UNIVERSITI PUTRA MALAYSIA

EFFECTS OF CONVERSION OF RANGELAND TO DRY FARMING ON SURFACE RUNOFF, SOIL EROSION AND SEDIMENT YIELD IN KARDEH DRAINAGE BASIN, IRAN

FARID SAEIDYAN

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BY

FARID SAEIDYAN

Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfillment of the Requirement for the Degree of Doctor of Philosophy

October 2012

DEDICATION

To my dear wife and best friend, Shideh and our son, Pouya

Without her support, I could not get through such grueling task.

Abstract of the thesis presented to the Senate of Universiti Putra Malaysia in fulfillment of the requirement for the degree of Doctor of Philosophy

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Chairperson: Associate Professor Wan Nor Azmin B Sulaiman, PhD

Faculty: Environmental Studies

Land use/cover changes may affect hydrological properties, soil erosion and sediment yield of a basin. In arid and semi-arid regions, these changes mostly appear as conversion of rangelands to dry farming. The main research question is: what is the effect of such conversion on hydrologic and soil characteristics of the basin. This research evaluates the trend of converting rangelands to dry farming in Kardeh Drainage Basin, Iran and its effects on surface runoff, soil erosion and sediment yield. Hydrologic simulations based on different design rainfall and the impacts of different scenarios of vegetation conditions on flood peak were assessed. Land use and vegetation maps 1970 and 2006 were prepared using aerial photographs and satellite images. Rainfall-Runoff relations and flood routing in the channel were obtained by using curve number and Muskingum methods respectively in *HEC-HMS* model. The effect of temporal distribution of rainfall on hydrologic simulation was studied. Future flood simulations were evaluated based on six future land use scenarios of vegetation cover condition ranging from highly vegetated cover (good) to sparsely vegetated condition (poor). The *Erosion Potential Method (EPM)* was used to evaluate the total annual sediment discharge for the basin. Multiple regression

approach was use to identify the most effective factors on the sediment yield of the sub basin.

The results of the study showed a drastic change of land use between 1970 and 2006 especially in the increment of dry land (91%) and reduction of rangeland (about 13%). In the same period, the predicted peak discharge at sub basin level appeared to increase more than the runoff volume. In addition, runoff concentration time and lag time was reduced as well as time to peak of hydrograph. The simulation output indicated that for a two year rainfall return period, changes of peak discharge increased significantly (70%). While for a rainfall return period of 100 years, the changes of peak discharge decreased (41%).

In future land use scenarios, simulations of 1 poor range condition to good range condition, peak discharge decreases drastically; however, the effects diminished as design rainfall return period increased.

Erosion and sediment yields increased about 82% from 1970 to 2006. Multiple regression analysis showed that 70% of the changes in sediment yield in the year 2006 are due to the effects of increase in dry farming area (R^2= 70%, $\alpha < 0.05$).

The results point to the fact that converting rangelands to dry farming in an arid and semi-arid region such as the Kardeh Drainage Basin, leads to many negative effects on hydrological properties, including increase in runoff coefficient, peak discharge, runoff volume, and decrease in concentration time, lag time and time to peak. The land use change was the major contributing factor to the increase of sediment yield in the basin.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia
sebagai memenuhi keperluan untuk ijazah Doktor Falsafah

KESAN PENUKARAN KAWASAN RAGUT KEPADA PERTANIAN KERING KE ATAS AIR LARIAN PERMUKAAN, HAKISAN TANAH DAN HASIL ENDAPAN DALAM LEMBANGAN SALIRAN KARDEH, IRAN

Oleh

FARID SAEIDYAN

Oktober 2012

Pengerusi: **Professor Madya Wan Nor Azmin B Sulaiman, PhD**

Fakulti: **Pengajian Alam Sekitar**

Perubahan guna/litupan tanah boleh menjejaskan sifat hidrologi, hakisan tanah dan hasil endapan sesebuah lembangan. Di kawasan-kawasan yang gersang dan separa gersang perubahan ini kebanyakannya muncul kerana penukaran kawasan ragut kepada pertanian kering. Persoalan kajian yang utama ialah apakah kesan bagi penukaran itu kepada ciri-ciri hidrologi dan tanah lembangan. Kajian ini menilai tren pertukaran bagi kawasan ragut kepada pertanian kering dalam Lembangan Saliran Kardeh, Iran dan kesannya ke atas air larian, hakisan tanah dan hasil endapan. Simulasi hidrologi berdasarkan hujan rekabentuk yang berbeza dan impak bagi senario keadaan tumbuhan berbeza ke atas puncak banjir telah ditaksir. Guna tanah dan peta tumbuhan 1970 dan 2006 disediakan menggunakan foto udara dan imej satelit. Hubungan hujan-air larian dan penghalaan banjir dalam saluran telah diperolehi masing-masing menggunakan kaedah nombor lengkung dan Muskingum dalam model *HEC-HMS*. Kesan agihan masa hujan ke atas simulasi hidrologi telah dikaji. Simulasi banjir masa hadapan telah dinilai berdasarkan enam senario guna tanah masa hadapan bagi

keadaan bertutup tumbuhan bermula dari bertutup tumbuhan tinggi (baik) hingga bertumbuhan jarang (buruk). *Kaedah Hakisan Potensi* (EPM) digunakan untuk menilai discas jumlah tahunan endapan untuk lembangan itu. Pendekatan regresi berbilang digunakan untuk mengenal pasti faktor yang paling berkesan ke atas hasil endapan sub lembangan itu.

Keputusan kajian menunjukkan perubahan guna tanah yang drastik antara 1970 dan 2006 terutamanya dalam pertambahan tanah kering (91%) dan pengurangan kawasan ragut (kira-kira 13%). Dalam tempoh yang sama, discaj puncak yang diramalkan pada peringkat sublembangan muncul meningkat lebih daripada isipadu air larian. Di samping itu, masa tumpuan air larian dan masa susulan telah dikurangkan di samping masa memuncak hidrograf. Output simulasi menunjukkan bahawa untuk kala kembali hujan 2-tahun perubahan discaj puncak meningkat dengan ketara (70%). Manakala bagi kala kembali 100 tahun hujan perubahan discaj puncak menurun (41%).

Dalam senario masa hadapan guna tanah, simulasi bagi 1 julat berkeadaan buruk kepada julat berkeadaan baik, puncak discaj menurun dengan drastik, namun kesannya berkurangan apabila kala kembali hujan rekabentuk meningkat.

Hakisan dan hasil endapan meningkat kira-kira 82% daripada 1970 ke 2006. Analisis regresi berbilang menunjukkan bahawa 70% daripada perubahan dalam hasil endapan dalam tahun 2006 adalah kerana kesan yang meningkat dalam pertambahan kawasan perladangan kering (R^2 = 70%, α <0.05).

Keputusan itu menumpu kepada fakta bahawa penukaran kawasan ragut kepada pertanian kering di kawasan gersang dan separa gersang seperti Lembangan Saliran Kardeh menghasilkan banyak kesan negatif ke atas sifat hidrologi, termasuk peningkatan pekali air larian, discaj puncak, isipadu air larian, dan penurunan dalam masa tumpuan, masa susulan dan masa memuncak. Perubahan guna tanah didapati menjadi faktor penyumbang utama kepada peningkatan hasil endapan di lembangan itu.

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I certify that a Thesis Examination Committee has met on 10 October 2012 to conduct the final examination of Farid Saeidyan on his thesis entitled " Effects of Conversion of Rangeland to Dry Farming on Surface Runoff, Soil Erosion and Sediment Yield in Kardeh Drainage Basin, Iran " in accordance with the Universities and University College Act 1971 and the Constitution of the Universiti Putra Malaysia [P.U. (A) 106] 15 March 1998. The committee recommends that the candidate be awarded the Doctor of Philosophy.

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Date: 21 March 2013

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

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Date:

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 or concurrently submitted for any other degree at Universiti Putra Malaysia or at any other institutions.

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FARID SAEIDYAN

Date: 10 October 2012

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