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ORIGINAL PAPER

Preparation of frost atlas using different interpolation methods in a semiarid region of south of Iran

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Abstract In this research, suitability of different kriging and inverse distance weighted (*IDW*) methods in estimating occurrence date of frost was evaluated. Data included minimum daily air temperature values from 27 meteorological stations of Fars province in southern Iran from 18 to 45 years. Data ranges of 0 to −1.5, −1.5 to −3 and below −3°C were considered as mild, moderate and severe frost intensities, respectively. Starting with the first day of autumn, iso-occurrence days for the frost intensities and occurrence probabilities (25%, 50%, 75% and 90%) were estimated using ordinary kriging, cokriging, residual kriging type 1 (*RK1*), residual kriging type 2 (*RK2*), universal kriging and *IDW* methods. In these models, the errors of estimated frost intensities at different probabilities were lowest in the *RK2* model, but lack of establishment of spatial structure due to long distance between stations caused the predictions not to be acceptable in some cases. In a proposed method (modified inverse distance weighted, *MIDW*), the trend between the first and last days of frost occurrence with earth elevation was removed, and the reminder values were estimated by (*IDW*) method. Although, the errors for estimated frost dates by *MIDW* and *RK2* methods were the same, but the *MIDW* method did not have the spatial establishment shortcoming. Furthermore, the simplicity and practicality of the *MIDW* method makes it a reasonable selection.

1 Introduction

Air temperature is the most important climatic characteristic, which determines the suitability of field crops due to its relationship with the length of the growing period and evapotranspiration (Hudson and Wackernagel 1994). It classifies the plant species (Rubio et al. 2002) and specifies the vegetational pattern (Richardson et al. 2004). Air temperature is also considered as a limiting factor for plant growth. Many studies have focused on the determination of air temperature threshold for different plant growth processes and have categorized them according to resistance to frost (Blennow 1993, 1998; Ventskevich 1985). One of the issues that threatens agricultural production in different parts of the world is related to frost damages. In meteorology, frost refers to the condition when air temperature is less than a threshold value for a relatively short period of time. Every year, major economic losses incur due to frost damages to agricultural products all over the world. Consequently, assessment procedures for protection of agricultural products against frost stress are very important. There is no doubt that a complete prevention of frost damages to farms is impossible; however, it would be possible to minimize the frost damages with appropriate managements of cropping pattern based on occurred frost events.

Several researches have attempted to estimate air temperature at unmeasured points in order to predict frost occurrence. Francois et al. (1999) mapped frost risk for Bolivian Altiplano using NOAA satellite surface temperatures and long-term records of air temperature from 17 weather stations. Air temperature was measured in meteorological stations, which spread sparsely in the non-residential and high elevation areas (Rolland 2002). Carrega (1995) noted the difficulty of estimation of weather parameters at ungauged sites. Hence, it seems necessary to determine the frost probability, or in other words, frost prediction in different areas and between the stations, to decrease damages of this phenomenon by employing different methods of frost protection (Dodson and Marks

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