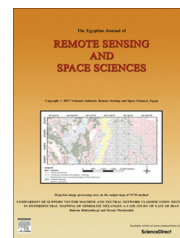




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RESEARCH PAPER

Forest losses and gains in Kurdistan province, western Iran: Where do we stand?



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Abstract Zagros forests in Kurdistan province of Iran are important habitats for many species including Persian squirrel. In the past few decades, human activities such as clear cutting and agriculture have reduced the quality and quantity of these forests. The current study used Landsat Thematic Mapper images from years 1987, 2000, 2010 and 2015 to map and monitor changes in the forest extent and density in the region. Radiometric, geometric and topographic corrections were applied to the satellite images. For supervised classification training signatures for different classes were established. Training sites were evaluated for possible discrimination of each class using transformed divergence method. The maximum likelihood algorithm was used for supervised classification and post-classification method was used to detect changes over a period of 28 years. The final map of land covers consisted of seven classes including barren land, agriculture, dense forest, semi-dense forest, mixed of sparse forest and rangeland, wetland plant, and water bodies. The results of change detection showed an increase in the amount of forests in this period of time, however, 3083.8 hectares of dense forests, which is one of the most important areas for wildlife such as the Persian squirrel, has reduced. This information can be used by natural resource managers and it is prerequisite for further ecological studies on wildlife species in the region.

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1. Introduction

The protection of all things connected with nature has gained increasing attention because of the massive rate of decline and

loss of habitats and the natural environments over the past century. Forest degradation is a major issue worldwide, resulting in temporary or permanent deterioration of density and structure of vegetation which can affect species composition and diversity (Grainger, 2013). Monitoring changes in forest cover and canopy structure through the time is important for many applications, such as forest planning and management (Sironen et al., 2001; Zimble et al., 2003), climate change studies (Nuutinen and Kellomaki, 2001; Zimble et al., 2003; Matala, 2005), and wildlife conservation (Coops and Catling, 1997).

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Traditionally, forest inventories using aerial photography interpretation and ground-based sampling have been used for forest mapping. These methods are rather time consuming and costly, especially in mountainous areas. Development of remote sensing technologies over the past few decades has provided new tools for advanced ecosystem management (Ayodeji Opeyemi, 2006) and a more automatic and efficient way for collecting data and measuring forests in terms of both cost and time (Yu, 2007).

Since the 1970s, satellite data have been contributing to forest mapping (Peterson et al., 1987; Martin et al., 1998; Tokola et al., 2001; Ahmadi Sani et al., 2009; Broich et al., 2011). Several approaches such as post-characterization comparison of disturbance index (Masek et al., 2008), time-series and classification of forest cover loss analysis (Broich et al., 2011; Potapov et al., 2011), time-series of forest classifications using joint probabilities (Caccetta et al., 2007) and change vector thresholds (Xian et al., 2009; Xian and Homer, 2010) have been developed for forest change detection and monitoring. Among different satellite images used for forest mapping, Landsat Thematic Mapper (TM) imagery is generally used for mapping over larger areas (Dorren et al., 2003).

Zagros forests with an area of about 6 million hectares (3.5 percent of Iran), are located in the west of the country. These forests have also been called western oak forests, due to the dominance of oak species (*Quercus* spp.). Western oak forests are home to many species including, the Persian squirrel (*Sciurus anomalus*) which is the indicator species of this region (Ziaaee, 2010). Persian squirrels and oak trees have symbiotic relationships, in which forests provide ecological requirements of Persian squirrels such as food and shelter and, in return, the Persian squirrel contributes in seed germination and forests' regeneration (Ziaaee, 2010). Deforestation and poaching are the major threats to wildlife in the region (Yigit et al., 2012). The lack of accurate knowledge about these forest habitats also hinders the effective planning and

management of these forests and the wildlife within them. Preparing update maps and awareness of past to present changes would be useful for wildlife conservation planning.

Change detection studies in parts of Zagros forests including Arasbaran (Ranjbar and Mesgari, 2002; Rasuly et al., 2010; Rezaee Moghadam et al., 2010), Bane (Amini et al., 2009), Ilam dam catchment (Shahkooeei et al., 2014), Saman forests, Chaharzarbar forests (Khan Hasani et al., 2008), (Susani et al., 2010), Ilam province forests (Mahdavi, 2010) and Marivan forests (Yusefi et al., 2012), showed considerable degradation in these forests. However, considerable parts of Zagros including forests of Kurdistan province which are important for conservation of Persian squirrel are yet to be investigated. The current study aimed to map a large area of Zagros forests in Kurdistan province, detect changes over a period of 28 years and discuss the importance of forest change for wildlife conservation. This information can be used by natural resource managers to adopt conservation and restoration strategies. In addition, such studies are prerequisite for further ecological studies on wildlife species such as the Persian squirrel in the region.

2. Material and methods

2.1. Study area

The study area is a mountainous forest located in the west of Kurdistan province, Iran ($35^{\circ}06'25''\text{N}$ – $36^{\circ}13'22''\text{N}$ and $45^{\circ}33'22''\text{E}$ – $46^{\circ}43'27''\text{E}$) (Fig. 1). The region covers more than 466,902 hectares of Zagros forests and is one of the most biologically diverse landscapes. The region is typically characterized by a semi-humid climate with extremely cold winters and annual precipitation of about 800 mm. Increasing populations, low level of awareness and high dependence of local communities on forests for their primary livelihood

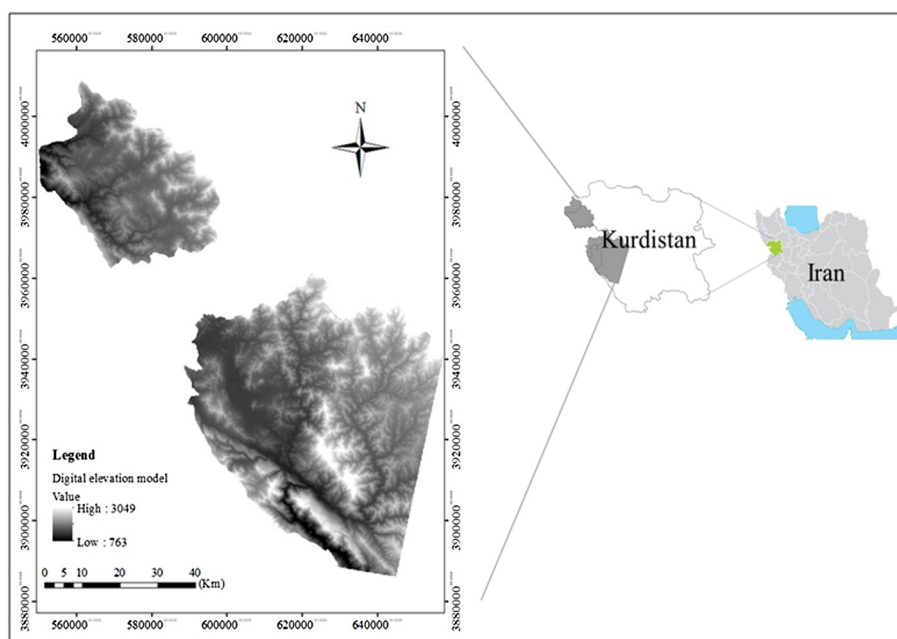


Figure 1 Study area located in Kurdistan province, western Iran.

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