Suitable Site Selection For Tea (Camelia sinensis) in City of Rize

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Abstract:

Northern Black Sea region is characterized as very steep topography with hilly terrain structure and high slopes. Numerous incidents were reported in the region related to landslide causing losses of life and property due to unsuitable site selection for tea (Camelia sinensis) cultivation. Recently there has been also a total increase in tea cultivated areas which is worsening the situation in the region. Therefore this study aims at defining the importance of suitable site selection for tea cultivation in the area. In order to accomplish suitable site selection for tea plant, a high resolution geodatabase was builted with related layer information such as DEM (Digital Elevation Model), slope, aspect, LULC (Land Use/ Land Cover), LCC (Land Capability Class) by considering the literature information on environmental and climatic requirements of tea plantation. The study area is the central part of Rize city and very close rural neighborhood of the city skirts that is totally 860 ha. After detailed spatial analysis of the geodatabase, 67.1 ha was the most suitable, 361.89 ha was moderate and 430.56 ha was found unsuitable for tea cultivation in the study area. In terms of the total area (366 ha) which is already under tea cultivation, 28.46 ha was the most suitable, 141 ha classified as moderately suitable and 196.27 ha was unsuitable. Finally, it can be concluded that approximately 54% of total tea planted gardens in the study area was unsuitable for tea cultivation due to very high risk of land slide occurrence. Therefore alternative species can be considered in those areas to mitigate the problem.

Key Terms: Tea (Camelia sinensis), GIS, Rize, Turkey.

Introduction:

The "tea plant" Camelia sinensis are widely distributed and cultured in different geographic locations such as Japan, Northern India, Indonesia, Sri Lanka, Tayland and many other east and far eastern countries. The most important country in terms of the tea production in the world is China. Turkey is placed at seventh order in total tea plantation volume but fifth in dry tea production. Yearly tea consuming rate per person is about 4 kg in Turkey (ÇSR 2009). Tea plant can grow under moderate climate conditions, with 1200 mm yearly precipitation, 70% humidity and 14°C average temperature (Usta 2005). Climate is the fundamental factor affecting quality and productivity of tea plantation. Other than widely distributed geographical regions, tea plant can be observed in some micro climatic conditions as it is in Northeastern Turkey. Northeastern part of Turkey is the only microclima in anatolian peninsula that tea plant can grow. The major tea producing cities are Rize (65%), Trabzon (21%), Artvin (11%), Giresun and Ordu (3%) (ÇSP 2008).

The city of Rize is bounded by (40.3316°E)-(41.2454°E) east and (40.5194°N)-(41.3248°N) north coordinates (Figure 1). Trabzon from the west, Erzurum from the south, Artvin from the east are neighbouring cities. Karadeniz ile çevrilidir. The total surface area of the Rize city is about 22 km² (Kandemir et al. 2006). 2012 adress based census estimated that the total population is about 324.152 for the city (URL-1).

Figure 1.Study area (Güneroğlu 2013)

Rize has a very steep geomorphology that formed by north anatolian mountain ecosystem lied parallel to the coastal strip. This unique geomorphology has forced the settlement in the area to be placed on coastal line and characterized as linear-littoral type. The general geomorphology can reach up to
northern plateau with relatively changing conditions in very limited and narrow coastal band. These areas are mainly used for settlement purposes (Reis et al. 2008) (Figure 2).

Figure 2. Rize

Soil type is generally red-yellow and reaches up to 600m elevation from the coast. The most productive soil covers almost 13.5 % of the region, the remaining part can be classified as V, VI, VII and VIII. When the total agricultural land is considered the most widely available soil type is VI with 48.5 % areal coverage. (Kandemir et al. 2006)

Rize city has very mild climatic conditions and average yearly temperature is about 14 C and longterm precipitation data (32 years) shows a mean value up to 2239 mm. (Kandemir et al. 2006; Reis et al. 2009; URL-2). The highest temperatures can be observed during July and August whereas the coldest period is between January and February. The longest sunlight period may occur in June with 6.4 hour a day. Eventhough seasonal changes are common, humidity is always over 75% in the region (Abanuz 2007) (Figure 3).

Eventhough there is no limiting factor in terms of climate for tea plantation in Rize, the steep character of the landscape, deforestation, landslides and very high precipitation rates are some factors that make the tea plantation risky in the region. So far there are many reported landslides occurrence caused death lives and property. Therefore it is inevitable to establish a comprehensive management plans for the tea plantation areas in the region.

<table>
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<tr>
<th>MONTHS</th>
<th>January</th>
<th>February</th>
<th>March</th>
<th>April</th>
<th>May</th>
<th>June</th>
<th>July</th>
<th>August</th>
<th>September</th>
<th>October</th>
<th>November</th>
<th>December</th>
</tr>
</thead>
<tbody>
<tr>
<td>The average temperature(°C)</td>
<td>6.5</td>
<td>6.4</td>
<td>7.9</td>
<td>11.6</td>
<td>16</td>
<td>20.3</td>
<td>22.8</td>
<td>23</td>
<td>19.9</td>
<td>16</td>
<td>11.7</td>
<td>8.5</td>
</tr>
<tr>
<td>The average high temperature(°C)</td>
<td>10.6</td>
<td>10.6</td>
<td>11.9</td>
<td>15.4</td>
<td>19.3</td>
<td>23.7</td>
<td>26.1</td>
<td>26.5</td>
<td>24</td>
<td>20.4</td>
<td>16.3</td>
<td>12.9</td>
</tr>
<tr>
<td>The average minimum temperature(°C)</td>
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<td>3.4</td>
<td>4.8</td>
<td>8.4</td>
<td>12.5</td>
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<td>19.9</td>
<td>16.8</td>
<td>12.9</td>
<td>8.6</td>
<td>5.4</td>
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<tr>
<td>Mean sunshine duration(hour)</td>
<td>2.2</td>
<td>3.1</td>
<td>3.4</td>
<td>4.3</td>
<td>5.4</td>
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<td>5</td>
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<tr>
<td>Average number of rainy days</td>
<td>15.2</td>
<td>14.1</td>
<td>15.9</td>
<td>15.6</td>
<td>14.7</td>
<td>14.5</td>
<td>14.4</td>
<td>14.9</td>
<td>15.2</td>
<td>15.6</td>
<td>14.1</td>
<td>15.2</td>
</tr>
<tr>
<td>The average total monthly rainfall[kg/m²]</td>
<td>218.8</td>
<td>178.5</td>
<td>150.9</td>
<td>97.4</td>
<td>97.4</td>
<td>137.6</td>
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<td>186.9</td>
<td>240.8</td>
<td>288.7</td>
<td>248.5</td>
<td>244</td>
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</tbody>
</table>

Figure 3. Meteorologic data for the period 1970-2011 in Rize (URL-3)

In this study, a land suitability method for tea plantation is proposed based on physical conditions of the area under investigation. Remote Sensing and GIS techniques were used to decide on and analysing the available data. A sepecial geodatabase is created and all spatial analyses were conducted on avaliable GIS layers. The main aim was to seek for the most suitable areas for the tea plantation in order to decrease the economic loses and increase the longterm productivity. Finally, the
most suitable areas were mapped and compared to available data.

**Materials and Methods:**

Multispectral high resolution aerial images were obtained from General Command of Mapping, Turkey. The images were taken in 2009 with special multispectral camera with (46cmX46cm) ground resolution. In addition to aerial images in order to fill the remaining gaps on the study area an IKONOS satellite image was used. Some other main inputs were city plan maps produced and disseminated by local authorities. Digital Elevation Model (DEM) was produced for the region by using 1/25,000 scale topographic maps provided by general Command of Mapping. All graphic input layers were registered and projected as ED-1950 datum with 6° UTM Zone-37N. Geodatabase and all other digitizing and mapping were conducted in ArcGIS 9.3 software environment. Main GIS layers are shown in Figure 4.

![Figure 4. Main GIS layers of the study](image)

1/25,000 scale topographic maps were digitized from the screen and converted to DEM after topologically cleaned and projected. In this study, ED-1950 datum and GCS-European 1950 coordinate system were used. Çalışmada kullanılan datum ED-1950 ve koordinat sistemi de GCS-European 1950'dir. In order to increase spatial precision of the study 6 degree country level national system was used. All graphic data after topologic cleaning were overlaid by 0.001m ground precision. Similarly, aerial images and satellite data were orthorectified and projected to same datum and coordinate system. Aerial images and satellite data were projected to UTM and converted to GCS-European 1950 system. UTM is national system that facilitate to produce national maps with higher precision (Reis vd., 2009). Geometric correction is basically converting an image data from pixel coordinates to another coordinate system. This process can only be done as planimetric (Karslı and Dihkan 2010). After that to get rid of some errors due to elevation an orthorectification process was applied to the data. In order to achieve that previously prepared DEM was used. After LULC and geologic maps of the area were prepared, the database became available for further spatial analysis on site selection. As a next step landscape elements of the area were digitized and rescaled according to literature. Produced landscape elements have the same spatial resolution of the aerial images. Available landscape elements were characterized as single tree, nested trees, group, bocage and tea.

In this study to decide on the most suitable areas for tea plantation, it was assumed that the land slope and linked to landslide issue is the major factor based on Reis et.al. (2009). Therefore slope ranges from 0-25% were considered the best areas for tea plantation, 25-45% the worst and the remaining
slope was considered as a moderate for the plantation of *Camellia sinensis*.

**Results:**

The total study area was 860 ha that is 366 ha of this region was used for tea plantation. But it is very difficult to decide whether this area is suitable for tea plantation or not due to precipitation, slope and landslide factors. Therefore, as a preliminary study based on available literature on landslide in the region, a suitability map of the area for the tea plantation was produced. Results of the study suggest that 67.1 ha of TNK areas is the most and 430.56 ha of the all study area is not suitable for tea agriculture. The remaining part was considered moderately suitable for the plantation practices (Figure 5).

**Figure 5.** Suitable area for tea in TNK

Another map for evaluating the region suitability by considering the areas that are already under use for tea plantation was also produced. It was shown on this map that almost 54% of the available tea plantation areas which are approximately 366 ha are not suitable for the plantation of tea (*Camellia sinensis*) due to landslides occurrence risk based on land slope characteristics (Figure 6).

**Figure 6.** Suitable area for tea in planted tea area
Landslides in the study area was also reported by individual surveying of the authors and personal communications of the local residents. Below some images taken by the authors were showed in Figure 7.

Figure 7. Landslides from the study area.

Conclusion:

Agriculture Protection Areas (TNK) were decided by an expert group from city council authorities by counsulting the ministry of agriculture, food and animals. Those areas should be decided according to their physical, vegetation and climatic as well as socio economic conditions of the region. Unfortunately it was explicitly shown that till now these areas were selected by considering only the city plan and not taking in to account some fundamental properties of the area. This can also be confirmed as our analysis proved that totally 429 ha of the 860 ha study area is suitable for tea plantation. This is only because of the high precipitation, soil properties and high slope of the region that causing landslide occurence and risk (Nefeslioğlu and Gökçeoğlu 2011; Reis et al. 2012). Landslides have been occured and caused lose of lives and economy for many years in the region. Therefore decision process should be strictly modified by considering and rearrangement the expert group responsible for TNK land registration. Expert group should include but not limited by landscape architects, agriculture engineers, forest engineers, city planners and etc.. It should also be stresseded that available YNK areas should be revised carefully by field surveys and in-situ observations.

After detailed spatial analysis of the geodatabase, 67.1 ha was the most suitable, 361.89 ha was moderate and 430.56 ha was found unsuitable for tea cultivation in the study area. In terms of the total area (366 ha) which is already under tea cultivation, 28.46 ha was the most suitable, 141 ha classified as moderately suitable and 196.27 ha was unsuitable. Finally, it can be concluded that approximately 54% of total tea planted gardens in the study area was unsuitable for tea cultivation due to very high risk of landslide occurence. Therefore alternative species can be considered in those areas to mitigate the problem. Region specific natural species such as "tilia, castanea, alnus" should be some alternatives. Some other agricultural alternatives can be "phyllostachys, actinidia, tilia or vaccinium". It can be concluded that this is the best way to increase long term sustainability of the tea plantation, promote the usage of forestry products as well as introduce new agricultural products to the region. Finally, landslide risks can be minimized by following eco-friendly and environmentally sensitive methodologies.

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