Acta Ecologica Sinica 36 (2016) 286–293

Contents lists available at ScienceDirect

Acta Ecologica Sinica

journal homepage: www.elsevier.com/locate/chnaes

# Three-dimensional spatial pattern of *Populus euphratica* nebkhas in the sparsely forested sandy land on the west of the Hotan River☆

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ARTICLE INFO

*Article history:*
Received 18 November 2014
Received in revised form 15 April 2015
Accepted 28 July 2015

*Keywords:*
*Populus euphratica* nebkhas
Western Hotan River
Three-dimensional morphological characteristics
Spatial distribution
Real-time kinematics

ABSTRACT

A *Populus euphratica* nebkha is a type of wind-accumulated landform. In arid desert areas, when the wind-sand flow is blocked by *P. euphratica*, sand materials accumulate under and around trees. West of the Hotan River, *P. euphratica* is widely distributed in the sparsely forested sandy land to the south of Mazartag Mountain. The *P. euphratica* nebkha geomorphology is formed by wind erosion of sand and has rarely been studied. Based on a field investigation using real-time kinematics (RTK), the three-dimensional morphological characteristics and spatial distribution of the *Populus euphratica* nebkhas at 10 plots west of the Hotan River were quantitatively analyzed based on GIS data and statistical methods. The results were as follows. 1) The nebkhas exhibited an irregular contour with significant spatial differences in morphological parameters. Most nebkhas were in the developmental stage. 2) All nebkhas exhibited a patchy distribution, and at the patch level, *P. euphratica* nebkhas were dispersed throughout the study area and distributed on slopes ranging from 20° to 40°. 3) *P. euphratica* nebkhas were mainly distributed in the southwestern portions of the study area and on both sides of the old watercourse.


## 1. Introduction

Hotan River had recently migrated from west to east in the Tarim Basin at a wide range in geological history [1], leaving many imprints in the Taklimakan desert on both sides of which *Populus* widely distributed. However, due to the low density community and serious erosion, the majority of community types have irreversible destructive succession, reflecting the fragility of the desert environment. Sand flow and accumulate in the case of interference by *Populus euphratica* and formed *Populus euphratica* nebkhas. Moreover, the research of *Populus euphratica* nebkhas is significant to the use of desert vegetation and bar of wind and sand erosion. Few scholars have yet studied it compared with nebkhas [2]. In terms of morphology, for example, Wu Shengli finds three sand types of *Tamarix*, *Phragmites australis* and *Alhagi sparsifolia* nebkhas with round bottoms, space forms of shield, conical or hemispherical, and sedimentary characteristics in Hotan River basin, that the bottom surface of the sand close to a circle, space shield geometry approximation, conical or domed, and sedimentary characteristics vary with time [3]. Yang Fan studies *Tamarix* nebkhas that gradually develop into asymmetric hummocky toward the wind direction, and have clear shadow outlines and the elongated shape of the asymmetric hummocky progressive development, Sha Mei Feng Ying clear outline in oasis-desert ecotone of Qira County [4]. Beyond that, Liu Bing also follow Qira County's oasis-desert ecotone finding that *Nitrarias phaerocarp* nebkhas present independent convex sand with nearly round or oval shape [5]. While *Karelinia caspica* nebkhas have shield shape at early development and hemispherical of stable stage, which is put forward by Wang Cui [6]. Han Lei brought forward that *Caragana stenophylla* nebkhas have conical morphology affected that by sand sources in Inner Mongolia Plateau [7]. Liu Jinwei found *nitraria* dunes is ellipsoid affected by wind and sand resources in Ebinur [8]. On the other hand of space pattern, numerous studies get on spatial correlation [11–15] and spatial heterogeneity [5,16–17].

Traditional methods for measuring sand morphological parameters are to use tape and geological compass, which is time-consuming and has greater impact of human error. This paper tries to use RTK (real-time kinematics) getting three-dimensional morphological characteristics [9,10], quantitatively analyzes it to provide scientific foundations for rationally using desert vegetations and stop sand erosion, and to accumulate data for the studies of *Populus euphratica* nebkhas.

## 2. Regional overview

Study area is located in the west of Hotan River, midwest of the Tarim Basin (Fig. 1), at a range of N 37° 41′41″–38° 26′21″ and E 79° 21′58″–

☆ Article history: Fund project: The remote sensing dynamic monitoring based on the NDVI time effects of the *Populus euphratica Apocheima cinerarius* Erschoff disaster in Tarim River basin (31460167).
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http://dx.doi.org/10.1016/j.chnaes.2016.06.007
1872-2032/

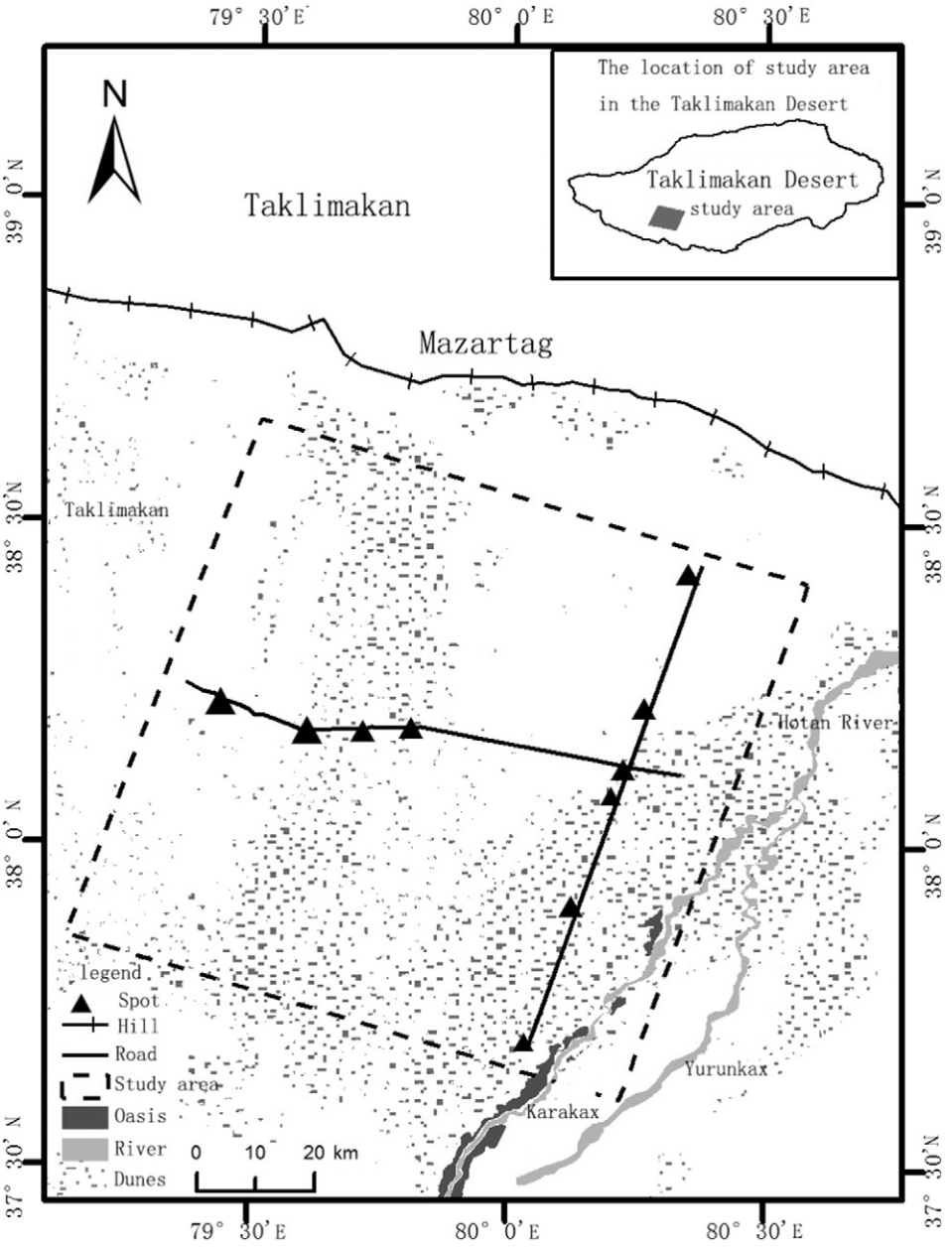


**Fig. 1.** Location of the study area and spots distribution.

80° 20′12″, which goes into Inner Eurasia, with extremely arid desert climate. Furthermore, its annual sunshine hours reach 2661.7 h, sunshine rate 58% ~ 65%, average annual precipitation 39.61 mm, average annual evaporation capacity 2648.7 mm, dryness beyond 60 and the maximum of autumn daily temperature range is 12.2–21.5 °C, with liquidity desert landform and sandificational soil [1]. The sandstorms is frequent. Species

**Table 1**
Information about 10 sample plots.

| The plot | Length/m | Width/m | Distribution of nebkhas | N | E |
|---|---|---|---|---|---|
| Plot 1 | 50 | 50 | Dense | 37°41′59″ | 80°2′6″ |
| Plot 2 | 100 | 100 | Sparse | 37°54′35″ | 80°7′26″ |
| Plot 3 | 50 | 50 | Dense | 38°12′52″ | 80°16′31″ |
| Plot 4 | 100 | 100 | Relatively sparse | 38°4′46″ | 80°12′37″ |
| Plot 5 | 100 | 100 | Sparse | 38°25′38″ | 80°21′48″ |
| Plot 6 | 200 | 200 | Sparse | 38°13′16″ | 79°26′11″ |
| Plot 7 | 200 | 200 | Sparse | 38°10′43″ | 79°36′22″ |
| Plot 8 | 100 | 100 | Sparse | 38°10′39″ | 79°42′51″ |
| Plot 9 | 100 | 100 | Sparse | 38°10′59″ | 79°48′27″ |
| Plot 10 | 100 | 100 | Relatively sparse | 38°7′18″ | 80°13′20″ |