

Comparison of Neural Network and ISODATA classifiers for Land Cover Assessment Using Optical Data

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Key words: Land Cover, Classification, Fuzzy ART, ISODATA, SOM

SUMMARY

There are several methods used to interpret the remotely-sensed images. Among the all, thematic information extraction through image classification is the most common method. Several image classification algorithms have been developed and examined in the scope of supervised and unsupervised techniques. Ground truth data are initially required for supervised image classification. When there is no ground truth data, the unsupervised image classification (clustering) techniques can be more preferable and plausible. Conventional methods such as Iterative Self Organizing Data Analysis Technique (ISODATA) and K-Means give sufficient results, however artificial neural network (ANN) techniques have more successful results than conventional ones. Self Organizing Maps (SOM) and Fuzzy Adaptive Resonance Theory (FuzzyART) are the two methods for Artificial Neural Network classification. In this study, we will compare the classification performance of ISODATA and ANN classification techniques (SOM, FuzzyART) for land cover assessment. The performance analysis was carried out using Error Matrix. The results indicated that FuzzyART has %4 and %12 better classification performance than ISODATA and SOM, respectively.

1. INTRODUCTION

With latest advances in remote sensing and computer technologies, the increasing availability and wide-range usage of remotely sensed images can help us to gather information about earth surface. (Benediktsson et al. 1990, Benediktsson et al. 1992, Richards 1993, Bruzzone et al. 1999,)

Land cover is a considerable variable linking to the human and physical environment.(Foody 2002,Otukei et al. 2010) Remote sensing provides data at the different spatial and temporal scales on the same geographical area at a lower cost than ground surveys methods.(Foody 2002,Mather et al.2004,Szuster et al. 2011) Remotely sensed images are commonly used for land cover assessment.(Foody 2002,King 2002, Otukei et al. 2010).Classification techniques are generally used to extract thematic information about earth surface. When priori classes of interest area are known, supervised classification are mostly used. Otherwise the unsupervised classifications (clustering) are the plausible ones. (Campbell 1996,Foody 2002)

Unsupervised classification (clustering) tries to find main clusters in remote sensing data sets. To understand radiometric measurements in raw satellite images is highly difficult. For the reason aforementioned, the unsupervised classification is famous in remote sensing (Wilkinson 2001) Several unsupervised classification techniques have been used in remote sensing. Among the all k-means and ISODATA are the traditional ones. (Duda et al.2001,

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Zhong et al.2011).Artificial Neural networks are commonly used in remote sensing classification by researchers for land use classification.(Heermann et al. 1992, Bischof et al. 1992 ,Civco 1993, Ji 2000,Pal et al.2003)

In this study, we explore the potential use of neural networks techniques (FuzzyART , SOM) and ISODATA for land cover assessment in the Terkos Lake basin in Istanbul.

2. STUDY AREA

The study area is located in European side of Istanbul at the northern Marmara region lies Turkey (Figure1).The geographical coordinates of the interest area are 40 '19"North and 28' 32"East.

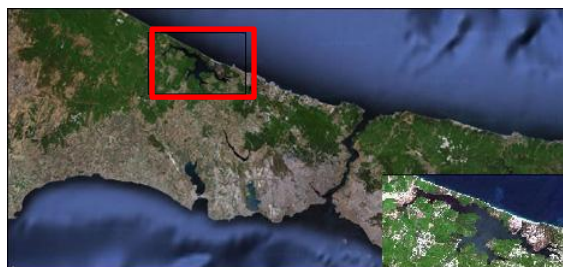


Figure 1: Location of study area (Url:1)

Terkos Lake, provides fresh drinking water for Istanbul since 1800s, is the most important one of the freshwater sources. Approximately %30 of the water demand of Istanbul are provided by Lake Terkos.(Balcik *et al.*2011) Terkos Lake basin with its fertile farmlands is the primary source of income for the villages. Also there are some refreshment areas around lake.

Due to the reasons mentioned above, Terkos Lake basin has great importance for the continuity of natural life cycle in Istanbul.

3. MATERIALS AND METHODOLOGY

3.1 Data Acquisition

Landsat 7 (ETM+) data was used in this study. These geo-referenced Landsat image was downloaded from USGS archive .The image was acquired on May,2000 on the location of path 181 and row 31,however most recent geometric and radiometric correction were applied on the data.

3.2 Image Classification

Image classification was applied using IDRISI Selva GIS and Image Processing Software and ERDAS IMAGINE 9.2.

In clustering ,there are no priori training data with known classes (Fischer 2001) ISODATA, FuzzyART and SOM unsupervised classification techniques applied to Landsat7(ETM+) data of Terkos Lake in Istanbul. All bands except panchromatic was used. In the following paragraphs a brief explanations about classification techniques mentioned are provided.

Iterative Self Organizing Data Analysis Technique (ISODATA) uses minimum distance classification algorithm. (Campbell et al.2011) It classifies pixels depending on minimum spectral distance formula iteratively (ERDAS 1997)

Fuzzy Adaptive Resonance Theory (FuzzyART) is proposed by G.A.Carpenter (1991).According to Wang et al.2011 ” *The Fuzzy-ART neural network is an unsupervised learning clustering and pattern recognition network(Carpenter et al.1991, Frank et al.1998)The traditional Fuzzy-ART consists of two layers of computing neurons: the input layer and the output layer, and a vigilance subsystem controlled by an adjustable vigilance parameter. The input vectors are applied to the Fuzzy-ART network sequentially. The network seeks for the “nearest” cluster that “resonates” with the input pattern according to a winner-take-all strategy and updates the cluster to become “closer” to the input vector. In the process, the vigilance parameter determines the similarity of the inputs belonging to a cluster. The choice parameter and the learning rate are the two other factors that influence the quality of the clustering results.*”Details for algorithm is found Wang et al.(2011)

Self Organizing Maps (SOM) is devised by Kohonen (1990).According to Ji (2000), “*Basically, the feature map neural network is a vector quantizer which creates class representation onto a two-dimensional map by self-organizing the connection weights from a series of input patterns to outputs nodes.*” Details for algorithm is found Wang et al.(2011)

4. RESULTS

4.1 Classification Results

For the study area it is aimed to determine five land cover types basically such as forest, water, barren land, forest2, farmland. All these land cover types were delineated in FuzzyART and ISODATA. However in SOM classification method, the “barren land” was not identified. It was replaced by a new class as “water2”. The results for three classification techniques examined for Terkos Lake basin shown in Figure 2

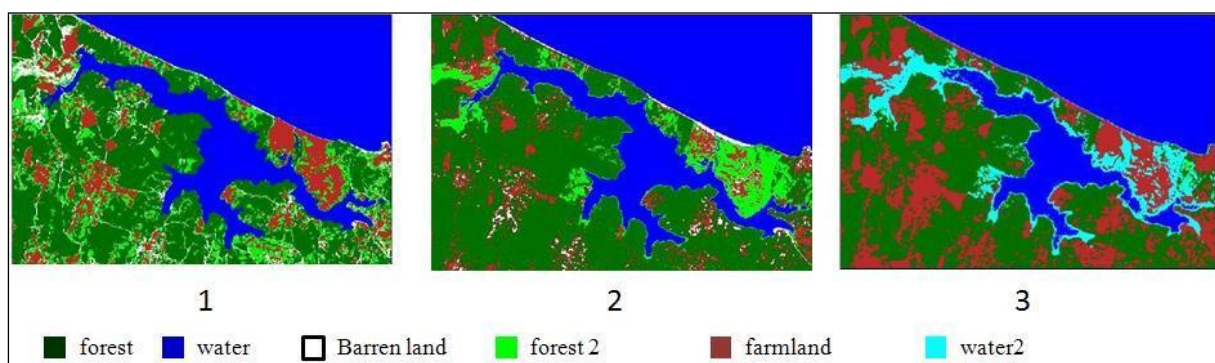


Figure 2: Classifications with FuzzyART(1),ISODATA(2) and SOM (3)

4.2 Accuracy Assessment

The accuracy assessment of classifications was carried out using Error Matrix. Overall classification accuracy and Kappa statistics are shown on Table 1.

<i>Method</i>	<i>Overall Accuracy</i>	<i>Kappa</i>
<i>FuzzyART</i>	%76	0.70
<i>ISODATA</i>	%72	0.65
<i>SOM</i>	%64	0.55

Table 1: Classification Accuracy

5. CONCLUSIONS

When geometric and radiometric corrections applied images such as Landsat are classified with high accuracy, the classified images can be used as a thematic map. This is the main reason why researchers have been developing the classification techniques for land cover assessment for years.

While identifying the land cover types for Terkos Lake basin, SOM was not able to identify the expected clusters. It can be concluded that clustering techniques are not always able to identify correct and one-label clusters. Due to similar spectral reflectance of land cover types, two or more classes can be mixed rarely or some cluster cannot be linked to the land cover.

As seen from Table1 ,FuzzyART has better classification performance than the other techniques for Terkos Lake basin . Artificial Neural Network techniques are widely used in remote sensing applications but does not have sufficient results every time as seen in SOM example contrary to FuzzyART .

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Url1: <http://www.mimdap.org/wp-content/uploads/2009/02/plan2.jpg> (Accessed **24.07.2012**)

BIOGRAPHICAL NOTES

Mustafa Ustuner is master student and working as research assistant in Geomatics Engineering/YTU, Turkey. His interest areas are information extraction from satellite images, land cover classification and related topics.

Fusun Balik Sanli obtained MSc in Geomatics from Yildiz Technical University (YTU), Turkey and ITC, The Netherlands. In 2004 she received a PhD on RS&GIS Graduate Studies from YTU for this thesis 'Defining Land Use Types by using Electro-Optical and SAR images'. She is currently working as vice head of Geomatics Engineering Department in YTU and academic staff in Photogrammetry Division. Her research expertise focuses on Optical&Radar Remote Sensing, Image fusion, Information extraction from SAR and Optical Images. She was the co-chair of the ISPRS WG VII/2 – Information Extraction From SAR Data (2004-2008)

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