

## SUB MODELS FOR OPTIMAL CONTINUOUS COVER MULTI SPECIES FORESTRY IN IRAN

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### ABSTRACT

Forestry in Iran is based on continuous cover forestry (CCF) management principles. CCF often leads to higher expected present values than rotation forestry (RF) with clear cuts. Furthermore, CCF has environmental advantages of several kinds. Many different species of trees grow together in large parts of these forests in Iran. Mixed species forests give advantages compared to monocultures, such as options to adapt harvesting of different species to changes in market prices, climate, species specific damages etc. In order to optimize multi species CCF in Iran, it is necessary to develop mathematical models for operations research studies that represent the relevant parts of the Iranian forestry planning problem. This presentation includes central components in this modelling process: Forest statistics, growth function estimations and the links to forest harvesting, logistics and the forest industry mills.

**Keywords:** Forest statistics; Caspian forest; Dynamic growth models; Optimization; Logistics.

### 1. INTRODUCTION

The area of natural forest in Iran is approximately 12.4 million ha of which about 1.9 million ha is managed as commercial forest called Iranian Caspian forest in northern Iran. The forests of Iran represent 7.5 percent of the total area of the country. Iranian Caspian forests are located on the south coast of the Caspian Sea and the northern slopes of the Alborz Mountain range from sea level to 2800 m. These forests grow in a strip 800 km in length and 2070 km wide. These are the most valuable forests in Iran. Industrial harvesting occurs only in the Caspian forest. Because of the severe climatic conditions and forest degradation, forests in other regions are not exploited for industrial wood production. Forest industries in Iran produce sawnwood and wood-based panels as well as pulp and paper from hardwood species. Moderate volumes of forest products, mainly paper, are imported. Modest quantities of wood are burned as fuel [5]. The number of options to model the dynamics of forests is almost unlimited. You may use stand models, models of individual trees, diameter class models, models that describe altitude, slope and directions, models in continuous time, in discrete time etc. The international demand for forest sector products has started to change. Some paper qualities have sharp demand decreases, mainly depending of lowered demand in the new internet based society. This transformation affects the whole forestry supply chain, which has to be considered as an integrated dynamical system with a lot of disturbances. Hence, when to manage the forest using multi species CCF, in our case in Iran, the main question for the forest industry is how much better this management regime is if the whole supply chain is considered and not only the management of the forest.

### 2. MAIN RESULTS

In order to collect volume and growth data, district number 2 of Losara forests that is located in Ploroad watershed, east of Guilan province was chosen. Its latitude ranges from 36 57' 38" N to 36

59' 40" N and its longitude ranges from 50 12' 10" E to 50 16' 40" E. These forests are located in Caspian mountainous area and its altitude ranges from 400 to 1200 meters. These forests are uneven-aged and the main species are: hornbeam (*Carpinus* sp), beech (*Fagus orientalis*), oak (*Quercus* sp), alder (*Alnus* sp) etc. The inventory area was 576 ha. A systematic random sampling method with network of 150\*200 m was used for inventory. The area of each sample plot was 1000 square meters. Therefore, 201 sample plots were determined and some items such as number of tree, tree diameter at breast height (DBH), trees height were measured at each sample plot. Furthermore, 3 sample plots at different 3 elevations were chosen to measure the tree increment. The available empirical data was used to estimate a modified logistic growth model where stand density, altitude and species mix were considered as explanatory variables. Logistic growth models have been found useful in continuous cover forest management optimization and examples of such studies are found in Lohmander [3] and Lohmander and Mohammadi [4]. The general dynamics of forests based on such models was analyzed and dynamic equilibrium conditions (stand densities and species mixes) for different altitudes were determined. In some cases, dynamic multi species model parameters are possible to determine via steady state observations of unmanaged forests. Optimization of management decisions in a changing and not perfectly predictable world, should always be based on adaptive optimization. Lohmander [2] describes these principles and typical implications for optimal forestry decisions. Adaptable logistic growth functions work well in such cases. The total forest sector model of this problem has to handle some criteria, maybe in conflict, such as the present value and the environmental value, as well as, the most influential disturbances. We shortly present how this can be modelled using a ranked multi criteria stochastic mixed integer programming model and why that approach is selected. We have not seen earlier applications of such models in this context. However, in distribution logistics, one method has recently been described in Kalinina et al.,[1].

### 3. REFERENCES

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