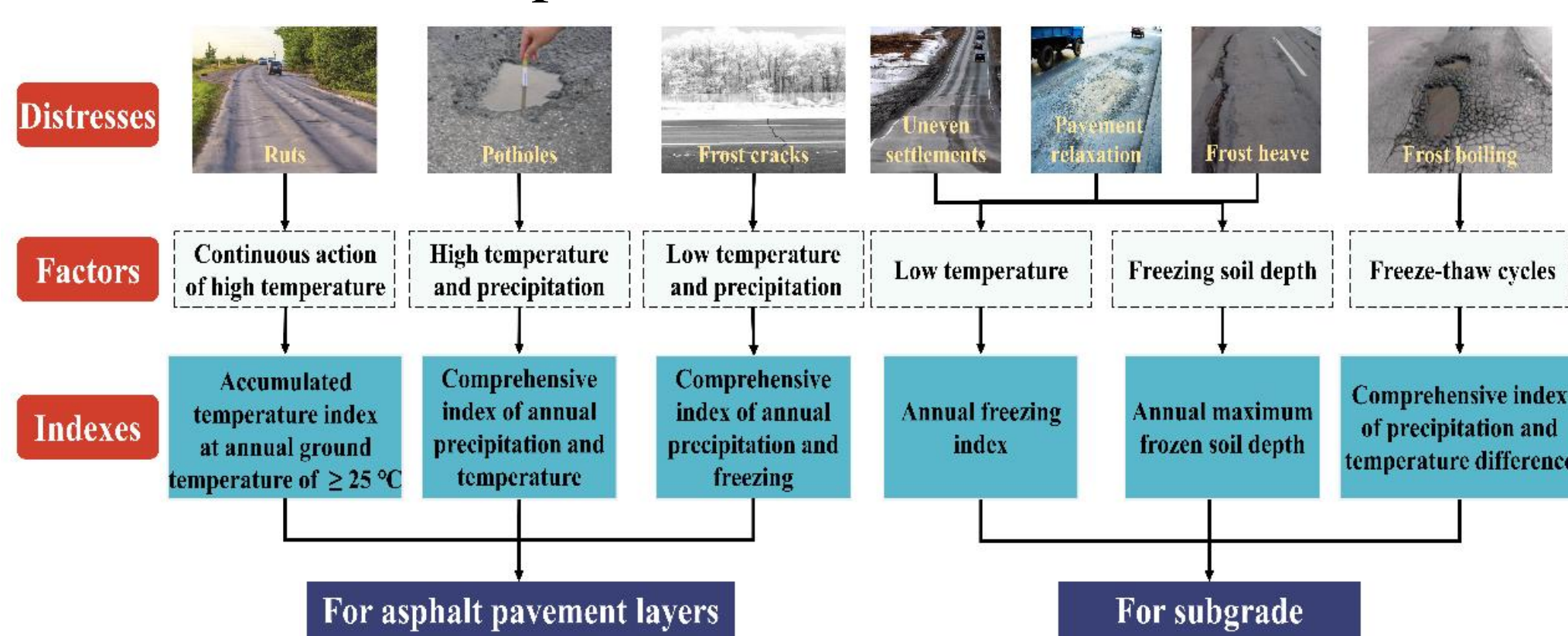
METHODOLOGY

Research region

- Inner Mongolia is located in the northern China, the climate in different regions of Inner Mongolia vary greatly that lead to the early deterioration of asphalt pavement.

Performance zoning methods

- Step 1:** different performance zoning indexes of asphalt pavement layers and subgrade were proposed based on environmental exposure effects.



- Step 2:** the zoning indexes were calculated based on climatic data of 36 meteorological stations in the past ten years, and spatially interpolated using ArcGIS platform.
- Step 3:** the service life of asphalt pavement was calculated based on the asphalt pavement performance prediction equations to verify the rationality of zoning indexes.

Layer	Thickness and material	Modulus (MPa)	Density (kg/m ³)	Poisson's ratio
Asphalt surface course	4 cm AC-13	7500	2300	0.25
Asphalt middle course	5 cm AC-16	8500	2400	0.25
Asphalt bottom course	7 cm AC-25	9000	2400	0.25
Semi-rigid base	20 cm cement stabilized macadam	8000	2100	0.25
Semi-rigid subbase	32 cm cement stabilized macadam	8500	2100	0.25
Subgrade	Infinite in-place soil	40	1800	0.4

- Step 4:** multi-index cluster and layer overlay methods were utilized to study the performance zoning of pavement layers and subgrade in Inner Mongolia.

DETERMINATION AND ANALYSIS OF ZONING INDEXES

Zoning indexes for asphalt pavement layers

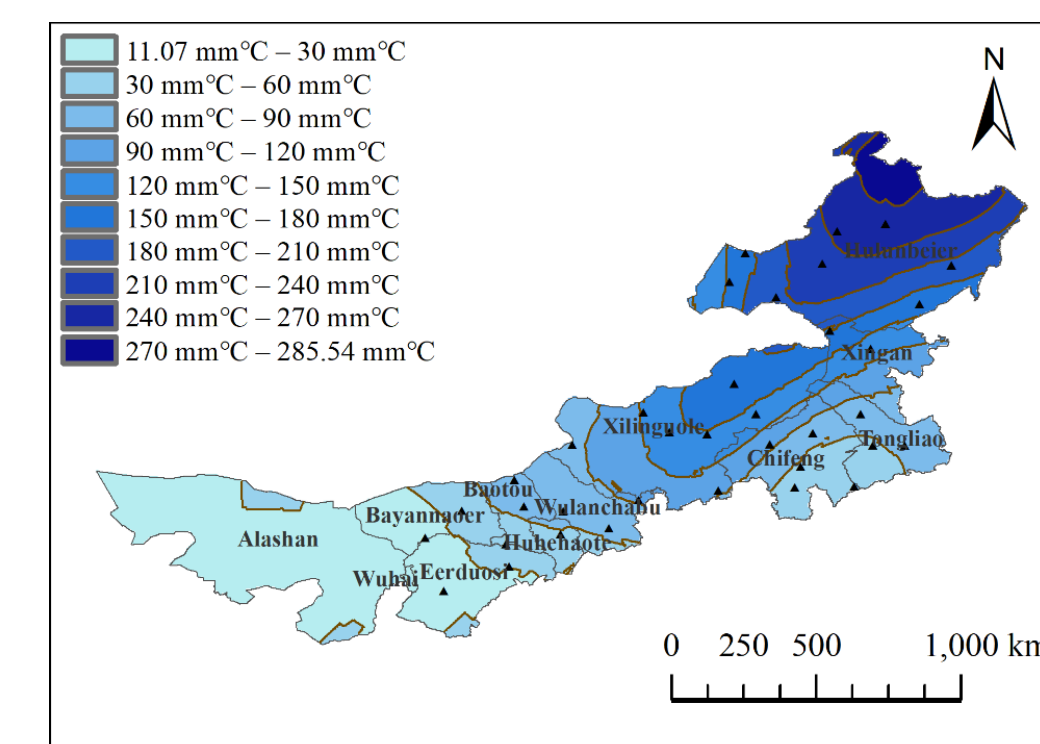
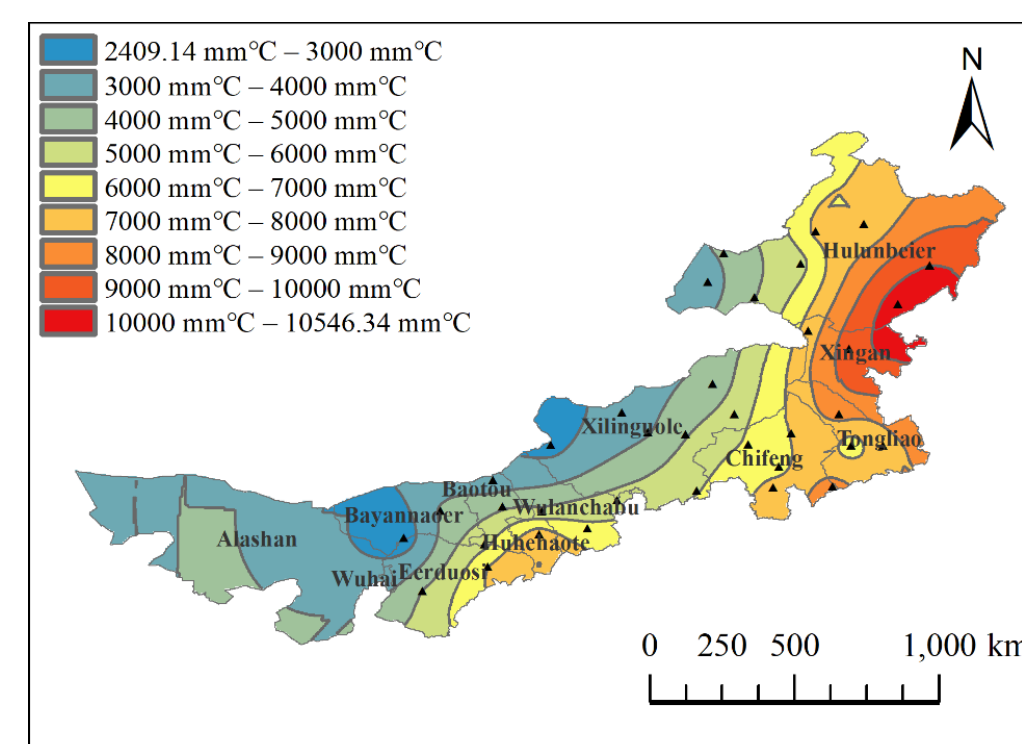
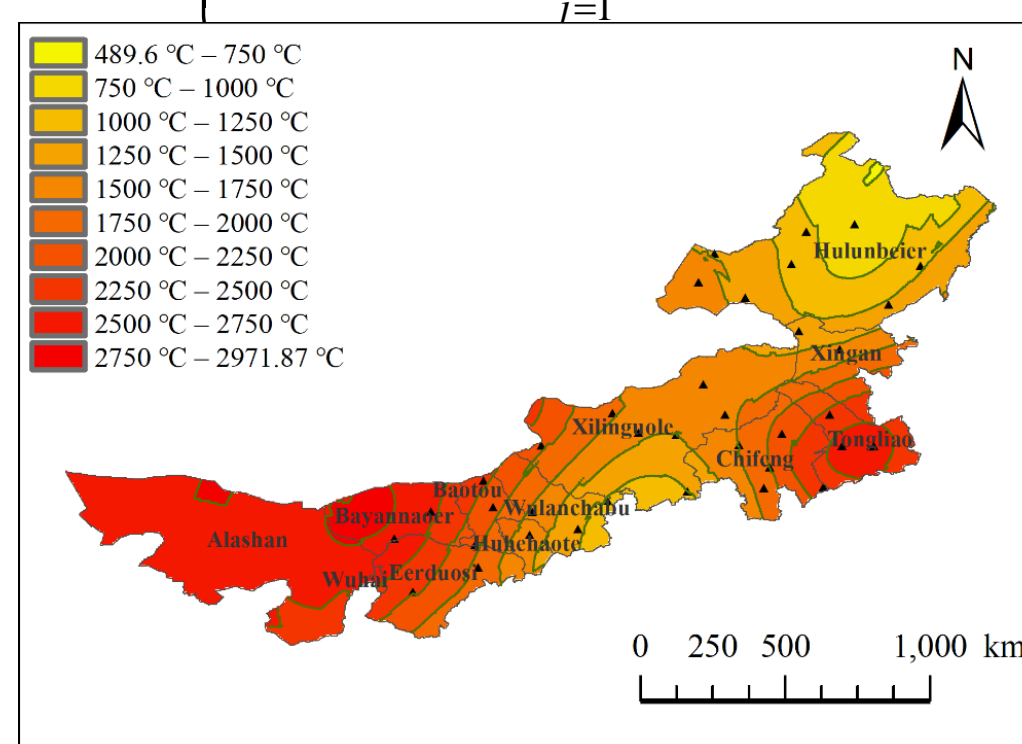
- Accumulated temperature index at annual ground temperature of ≥ 25 °C
- Comprehensive index of annual precipitation and temperature
- Comprehensive index of annual precipitation and freezing

$$AGT_{25^{\circ}\text{C}} = \frac{1}{n} \sum_{i=1}^n AGT_{25^{\circ}\text{C},j}$$

$$AGT_{25^{\circ}\text{C},j} = \sum_{i=1}^m g [T_{i,j}]$$

$$PT_{0^{\circ}\text{C}}I = \frac{1}{n} \sum_{i=1}^n \sum_{j=1}^m (g [T_{i,j}] \times P_{i,j})$$

$$PFI = \frac{1}{n} \sum_{i=1}^n \sum_{j=1}^m (g [T_{i,j}] \times P_{i,j})$$



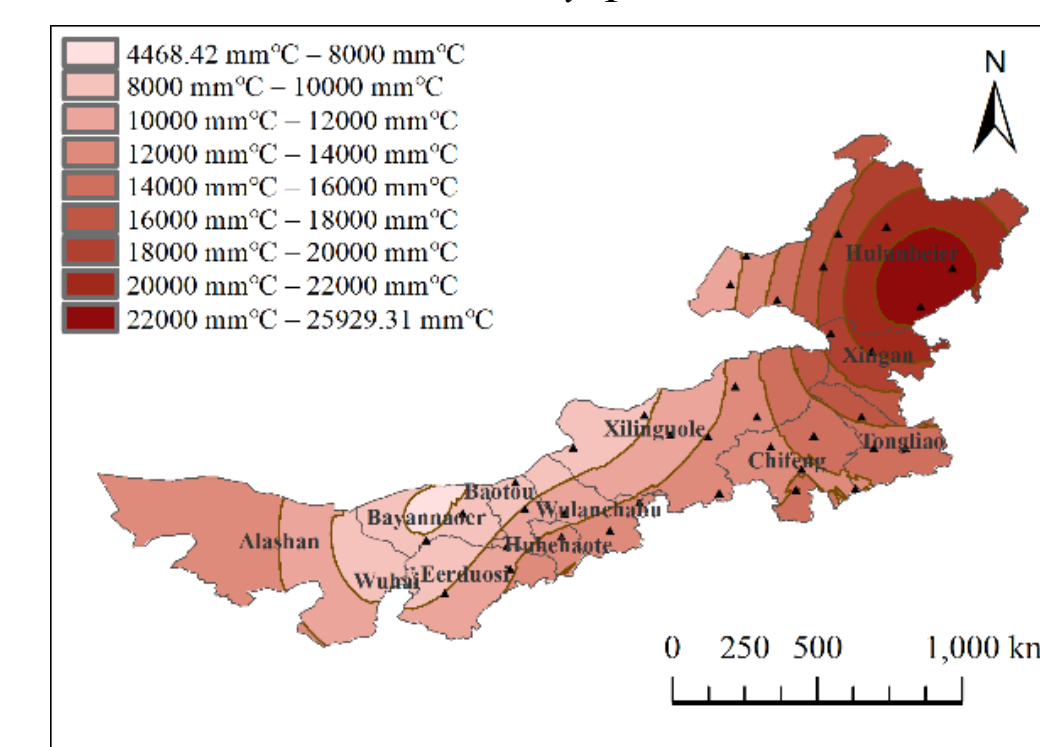
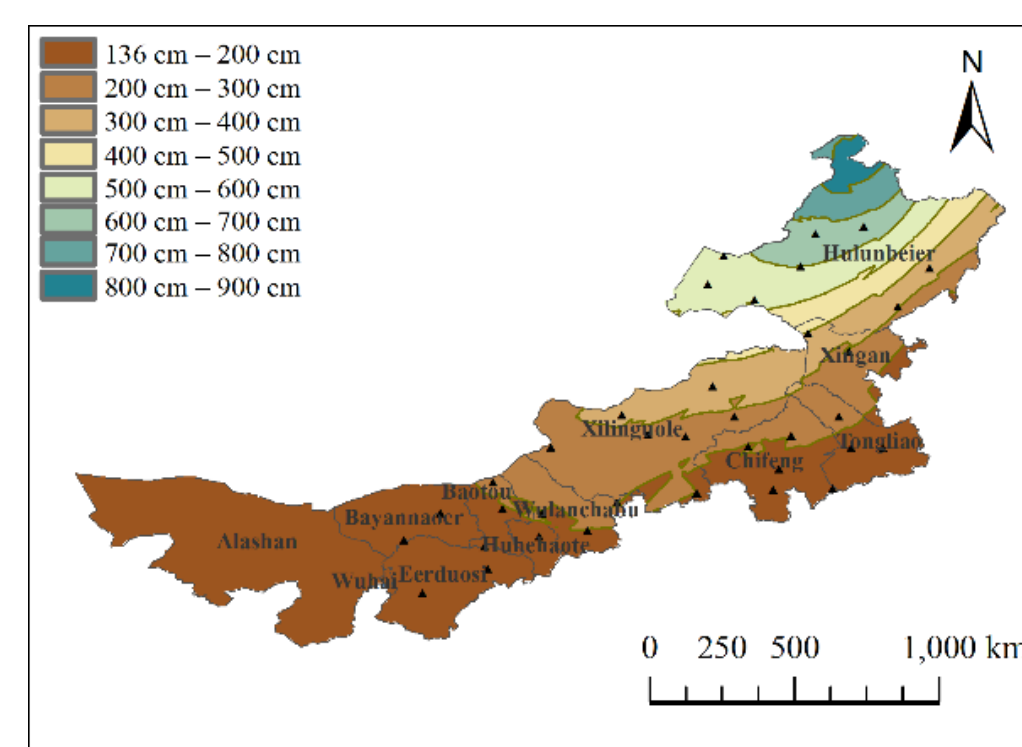
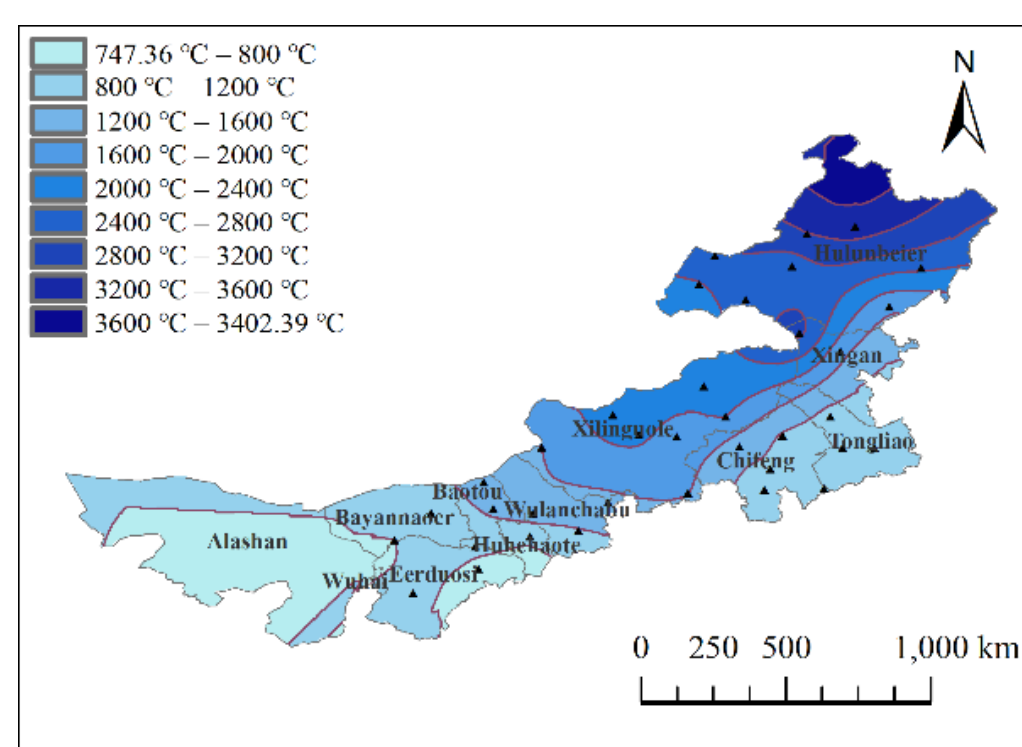
Zoning indexes for subgrade

- Annual freezing index
- Annual maximum frozen soil depth
- Comprehensive index of precipitation and temperature difference

$$FI = \frac{1}{n} \sum_{i=1}^n \sum_{j=1}^m |A [T_{i,j}]|$$

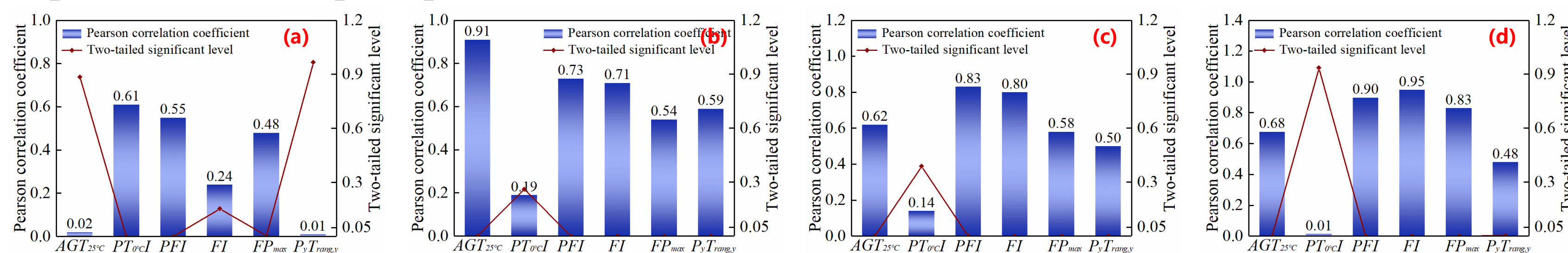
$$FP_{\text{max}} = \max_i (FP_{\text{max},i})$$

$$P_y T_{\text{rang}, y} = \frac{1}{n} \sum_{i=1}^n P_y \times T_{\text{rang}, y}$$



Zoning Indexes Verification

- It is verified that the proposed performance zoning index can better characterize the service performance of asphalt pavement structure

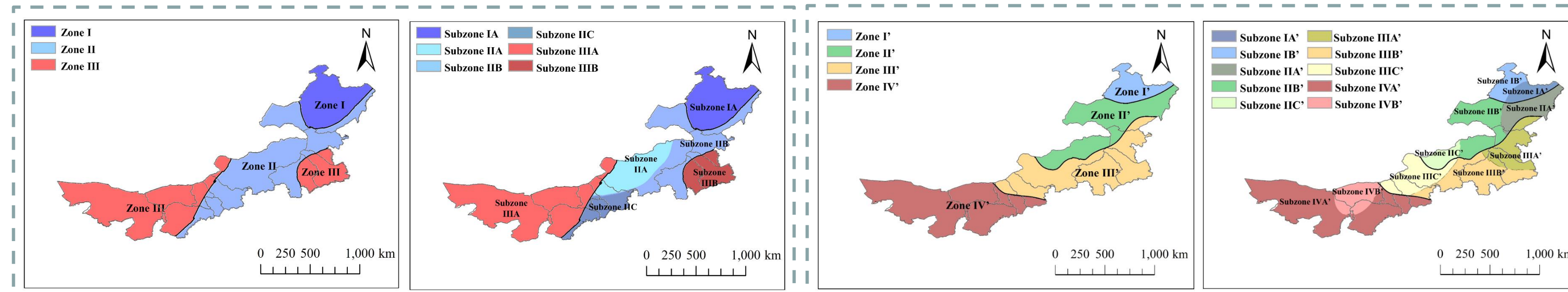


Correlation analysis of pavement service life and zoning indexes: (a) Fatigue cracking of asphalt pavement layer; (b) Fatigue cracking of cement stabilized layer; (c) Permanent deformation of asphalt pavement layer; (d) Vertical compressive strain on subgrade surface.

ESTABLISHMENT OF THE PERFORMANCE ZONING

Performance zoning scheme for asphalt pavement layer

Performance zoning scheme for subgrade



Performance zoning map : (a) Primary performance zoning (b) Secondary performance zoning.

CONCLUSION

- Based on the fact that environmental exposure effects, such as temperature, precipitation, frozen soil and freeze-thaw cycles are the main factors leading to the premature failure of asphalt pavement in cold regions, different performance zoning indexes for asphalt pavement layers and subgrade were proposed.
- The performance zoning scheme was established for asphalt pavement and subgrade respectively.