
**UNIVERSITI PUTRA MALAYSIA**

# *CLIMATE CHANGE AND ITS IMPACT ON REFERENCE EVAPOTRANSPIRATION AT RASHT CITY, IRAN*

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# CLIMATE CHANGE AND ITS IMPACT ON REFERENCE EVAPOTRANSPIRATION AT RASHT CITY, IRAN

**By**

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**Thesis Submitted to the School of Graduate Studies, University Putra Malaysia, in Fulfilment of the Requirement for the Degree of Master of Science**

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Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Master of Science

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**February 2011**

**Chairman: Professor Ir. Lee Teang Shui, PhD**

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There are various factors of uncertainty regarding the impact of climate change on reference evapotranspiration ($ET_o$). The accuracy of the results is strictly related to these factors and ignoring each of them reduces the precision of the results, thereby affecting their applications. In this study, the uncertainty related to two methods of calculating $ET_o$, the Hargreaves-Samani (HGS) and Artificial Neural Network (ANN); the climate change models: Atmosphere-Ocean General Circulation Model (AOGCM); and downscaling method under the climate change scenario (A2) for the period 2010 to 2039 was evaluated. Meteorological data for the Rasht station located in the northern part of Iran collected for 1961-1990 was used to evaluate the climatic data and calculate $ET_o$. Since there were no lysimeter installed in the area, the FAO Penman-Monteith (PM, 1998) method was adopted as the reference $ET_o$ method and the $ET_o$ of the period (1961-

1990) produced by HGS and ANN methods was evaluated using performance functions including mean absolute error (MAE) and regression coefficient ($R^2$). Next, the Hadley Centre Coupled Model, version 3 (HadCM3) climatic model and the Canadian Global Climate Model, version 3 (CGCM3) climatic model and the Statistical Downscaling Model (SDSM) were applied to generate maximum and minimum temperatures for use in simulating $ET_o$ using the HGS and ANN methods for 2010 to 2039. Results obtained showed average temperature increases of 0.95 $^oC$ with the HadCM3 model and average temperature increases of 1.13 $^oC$ with the CGCM3 model, relative to observed temperatures for 2010 to 2039. Accordingly, the predictions showed average increases of $ET_o$ ranging from 0.48 to 0.6 (mm/day) for the period of 2010 to 2039. The study also revealed that uncertainty with the AOGCMs is more than the $ET_o$ models applied in this study.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Master Sains

**PERUBAHAN IKLIM DAN HENTAMANNYA TERHADAP PENYEJATPELUHAN RUJUKAN DI BANDAR RASHT, IRAN**

Oleh

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**February 2011**

**Pengerusi: Prof. Lee Teang Shui, PhD**

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Terdapat berbagai faktur ketidakpastian mengenai hentaman perubahan iklim keatas penyejatpeluhan rujukan ($ET_o$). Kejituan keputusan amat berkait-hubung dengan faktur faktur dan sekiranya tidak ambilkira setiap faktur akan mengurangkan kepersisan keputusan, namun akan menjejaskan kegunaan. Dalam kajian ini, ketidakpastian berkaitan dengan dua kaedah untuk menghitung $ET_o$, Hargreaves-Samani (HGS) dan Rangkaian Saraf Buatan (ANN); model model perubahan iklim: Model Pengeliling Umum Atmosfera-Lautan (AOGCM); dan kaedah kurangsaiz bersenario perubahan iklim (A2) bagi jangkamasa 2010 ke 2039 telah dinilaikan. Data meterologi untuk stesyen Rasht terletak di bahagian utara Iran dikumpulkan bagi 1961 – 1990 telah diguna demi menilaikan data iklim dan menghitung $ET_o$. Memandangkan bahawa laisimeter tidak dipasang di situ, maka kaedah FAO Penman-Monteith (PM, 1998) telah digunapakai

sebagai kaedah $ET_o$ rujukan dan $ET_o$ bagi jangkamasa (1961 – 1990) dihasilkan dengan kaedah kaedah HGS dan ANN dinilaikan dengan fungsi fungsi prestasi termasuk ralat mutlak purata (MAE) dan pekali regresi ($R^2$). Kemudian, Model iklim Coupled Hadley Centre Versi 3 (HAdCM3) dan model iklim global Canada versi 3 (CGCM3) dan model Statitik Kurangsaiz (SDSM) diguna untuk menjana suhu suhu maxima dan minima untuk dipakai demi mensimulasikan $ET_o$ dengan kaedah kaedah HGS dan ANN bagi 2010 ke 2039. Keputusan yang dihasilkan menunjuk bahawa tambahan suhu purata sebanyak 0.95 $^oC$ dengan model HadCM3 dan 1.13 $^oC$ dengan model CGCM3, bernisbi ke suhu ditinjaukan bagi 2010 ke 2039. Namun begitu ramalan menunjukkan tambahan $ET_o$ purata sebanyak 0.48 ke 0.6 (mm/hari) daripada 2010 sehingga 2039. Kajina ini juga menunjukkan bahawa ketidakpastian betkaitan dengan model model AOGCM lebih bererti dibandingkan model model $ET_o$ yang digunakan dalam kajian ini.

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I certify that a Thesis Examination Committee has met on (February 2011) to conduct the final examination of Heerbod Jahanbani on his thesis entitled "Climate Change and its impact on Reference Evapotranspiration at Rasht City, Iran" in accordance with the Universities and University Colleges Act 1971 and the Constitution of the Universiti Putra Malaysia [P.U.(A) 106] 15 March 1998. The Committee recommends that the student be awarded the Master of Science.

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This thesis was submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfilment of the requirement for the degree of Master of Science. The members of the Supervisory Committee were as follows:

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## DECLARATION

I declare that the thesis is my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously, and is not concurrently, submitted for any other degree at Universiti Putra Malaysia or at any other institutions.

**HEERBOD JAHANBANI**

Date: 7 February 2011

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