



**UNIVERSITI PUTRA MALAYSIA**

**ASSESSMENT OF LAND DEGRADATION IN RELATION TO HUMAN-INDUCED CAUSES IN AGRO-ECOLOGICAL ZONES IN THE MEREK CATCHMENT, IRAN**

**MOSAYEB HESHMATI**

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INDUCED CAUSES IN AGRO-ECOLOGICAL ZONES IN THE MEREK  
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**By**

**MOSAYEB HESHMATI**

**Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia,  
in Fulfilment of the Requirements for the Degree of Doctor of Philosophy**

**November 2010**



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**Chairman: Prof. Dato' Nik Muhamad Nik Ab.Majid, Phd**

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Land degradation is the loss in the productivity of land resources due to many factors, especially soil erosion. Nutrient depletion and soil organic carbon (SOC) loss are the main impacts of erosion which not only cause declining crop yields, but also induce off-site impacts, such as eutrophication and greenhouse gas (GHG) emission. The objectives of this study were to identify land degradation factors through studying the physico-chemical and mineralogical properties of soil and rocks as well as human-induced factors within agro-ecological zones and estimate the erosion rate and loss of plant nutrients (N, P, K and SOC) for integrated management of the degraded areas.

The study was conducted at the Merek catchment, Iran which is geologically characterized by limestone, sandstone, shale and marls in order to determine the factors responsible for land degradation. In this study, geomorphological facies within the three agro-ecological zones in the catchment were mapped by overlapping geological, topographical, land use and erosion data using satellite

image and geographical information system (GIS). Rock and soil samples were randomly sampled within each facies to determine their physico-chemical and mineralogical properties.

The erosion rate and loss of plant nutrients (N, P and K) and SOC were estimated using modified pacific southwest inter agency committee (MPSIAC) model. The erosion rates in the agriculture area, rangeland and forest were 10.61, 11.02 and 13.05 t ha<sup>-1</sup>yr<sup>-1</sup>, respectively. The respective predicted annual N depletion by erosion were 15.16, 18.73 and 23.75 kg ha<sup>-1</sup>yr<sup>-1</sup> in agriculture area, rangeland and forest zone, while that of P were 0.172, 0.170 and 0.165 kg ha<sup>-1</sup>yr<sup>-1</sup>. The depletion of K in the agriculture area, rangeland and forest were 4.47, 4.65 and 5.15 kg ha<sup>-1</sup>yr<sup>-1</sup>, respectively. The highest loss in SOC was in the forest with a value of 306.10 kg ha<sup>-1</sup>yr<sup>-1</sup>, while the lowest was in the agriculture area at 147.23 kg ha<sup>-1</sup>yr<sup>-1</sup>. The high loss of SOC in the forest zone is due to serious soil erosion, which is accelerated by sloping land.

Part of the study area is geologically and topographically susceptible to landslide. This area mainly comprises unstable soils that tend to promote incidence of landslide. The study found that landslide has affected about 15% of the catchment and that its occurrence was promoted by unstable soils, being eroded at the rate of 13.07 t ha<sup>-1</sup>yr<sup>-1</sup>. Field observations showed that the landslide was initiated by crack formation in areas having smectite, a mineral which can swell and crack, depending on the availability of water. Smectite is the dominant mineral in about 80% of the area affected by landslides. Low aggregate stability in the topsoil further promotes

the occurrence of landslides. Most of the landslides occurring in the forest areas were observed where the canopy cover was less than 15% with slope of 10-40%.

Social issues such as low income, poverty and low level of welfare and education contribute to land degradation in the study area. Subsequently, farmers, herders and nomads were interviewed and relevant experts were consulted. The results revealed that improper tillage practices, overgrazing and forest clearance were the worst significant human-induced factors causing land degradation. The other factors include crop cultivation without rotation and fallow period, improper tillage practices, crop residue burning and conversion of rangelands and forest to agricultural lands.

Training and extension, soil conservation measures with farmer's participation, enactment of new laws and amending of current laws (for monitoring agricultural activities such as fertilizers and pesticide application and burning of crop residues), forest preservation, improving the current grazing systems and empowering government employees are the possible measures to curtail land degradation in the study area. It is suggested that the government should create job opportunities among the unemployed in the village and enhance their welfare by introducing insurance, health services and educational opportunities.

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**KAJIAN DEGRADASI TANAH YANG BERKAITAN BERKAITAN  
DENGAN PENYEBAB MANUSIA-TERINDUKSIDI ZON AGRO-  
EKOLOGIKAL TADAHAN MEREK, IRAN**

Oleh

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Kemerosotan tanah dimangkin oleh pelbagai faktor termasuklah fenomena hakisan tanah. Objektif penyelidikan ini dijalankan bertujuan untuk mengenal pasti faktor-faktor penyumbang kepada kemerosotan tanah melalui ujikaji analisa sifat-sifat fizikal, kimia dan mineral dalam tanah dan batu-batuan di kawasan kajian. Selain itu, kajian ini juga bertujuan untuk melihat impak daripada aktiviti manusia terhadap tahap hakisan dan juga kesanya terhadap nutrisi dalam tumbuhan (N, P, K dan organic karbon dalam tanah) untuk membentuk pengurusan kawasan yang mengalami degradasi secara bersepadu dan mampan. Penyelidikan dijalankan di kawasan tadahan Merek, Iran dimana tanah di situ terdiri daripada batuan kalsium karbonat, batuan pasir, 'shale' dan 'marls'. Pensampelan batu-batuan dan tanah diambil secara rawak dari plot kajian untuk analisa sifat-sifat fizikal, kimia, dan mineralnya.

Tahap hakisan dan kemerosotan nutrisi dalam tumbuhan (N, P, dan K) serta organik karbon dalam tanah dianalisa dengan menggunakan alat model MPSIAC. Tahap hakisan tanah dalam plot pertanian, padang ragut dan hutan adalah 10.61, 11.02 dan 13.05 t ha<sup>-1</sup> tahun<sup>-1</sup> masing-masing. Manakala bagi kandungan kalium (K) adalah sebanyak 0.172 kg ha<sup>-1</sup> tahun<sup>-1</sup> di plot pertanian, 0.170 kg ha<sup>-1</sup> tahun<sup>-1</sup> di kawasan padang ragut dan 0.165 kg ha<sup>-1</sup> tahun<sup>-1</sup> di plot hutan. Kandungan organik karbon dalam tanah didapati paling tinggi di plot hutan (306.10 kg ha<sup>-1</sup> tahun<sup>-1</sup>) manakala tahap organik karbon dalam tanah paling rendah didapati di plot pertanian (147.23 kg ha<sup>-1</sup> tahun<sup>-1</sup>). Punca kehilangan organik karbon dalam tanah di plot hutan berpunca daripada hakisan tanah yang serius di mana topografi semulajadi plot hutan tersebut yang curam dan terdedah kepada fenomena hakisan.

Masalah tanah runtuh dalam kawasan tersebut disebabkan oleh struktur tanahnya yang tidak stabil. Kandungan mineral smektit yang tinggi dalam tanah merupakan punca kepada ketidakstabilan tanah kerana mineral tersebut mudah mengembang dan mengecut berdasarkan kandungan air yang terdapat dalam tanah. Mineral smektit ini juga mendominasi hampir 80% kandungan tanah dalam kawasan yang terjejas. Masalah tanah runtuh ini juga dikuatkan lagi dengan kestabilan agregasi yang rendah pada lapisan paling atas tanah. Selain itu, kebanyakan kejadian tanah runtuh direkodkan berlaku dengan kerap di hutan yang mempunyai kanopi kurang daripada 15% dengan tahap kecuraman 10-40%.

Para petani, penternak dan penduduk nomad yang tinggal atau bekerja dalam lingkungan kawasan kajian ditemuramah bagi mengetahui pandangan mereka

terhadap kemerosotan tanah di kawasan kajian ini. Selain itu, temuramah juga dibuat dengan pakar-pakar dalam permasalahan hakisan tanah ini. Jawapan yang diperolehi secara lisan membuktikan bahawa cara perladangan atau pertanian yang tidak mampan, eksploitasi penggunaan tanah tanpa had dan pembukaan kawasan hutan merupakan akitiviti manusia yang paling menjejaskan struktur tanah kawasan tersebut.

Faktor-faktor lain yang menyumbang kepada kemerosotan tanah termasuklah kegiatan penanaman kontan yang tidak berkonsepkan tanaman giliran. Masalah hakisan tanah ini dapat dielakkan atau setidak-tidaknya dikurangkan impaknya terhadap kawasan tersebut melalui perlaksanaan aktiviti-aktiviti seperti latihan amalan penanaman baik, latihan industri kepada para penduduk yang terlibat serta aktiviti lain yang dapat menimbulkan kesedaran sivik dalam diri setiap masyarakat tentang kepentingan konservasi tanah yang lebih kompeten. Selain itu, undang-undang yang lebih ketat serta mesra alam hendaklah dikuatkuasakan (pemantauan aktiviti pertanian seperti penggunaan baja, racun serangga, serta pembakaran terbuka). Undang-undang sediakala hendaklah dipantau dengan cekap dari semasa ke semasa tahap pematuhannya oleh penduduk di situ. Pihak kerajaan pula haruslah memainkan peranan dalam membantu membangunkan taraf hidup penduduk di kawasan Merek, Iran dengan membuka lebih banyak peluang pekerjaan dalam pelbagai bidang kepada para penganggur di kawasan tersebut agar mereka dapat membantu meringankan beban yang tanggung.



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I certified that a Thesis Examination Committee has met on **24 November, 2010** to conduct the final examination of Mosayeb Heshmati on his thesis entitled **“Assessment of Land Degradation in Relation to Human-Induced Causes in Agro-ecological Zones in the Merek Catchment, 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 Doctor of Philosophy.

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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 institution.

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**Mosayeb Heshmati**

**Date:** 24 November 2010

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