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Assessment of Bayesian structure of hidden Markov model for real time prediction of maize phenology

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Abstract

The Crop Progress Percentage (CPP) in a given phenology stage reflects growth status in life cycle. Generally, routine field measurements of this parameter are lacking, hence various alternative approaches have been proposed for its estimation. The statistical methods such as Bayesian approaches and hidden Markov models (HMMs) have appropriate structural skills for solving problems with variety of continuous or discrete data and can be combined with remotely sensed data also. The aim of this study is evaluation of hidden Markov models' skill in real time prediction of maize progress percentage in research field of university of Tehran located in Karaj. The HMMs follow the Bayesian structure in which, there are usually two layers; hidden and observable. Different phenological stages including Emergence to Milky were considered as the hidden layer and both Normalized Difference Vegetation Index (NDVI) and Accumulated Growth Degree-Day (AGDD) features, extracted from air temperature and LANDSAT7 ETM+ images, as a vector variable of observable layer. Calibration and evaluation of the model was performed using a 9 years (2002-2010) data set of the field phenology observations and meteorological data. According to the results, in general, for all phenological stages, the HMM was able to estimate the CPPs with average RMSE of 14%, which confirms the applicability of this approach as a suitable tool. Further studies in other climatic regions of the country are recommended for more scrutiny of phenological prediction models using remotes sensing and statistical approaches.

Key words: Progress percentage, Phenology, AGDD, NDVI

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Assessing the impacts of meteorological drought on yield of rainfed wheat and barley (Case study: Khorasan Razavi province)

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Abstract

The drought causes severe damages to agricultural sector especially rainfed crops production. In this study, the impacts of meteorological drought, in terms of some common indices, on rainfed wheat and barley were assessed. 19 years (1995-2013) weather data including rainfall, temperature, sundial, evaporation and relative humidity of meteorological stations in Khorasan Razavi province, north east of Iran, were collected and examined. Several drought indices namely, The Standardized Z index, Standardized Precipitation Index, Percentage of normal and Deciles were worked out. The statistical relation of both crops' yield with meteorological data was determined. During the cropping year 2000-2001, Mashhad, Sarakhs, Sabzevar, Gonabad, Kashmar, Nishapur and Golmakan stations, had the lowest amount of rainfall which led to severe and extreme drought. The minimum amount of the crops yield was recorded at the same year. For the rest of stations, i.e. Torbatjam, Ghoochan and Torbat Heydarieh stations, the driest year was 2007-2008 followed by an intense to extreme drought but the lowest yield was not observed in the same year. The most significant variables affecting the yield were found to be rainfall and relative humidity. The relations between yield and meteorological variables were significant in most of the cases. In general, the agricultural and meteorological droughts occurred almost simultaneously, except for the regions with very low rainfall.

Keywords: Rainfall, Drought, Rainfed cropping, Khorasan province

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A stochastic multi-station model for daily rainfall generation in North-East of Iran: Effect of time non-stationarity

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Abstract
For many models (e.g. hydrological, meteorological, crop yield) stochastic daily rainfall generation is required. Most of the stochastic models are single-site, while there are rather few ones that deal with the rainfall correlation structure (occurrence and amount) as a multi-site approach. A plausible shortcoming of these models, however, is due to not considering the possible time-non-stationarity. A total of 36 raingauges stations in North, Razavi and South Khorasan provinces, northeast of Iran with 30 years of record were considered in this study. A stochastic rainfall simulation model for 6 rainy months of November to May was adopted, in which, first order Markov approach for rainfall occurrence and Gamma probability density function for rainfall amount were involved. Model parameters (rainfall probability conditioned to rainy and dry for previous day for rainfall occurrence and two parameters of Gamma distribution) were found to be dependent on the month of the year and geographical location; yet, no significant relations were found to describe them. It was showed that all parameters were non-stationary in time, such that considering this behavior, increased the accuracy of simulations.

Keywords: Arid and semi-arid climates, Gamma probability density function, transition matrix, Iran, Rainfall

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Drought forecasting by SPI and EDI indices using ANFIS method based on C-mean and SC clustering (Case study: Kohgiluyeh and Boyer Ahmad Province)

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Abstract
Drought is one of the most and oldest natural disaster that cause significant environmental impacts. Despite Kohgilouyeh and Boyerahmad is in the third place in terms of rainfall but the drought has affect the province intermittently and causes many heavy losses. In other to drought crisis management, finding the index measurement of the drought to predict and evaluate the spatial and temporal of this phenomenon, seems essential. In this research, using Artificial Neural Networks (ANN) and Adaptive Neuro Fuzzy System (ANFIS) model with phase clustering analysis with standardized precipitation index (SPI) and effective drought index (EDI) were used to predict drought. The results of study indicate that the SPI index by validation coefficient 0.87 has more capability and accuracy than EDI index by validation coefficient 0.73 in predicting of drought. On the other hand according to C-mean and SC clustering in modeling for predicting the drought, ANFIS approach has more efficacy the result show that, clustering causes the increasing of model accuracy in verification and calibration stages. C-mean clustering by calibration coefficient 0.93 and validation coefficient 0.87 is the best model.

Keywords: Drought, Clustering, ANFIS, Kohgilouyeh and Boyerahmad, SPI and EDI

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The effect of submergence depth on water and soil temperature in paddy field (Case study: Rasht)

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Abstract

Soil temperature plays very important role in bio chemical processes, root water uptake and also evapotranspiration. This parameter is influenced by environmental factors such as soil moisture content. Recently water shortage has led to adopt intermittent irrigation in Sepidroud Irrigation network in Gilan province, north of Iran. In this method, different submergence depth is applied, which change the root zone (soil and water) temperature. The aim of this study was to investigate the effects of water depth on soil and water temperature in a paddy field. Paddy minis lysimeters, based on completely randomized block design with 5 treatments of constant level of water in the field, (5, 2.5, 0, -5 and -10 cm of the soil surface) in three repetitions. Measurements were including soil temperature at the depths of 5 and 10 cm from soil surface (T_5 and T_{10}) and water temperature in the morning and evening. The results showed that T_5 was significantly more that T_{10} .In the morning, water temperature, at and below surface (non-submerged treatments) was lower than soil temperature at the same depth, while in the evening, water temperature was more than soil temperature at the same depth. In daily scale, the water temperature was more than soil temperature at the same depth. Soil temperature was decreased by reduction of soil water depth. In general, the presence of a thin layer of the water on soil surface had a cooling effect on soil but as the water reaches the soil surface, the soil environment becomes much warmer. The reduction of the submergence depth 10 cm below the surface significantly affected the made microclimate of the soil colder, by 1.5° Celsius in average.

Keywords: Lysimeter, Rice, Root zone temperature, Water depth

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Trend analysis of phenological stages length and chilling requirements of apple tree (Case study :Karaj station)

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Abstract
Determination of chilling and heating requirements is an important process for selecting fruit trees specifically adapted to climatic regions. In this study, the thermal thresholds of different phenological stages of apple tree (Red Delicious variety) were determined for further analysis. Long-term hourly and daily temperature data from 1985 to 2014 of Karaj station were collected and used for running three chilling requirement models namely CH, UTAH and CP. The results showed that the chilling requirement of this late variety is not satisfied. A significant decreasing trend in accumulated chilling units was observed. Application of growing degree days (GDD) model confirmed that the required heat units are maintained without limitation. The findings revealed that there exists a significant decreasing trend in occurrence date of phenological stages which might be due to higher temperature during the season. These conditions (earlier onset of vulnerable reproductive phases) increase the risk of frost and chilling damage. In most phenological stages of the apple tree, the mean air temperature showed an increasing trend. According to the results, late varieties are not suitable for current climatic conditions of Karaj climate and should be replaced with early ones. Further agroclimatic studies are recommended for more scrutiny across the country considering the sequences of global warming.

Keywords: Apple tree, GDD, Hourly temperature, Chilling requirement, Phenology, Iran

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