FORMEC´09
June 21nd – 24th, 2009, Kostelec n. Č.l. / Prague – Czech Republic

ASSESSMENT OF FOREST STORAGE LOCATIONS IN WOOD SUPPLY CHAIN

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Abstract: *The objective of this study is to analyze whether the present locations of forest storages are appropriate for easy distribution of wood to consumers. Therefore, in Isparta region of Turkey, main catchments were identified for modeling of wood flow by using digital elevation data in GIS environment. Then, watershed-based storage location strategy was developed. Actual and proposed storage locations were analyzed by evaluating information about harvesting and consumption points where customer or end user may be located. The appropriateness of storage locations was discussed and it was concluded that some of the forest storages should be closed, reducing the total number nearly by half, and some others should be transferred to new locations.*
Keywords: Location of forest storage, Physical distribution, GIS, Isparta Regional Directorate of Forestry.

1. Introduction

Forest storage (FS) places are important terminal points of wood supply chain and their location has an affect on the value of wood products. Timber and other wood materials are usually produced by local forestry authorities, carried to storages and sold to consumers through these storage locations. However, selling standing trees on a forestland (stumpage) is a new approach for Turkish forestry in terms of production and marketing of wood products. In order to supply raw wood material with low cost to customers forest storage has as a key role. Therefore, their locations, numbers and distribution over a region are very important in production and marketing.

In Turkey, forestland covers an area of approximately 21.2 million hectares, and annual allowable log production is approximately 15-16 million cubic meters (GDF, 2009). These forestlands are mainly mountainous landscapes with steep slopes. In addition, accessible forestland is very limited due to the fact that forest road density ratio is low in some regions. The harvesting operations are carried out in only certain periods in a year, which may depend on weather, vegetation period and market demand. Therefore, the raw wood materials should be harvested and transported to roadside storage places in a reasonable time for marketing. Accumulated wood is sold to consumers by means of public auction, and therefore these storage places are, in a way, showcases of forest administrations.

Considering these features, there are 3 alternatives to determine location of FS: 1) the closest to marketplace, 2) the closest to production site, 3) the most appropriate place between marketplace and production site. Forestry legislation recommends following criteria for determining the location of FSs.

1. FS should be located on a property of forest administration or state, 2- The locations should be on the intersection area of valleys of harvesting blocks or on the suitable place of the biggest valley, 3- They should be available for summer and winter transportation, also well-known place from customers, 4- They should be sheltered against flood and erosion hazards, 5- The distance from landing locations in forest should be 25 km, and the distance from each other should be maximum 50 km if there are any

connection state roads and forest roads in that area. 6- It should be on a low slope terrain for easy entrance and exit of loaded vehicles, 7- They should be at least 20 hectares in size, 2 m^2 for 1 m^3 wood material, 8-The location should be near a village and near a water source, 9- It is important that suitable labor force should be accessible (GDF, 1996; Acar, 1998).

It appears that some FSs in Isparta region don't satisfy these rules. Therefore, it is important to evaluate the present storage locations in terms of current supply and demands centers. The objective of this study is to analyze whether the present locations of storages are appropriate for supplying wood material to consumers.

2. Study Area

The study area is Isparta Regional Directorate of Forestry located in Southern Turkey (Figure 1). It is approximately 1.8 million hectares in size and has 6 local administrations, including Isparta, Burdur, Bucak, Sütçüler, Eğirdir and Gölhisar forest districts (IRDF 2009).

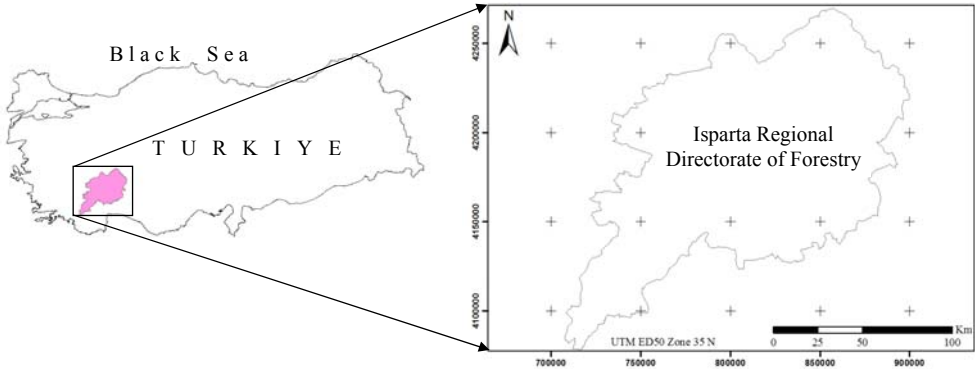

Figure 1. Boundaries of Isparta Regional Directorate of Forestry

The study area has an altitude of 76–2976 m. There are several water bodies that consist of natural lakes, dam lakes and several ponds. There are also many streams and natural water springs in this area. These areas cover 100.000 hectares of study area. The region, therefore, is also called "Lakes District" of Turkey.

3. Dataset

Shuttle radar topography mission (SRTM) data and administration border map of Isparta Regional Directorate of Forestry were used in the study. SRTM data is an elevation data obtained from radar system that positioned onboard the space shuttle. Two different type radar antenna panels were utilized for the space mission, such as C-band and X-band (JPL, 2009). The C-band data that are free of charge from GLCF (GLCF, 2009) were used in this study.

SRTM data are distributed in 3 different grid resolutions, including 1″ (approximately 30 m), 3″ and 30″. SRTM1 data having 1″ spatial resolution may be used only for United States without permission. But for the other countries, they can be obtained with special permission. However, the SRTM3 and SRTM30 data, 3″ and 30″ spatial resolution, are available freely (Bildirici et al., 2008). SRTM3 scenes as identified by path/row numbers, 178/34 and 179/34, in WRS-2 (Worldwide reference system) were used in the study (Çoban and Eker, 2009).

4. Methodology

To analyze locations of present forest storages, watershed modeling has been carried out for the whole area. Geographic Information System (GIS) was utilized to accomplish this task. For this, administrative border of Isparta Regional Directorate of Forestry is realized as a simple watershed and wood flow is considered similar to water flow. To determine catchments, the Arc Hydro Tools working on ArcGIS

software is used. The Arc Hydro Tools are a series of tools built on top of the Arc Hydro database that facilitates the analyses often performed in the water resources area (ESRI, 2009).

SRTM3 data were used as a digital elevation model (DEM) after voids were filled by using SRTM30 data in these scenes. Then SRTM data and administrative map of Isparta Regional Directorate of Forestry were registered by using UTM projections and ED-50 datum. The digital elevation model obtained from SRTM3 data was processed in ArcHydro tools step by step as shown in Figure 2.

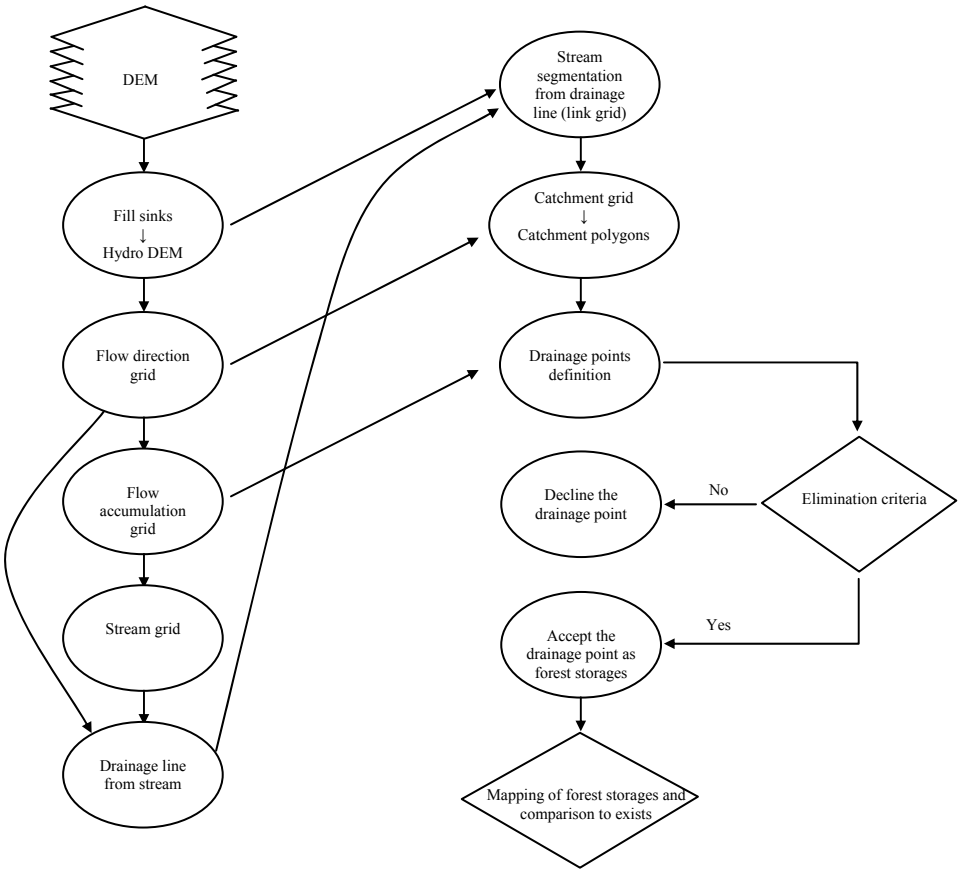

Figure 2. Workflow about determination of forest storages by using Arc Hydro Tool.

The following criteria were used for the selection of forest storages:

a) When several drainage points come together to form a cluster, only the one at the central point is chosen.
b) Maximum distance from main consumer centers is 50 km
c) Maximum distance between storages is 25-30 km
d) Should be close to main transportation roads (especially asphalt roads- main roads)
e) Every local forest district should have sufficient number of storages

Buffer polygons for each proposed forest storage was generated at distance of 30 km. These polygons were clipped by using input feature, border of region. The similar procedure was applied for the present forest storages. Buffer polygons were also produced for main customer centers at distance of 50 km that was acceptable distance for transporting timber, determined by oral interview with customers. These customer polygons were also clipped by using border of region. After that, the present and proposed forest storage buffer areas were clipped from customer buffer polygons to determine correspondence ratios between them.

5. Results

After processing DEM data within ArcGIS, the 245 catchment polygons and their drainage points were obtained (Figure 3).

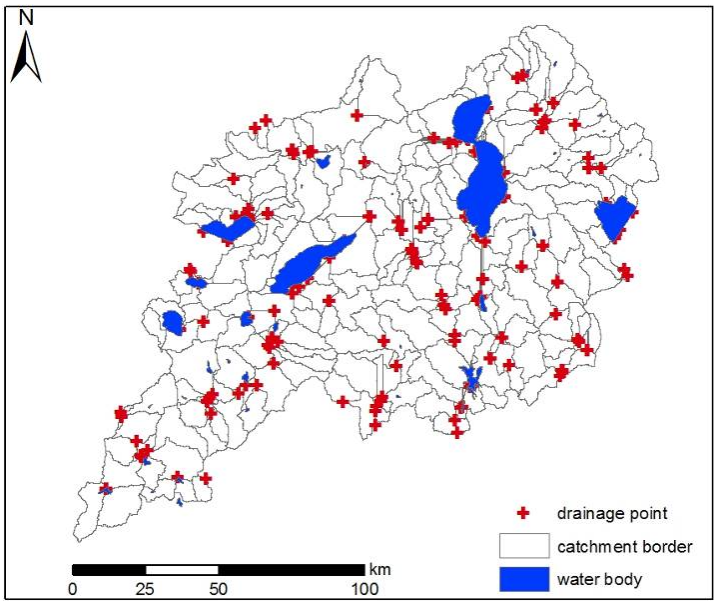

Figure 3. Catchment polygons of watersheds and their drainage points

These drainage points were eliminated according to the criteria, described in methodology section. Although currently the total of 26 forest storages is located in the study area, there were 14 points chosen as probable forest storage locations as a result of this selection. Present and proposed forest storages and also main customer center location have been observed in Figure 4.

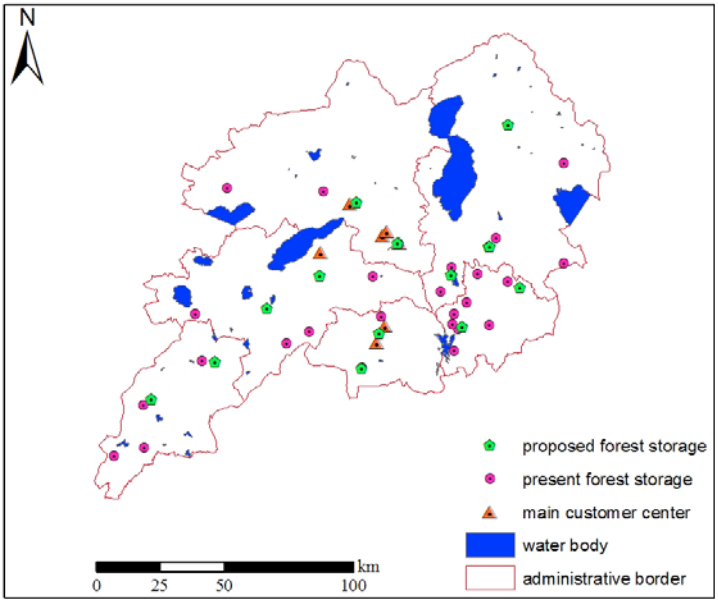

Figure 4. Present and proposed forest storages and main customer centers

Overlay areas of planned and present forest storages were only slightly different (Figure 5). The ratio of correspondence area between buffer areas of forest storages and total study area was 85 percent for present forest storages (Figure 5a), 81 percent for proposed forest storages (Figure 5b).

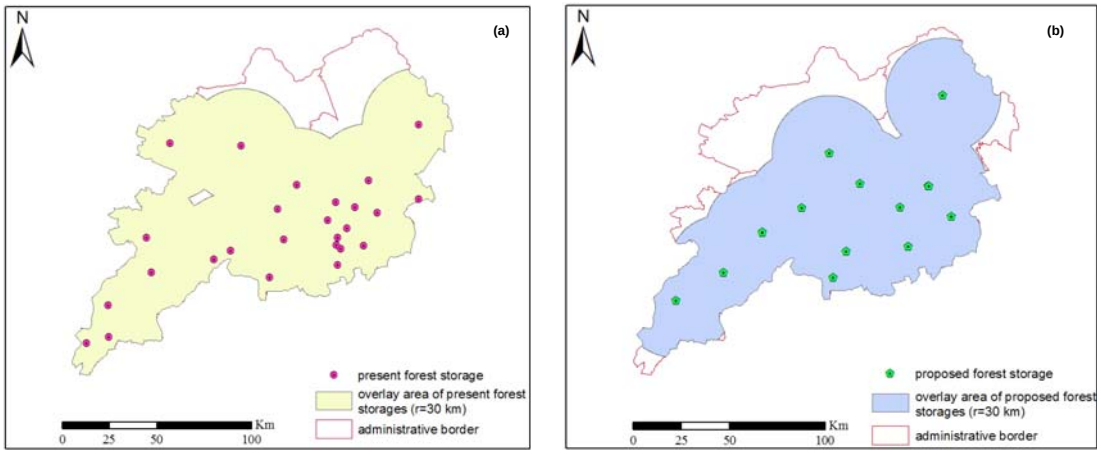

Figure 5. Coverage areas of present (a) and proposed (b) forest storage locations within the administrative border (r = 30 km for each location).

Buffer polygons produced for main customer centers at distance of 50 km were clipped from region border. Extracted areas were shown in Figure 6.

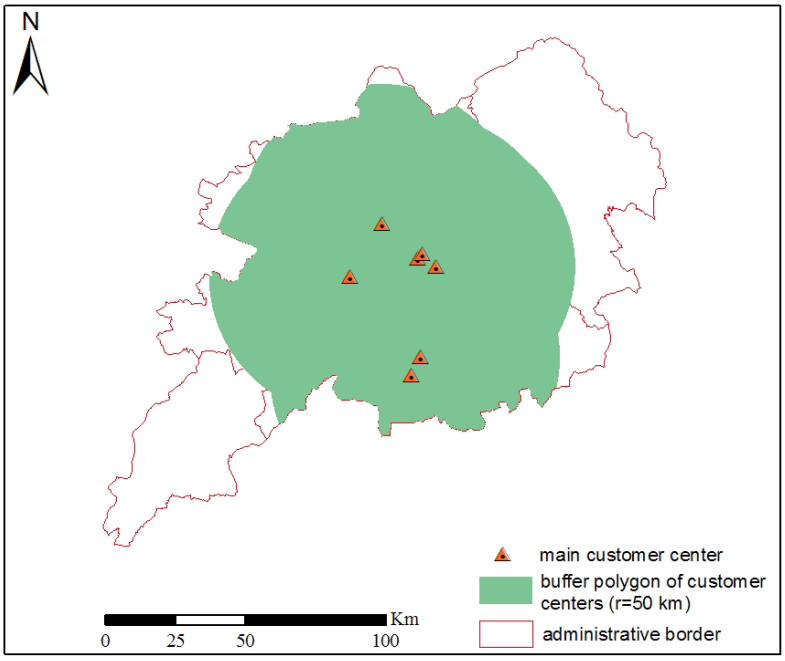

Figure 6. Coverage area of main customer centers within the administrative border (r = 50 km for each location).

When buffer areas of present and planned forest storages were compared with clipped area of customer centers individually, it was shown that size of overlay areas created was nearly similar as shown in Figure 7. The ratios of correspondence areas between buffer areas of forest storages and clipped area of main customer centers were 88 percent for present forest storages (Figure 7a), 82 percent for proposed forest storages (Figure 7b).

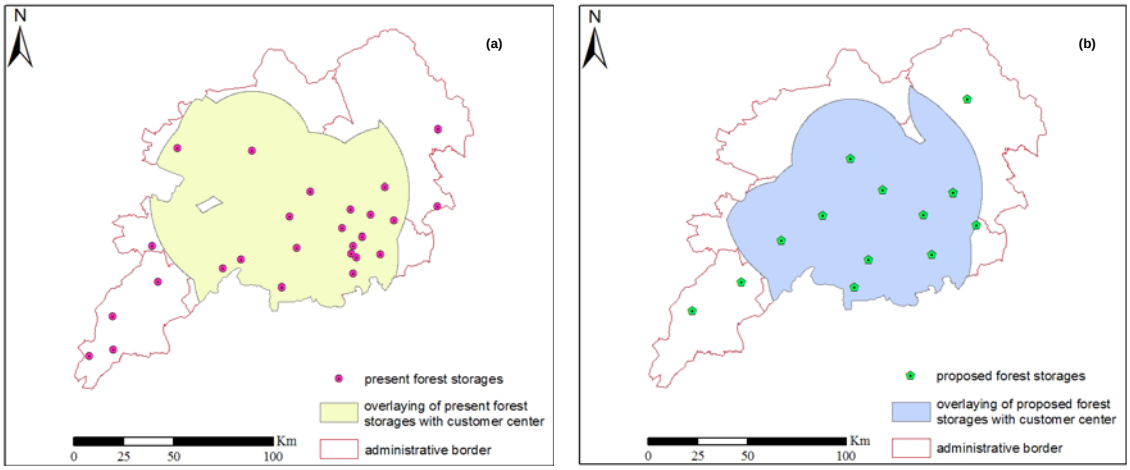

Figure 7. Overlaying of present (a) and proposed (b) storage buffer polygons with customer center polygon within the administrative border.

6. Conclusion

In this study, watershed based modeling has been applied to determine locations of new forest storages using GIS. The results indicate that the planned forest storages (14) are adequate for supplying forest products to customers in this area. The number and the location of these forest storages are suitable for network of forestry production system in this area. The size of coverage area of the proposed forest storages is nearly similar to the coverage of current forest storages. Decreasing the number of present forest storages nearly by half will affect operational costs positively. Additionally, bigger storage areas with larger storage capacity will be established, thus, the customers will have more options in terms of product selection, and they can satisfy all their needs from a single sales office. However, before constructing new forest storages suggested by this study, physical conditions, social relations or the other possible restrictions of those particular locations should be considered. However, this method can be used as a starting point to determine new forest locations without any obstructions.

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