LAND USE AND LAND COVER CLASSIFICATION AND CHANGE DETECTION OF THE CASPIAN SEA FOREST BELT

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INTRODUCTION

The forests of southern Caspian region in Iran is considered the remnants of Hyrcanian vegetation zone within the Euro-Siberian region. The vegetation zone is a green belt stretching over the northern slopes of Alborz mountain ranges and includes three habitats of alluvial flats of coastal plain, northern slopes of Alborz, and the subalpine meadows. The most outstanding feature of the region is the broad-leaved deciduous forests, ranging in altitude from sea level to 2800 m. The vegetation is well distinguished from other areas by high annual precipitation (600-2000mm), a considerable part of which falls in summer. The high air humidity and higher winter temperatures at the lower altitudes make the greater part of this area most favourable for mesic forest, not unlike those of western or southern Europe. In recent decades, a variety of anthropogenic forces such as urbanization, agricultural expansion, and unsustainable logging has reduced the extent and impacted the health and function of these forests (Figure 1). In this study, we use high resolution satellite observation over two decades to quantify the changes in southern Caspian forests, a challenging problem due to complex terrain and frequent cloud cover. Most of the recent remote sensing based maps are at continental and global scales (1-km resolution) and do not provide detailed information on land use activities, deforestation patterns, and agricultural expansions in the region [2] [7].

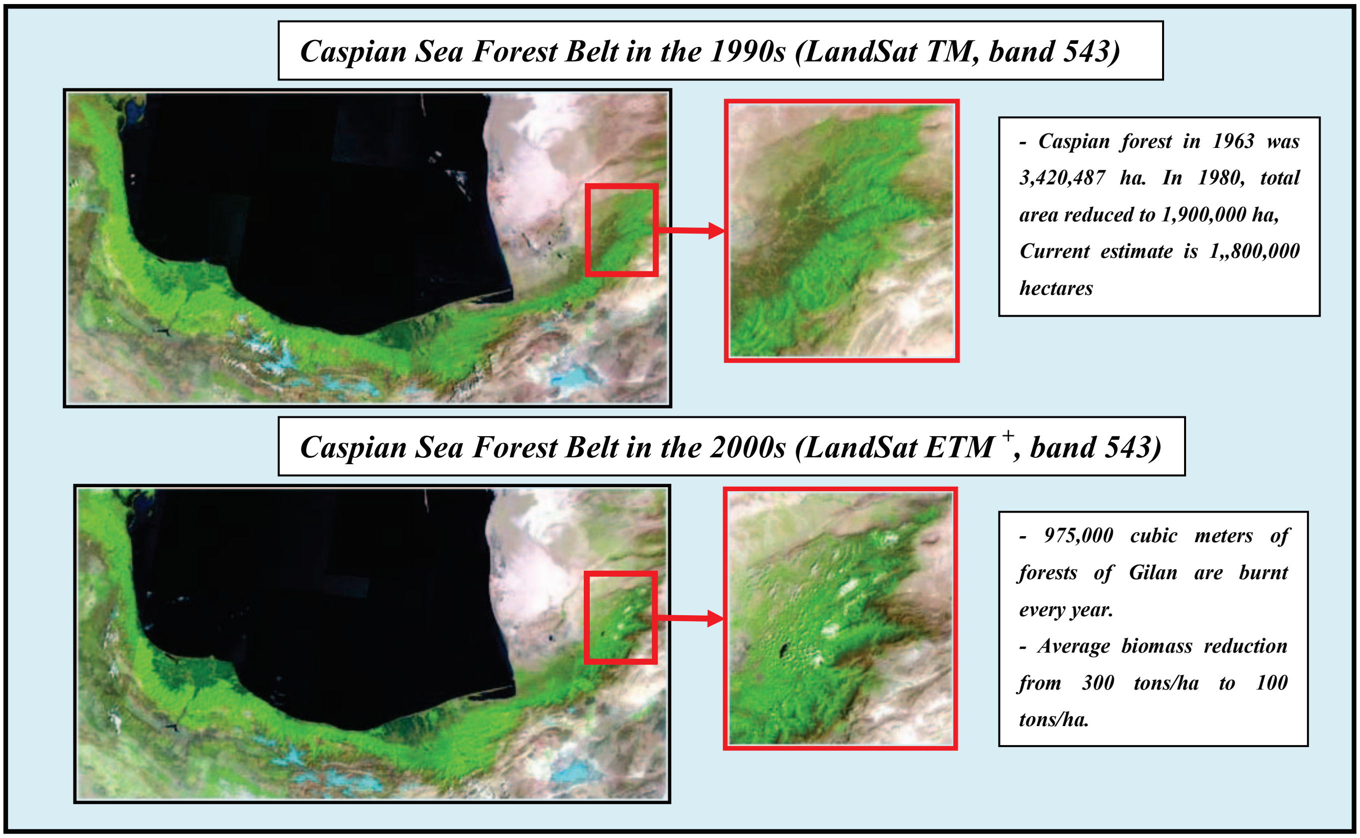

Figure. 1

METHODS AND EXPERIMENTAL DESIGN

There are two goals that our study intends to achieve. First and foremost, we will present the first high-resolution (30 m) map of land-use/land-cover (LULC) classifications with 15 classes, from Landsat Thematic Mapper (TM) and Landsat Enhanced Thematic Mapper Plus (ETM+), for the 1990s and 2000s, covering the area of the whole forest belt which is situated in the southern coast of Caspian Sea. Secondly, based on the land-use/land-cover classifications, we will assess the land-cover/land-use change of Caspian Sea forest belt, between 1990s and 2000s.

The classification methodology is based on 20 scenes of LandSat TM and ETM+ imagery covering the entire Caspian Sea forest belt. In order to increase the differentiability of vegetation types, normalized difference vegetation index and SRTM topography data were also added into our data set. All LandSat imageries were calibrated to exoatmospheric reflectance (ρ_p). The NDVIs from the 1990s TM were then calibrated to the 2000 ETM1 image using linear regression models derived from 25 known invariant targets (i.e., their land-cover type and appearance did not change in any of the two images). These targets were drawn from water bodies, grasslands, and dense forests. This process should have removed most remaining calibration problems between the different sensors and atmospheres, and it is as successful as absolute radiative correction [2], which is not possible here because of the lack of accurate atmospheric data for most images.

The classification approach will be a combination of unsupervised clustering, image segmentation and the Maximum Likelihood supervised classification [4] with a set of hierarchical classes that can be finally aggregated to a few major land cover classes. The aggregated classes will be chosen to represent the overall vegetation and land use types, to be monitored easily for land conversion. The final classification result has 15 land-use/land-cover types.

A change detection approach based on a combination of image classification and NDVI changes will be employed to develop land use change maps [2] [8]. The approach is divided into two steps: First, we classify the 1990s images using a combination of unsupervised clustering and the maximum likelihood classification similar to the 2000 baseline map. Next, we will use a segmentation of normalized differences of NDVI between 1990 and 2000, $(NDVI_{2000}-NDVI_{1990})/(NDVI_{2000}+NDVI_{1990})$, to identify pixels that have been changed in vegetation cover between the two dates. We will then develop a set of rules, to combine the 1990 classification and the 1990-2000 NDVI change detection to identify class types and the direction of change between the two dates. This approach has the advantage of making the 1990 classification map spatially and thematically compatible to 2000, and at the same time improving the accuracy of changes between the two maps. The resulting map is validated by using a combination of field data and available higher resolution IKONOS images (4.1m) distributed over the region.

PRELIMINARY RESULTS AND DISCUSSION

Our study not only provides the latest information of the Caspian Sea forest area, but also increases the spatial/temporal resolution and accuracy of global assessments. The classification data and LULCC detection results will be useful for both the resource management and scientific applications. Our project will incorporate the maps in a model to assess regional variations in the extent and the underlying forces of deforestation and ecosystem degradation and further examine the impact of anthropogenic changes on water and energy cycle of the region.

Keywords: CASPIAN SEA FOREST BELT, CLASSIFICATION, FOREST TYPES, LAND-USE/LAND-COVER CHANGE, LANDSAT

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