Journal of Arid Environments xxx (2017) 1–11

Contents lists available at ScienceDirect

Journal of Arid Environments

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

Stabilization of calcareous sand dunes using phosphoric acid mulching liquid

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ARTICLE INFO

Article history:
Received 22 April 2017
Received in revised form
20 August 2017
Accepted 19 September 2017
Available online xxx

Keywords:
Urmia Lake
Calcareous sand
Phosphoric acid
Sand dune
Mulch
Dicalcium phosphate

ABSTRACT

The water level reduction of Urmia Lake in the northwest of Iran has led to the shrinking of the lake area, exposure of the salt in the dried areas, desertification of shorelines, and creation and development of sand dunes in some coastal areas, especially Jabal Kandi region. The sand particles of these dunes are smaller than 300 μm and are aragonitic (calcareous). In this research, the potential of stabilizing and fixing of calcareous sand dunes of Jabal Kandi region by spraying diluted industrial phosphoric acid as a novel mulching liquid was considered for the first time. Due to the chemical reaction of calcareous sand with diluted phosphoric acid, in situ dicalcium phosphate dihydrate cement is produced, which sticks the unreacted part of sand particles together and leads to the creation of a stiff calcium carbonate/phosphate crust. The results of the laboratory tests including measuring the penetration resistance and wind erosion modulus of the crust showed that through the use of adequate percentage and volume of phosphoric acid, the produced crust had a considerable mechanical strength and could control the wind erosion of the stabilized sand. This method could be executed with a controlled plan to fix some shifting sand dunes, stop their drifting and change them to windbreakers, especially near rural areas and agricultural lands. Also, in the untreated areas between the fixed sand dunes, re vegetation plans could be executed.

1. Introduction

Aeolian processes play an important role in shaping arid and semi-arid regions worldwide (Okin et al., 2006). One of the most important natural hazards of the world in the arid and semi arid areas such as deserts, beaches and the bed of dried lakes is the wind erosion of fine graded materials (Kok et al., 2012). Sand dunes could be created by the erosion of sandy sediments adjacent to saline lakes (Hardie et al., 2009); for example, the dried bed of dried Aral Lake has been the source of dust and storms of sand and salt (Issanova et al., 2015).

Extensive areas of dry lands and the increase in population pressure on land and water resources made Iran vulnerable to desertification (Amiraslani and Dragovich, 2011). Urmia Lake is the greatest lake of Iran and one of the largest saline lakes in the world. The lake is located in a semi arid and desert steppe environment and in recent decades, the water level of the lake has been decreased (Hassanzadeh et al., 2012; Warren, 2016). This water level reduction has led to the shrinking of the lake area, exposure of the salt in the dried areas, desertification of shorelines, and creation and development of sand dunes in some coastal areas (Fathian et al., 2015; Tisseuil et al., 2012). One of the critical areas on the west border of Urmia Lake, where sand dunes have developed, is Jabal Kandi region (Fig. 1). The sand particles of these dunes are smaller than 300 μm and are aragonitic (calcareous). These aragonite dune sands are related to the coastal sediments of Urmia Lake. In this region, the problem of the movement of sand dunes to the rural areas and agricultural lands has been one of the environmental hazards of Iran in recent years. Agricultural lands and rural areas of Jabal Kandi, Gul Tappah, Soltan Abad, Morgu Kandi and Maku Kandi villages directly are facing movement of sand dunes. Some field scale pilot projects were carried out for the stabilization of sand dunes in the region,e.g., creating the green zone and mulching with several biodegradable mulching liquids in separate

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https://doi.org/10.1016/j.jaridenv.2017.09.011
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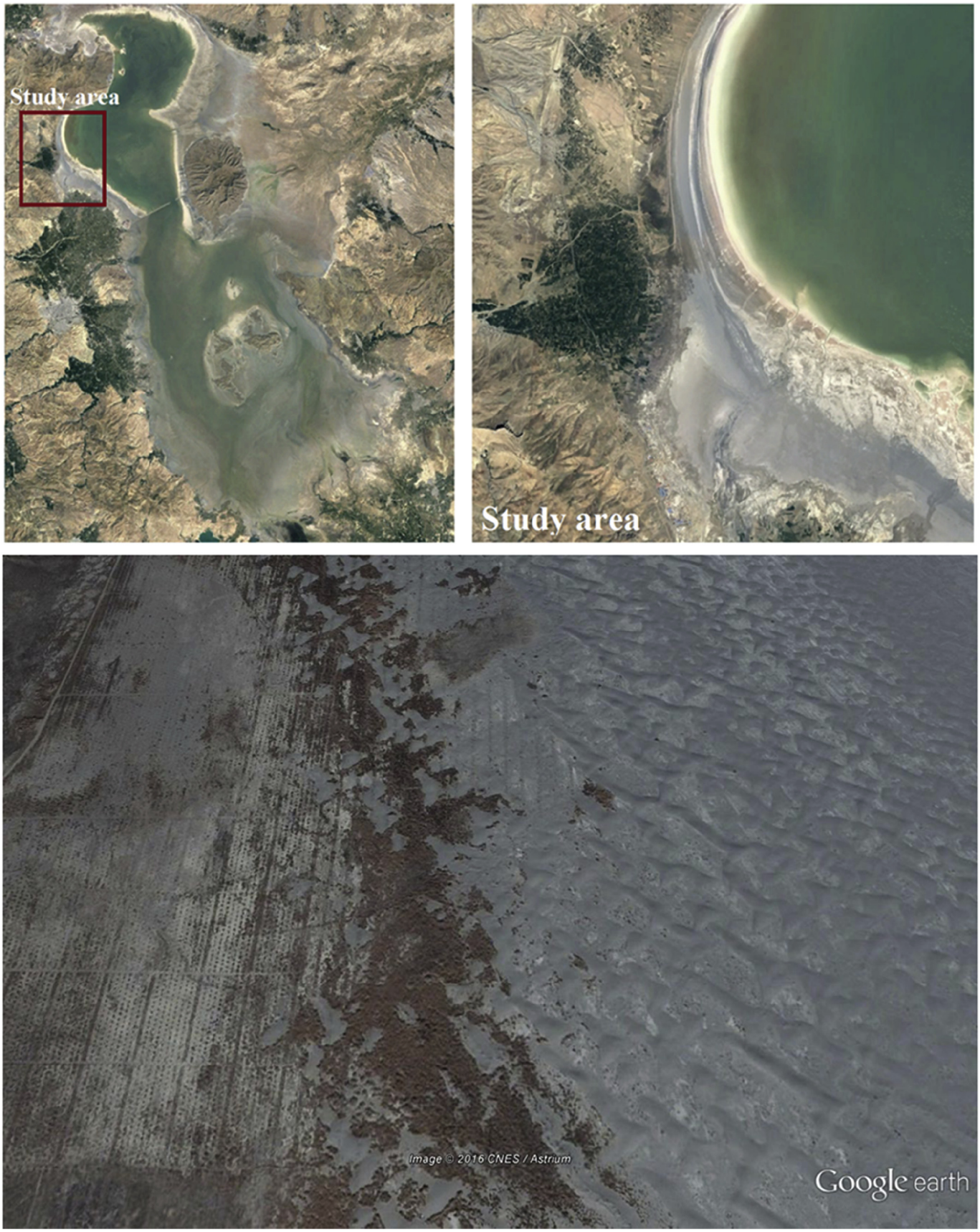

Fig. 1. Study area: Urmia Lake aerial map (top-left), the aerial map of Jabal Kandi region (top-right) and aerial map of migrating sand into agricultural lands(bot).

Please cite this article in press as: Katebi, H., et al., Stabilization of calcareous sand dunes using phosphoric acid mulching liquid, Journal of Arid Environments (2017), https://doi.org/10.1016/j.jaridenv.2017.09.011