

# The system of forest management in Croatia

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## Abstract

Forest management in Croatia has a very long tradition and a prominent role in the history of forestry, particularly in the post-communist period and in the process of denationalization. The numerous activities of the 150-year-old Association of Forestry Engineers and Technicians include the publication of a scientific-specialist paper “Forestry Journal”, which has been coming out for 120 years. The foundations of present-day forestry were laid down in the Austro-Hungarian Empire, when Maria Theresa issued a legal order called “Urbarium”. Today, modern forestry is based on the system of forest management which unites and complements other systems in forestry. The introduction of new technologies for data collecting, storage and communication, accompanied with training forest staff in the usage and transfer of know-how in practice, has enabled the creation of a new system of forest management.

**Keywords:** forest management system, natural forests, new technologies, data base, remote sensing, Croatia

## I Introduction

### I.1 The history of the system of forest management

The first written documents in Croatia are contained in the statutes of coastal towns dating from the 13th century. All these statutes (Korčula 1214, Trogir 1240, Dubrovnik 1272)

prescribed measures for forest protection, banned or regulated felling activities and pine bark removal, and other items (Meštrović, 1992). Felling on the hill of Marjan was banned by the Statute of Split (1312). The Poljice Statute (1333) defined the problems of grazing, firewood, pastures and hunting.

“The First General Forest Act” (1451) originates from Istria. The establishment of oak reserves for the need of arsenals and the building of

waterways was regulated by the law from 1470.

Cutting down forests and turning forestland into ploughfields, meadows and pastures was banned by the laws from 1475 and 1495.

In order to ensure the success of these provisions, the Council of Ten (1538) appointed the timber official for Istria, Kvarner, and Dalmatia, and issued an order for an accurate cadaster to be drawn up in six months' time.

A new, more detailed cadaster plan about some taxation elements was based on the 1568 Decree. It was revised every 20 years until 1801. Forests were divided into annual felling strips and the felling ripeness was determined. Seed bearers were always left standing, while acorn collecting and grazing were banned for certain periods of time. In other Croatian regions most of the forests were owned by feudal lords until the 16th century.

Parts of forests were excluded from feudal ownership by the Segregation of 1876, thus leading to the formation of land communities.

By the Act of 1871, the right to use parts of state forests was bought off, and forests were divided into state and municipal ones/forests of income municipalities).

In 1769, Empress Maria Theresa issued a "Legal Forest Order" in the Croatian language, where methods of forest division into annual felling strips were prescribed, and rotations determined (oak: 200 years, maple: 100–150 years, beech: 120–150 years, poplar, linden and elm: 30–50 years, birch: 30–50 years, willow: 20–30 years, alder: 40–50 years, fir and spruce: 80–100 years). On the

basis of this Order, management bases were drawn up in 1769, 1853, 1875, and 1881.

In 1852, the "General Forest Law" was completed, which provided a cornerstone for forest management in general. The first forestry school in the Slavic south was established in Križevci in 1860. An "Instruction for mensuration, assessment and tending forests in the income municipalities in the Croatian-Slovenian Krajina" was passed in 1881. It prescribed the regulation of annual cuts according to the Austrian tax of 1788, which determined sale values of forests. The method was aimed at establishing a normal growing stock in forests so that the principle of sustainability could be maintained.

In 1894, a "Law regulating the appointment of expert staff and the use of forest management in forests of special public interest" was passed, while, a "Decree on the compatibility of management basis and programmes, and annual felling and tending programmes", with its component part "A direction for drawing up management bases and programmes" was passed in 1903. The direction gave a detailed account of all steps to be taken in dividing forests into management units (management classes), felling sequences, departments and divisions. A sustainable yield was prescribed with rotations of absolute maturity, as well as felling methods (clear, regeneration, selection, group cutting). A "combined area and growing stock method" was prescribed for high forests with clearcutting and regeneration

cutting, and a “norm method” for high selection forests.

“The Instruction” from 1903 was applied to all forests except the state ones. On the basis of Forest Law from 1929, “Guidelines for the management of state forests” were drawn in 1931. They prescribed management entities which were divided into management units, which were further divided into departments and divisions, while a “method of age class” was prescribed for high regular forests with stand management. A control method was prescribed for selection forests. As these were impractical to use, the “Instructions for tree marking and determining yields in selection forests” were passed in 1937.

In 1946, “Temporary instructions for forest inventory” were passed, and in 1948, “General instructions for forest management”, prescribing the drawing up of a general plan for a forest area and of a special study for each management unit. In 1961, a “New system of managing selection forests” was drawn up by D. Klepac, based on the optimal state.

A new Forest Act was passed in 1967, followed by a “Regulation on drawing up forest-economic bases, forest management bases and forest improvement bases” in 1968. In 1976, a new “Regulation on drawing up forest-economic bases, management bases and forest improvement bases” was passed.

Based on the Forest Act (1977), a “Regulation on methods of drawing up area forest management bases, management bases for management units, and forest management programmes” was passed in 1981.

A new “Regulation” was passed in 1985.

A new Forest Act was passed in 1990, a new Regulation in 1992, and the latest valid “Regulation on drawing up the management plan” (Meštrović 1978, Meštrović et al. 1992) was drawn up in 1997.

Piškorić and Vukelić (1992) mention the following important dates:

- 1860: the agricultural-forestry school was established in Križevci,
- 1876: the Croatian-Slavonian Forestry Association was founded,
- 1877: the first issue of Forestry Journal came out,
- 1898: the Forestry Academy was established,
- 1919: the Agriculture and Forestry Faculty of Zagreb University was founded,
- 1945: the Institute of Forest and Hunting Research was founded in Zagreb,
- 1947: the Institute of Karst Afforestation and Amelioration was founded in Split,
- 1949: the Institute of Timber Industry Research was founded,
- 1969: the independent Forestry Faculty of Zagreb University came into being,
- 1974: the Forest Research Institute was established in Jastrebarsko.

## 1.2 On the system and method of forest management

Contemporary theory and practice utilizes two methods of determining yields in high forests. One is the old, classical, well-established method based on age, rotation and age class. The other is a newer, biologically and economically more adequate method suitable both for forests of unequal composition and for selection forests. This method uses increment and volume grouped according to diameter classes (Miletić 1987).

Modern forest management aims at utilizing manifold functions of a forest by taking into account physical, economic and social criteria. Apart from direct benefits from forests, indirect ones, which often surpass the former, are also regarded, especially in terms of the protection of the environment (Klepac 1987).

Miletić (1987) writes about various methods of forest management and their systems used for shorter or longer periods in Croatian forestry.

Klepac (1980) writes about the measures undertaken to promote forestry development in Croatia in the spirit of the message from the Fifth World Forestry Congress in Seattle.

Klepac (1984) talks about the system and method of managing forests in the "Plitvice Lakes" National Park, based on the management programme for these forests, where the selection method was adopted.

Forest management in the light of the achievements in forestry science and economic development was the

subject of a symposium held in 1985 (Meštrović).

In the fifties, Horvat and Bertović (1961) introduced a new interdisciplinary approach to forest management in Croatia, which was later further developed and applied in practice by Cestar et al. (1979). Scientific disciplines of geology, pedology, phytocoenology, forest management, silviculture, and forest economics were united under a discipline called forest typology. Today, forest typology has become a new integral scientific discipline, which is based on an extensive data fund collected in about 3 000 plots over a period of 30 years (Krznar 1991). This has led to the formation of a modern data base (BAZA EGT RH) backed by technological support (Bekić et al. 1992). The data base has enabled a new approach to analysing and studying structural elements in forest ecosystems, and, with the use of modelling tools, has provided a foundation for checking (confirming) old results and drawing up new models in today's changed circumstances.

## 2 New technologies

Several centuries of managing forests and forestland, regulated by legislative measures, has resulted in the present state of forests in Croatia, which are mostly of natural origin. This provided a base for the creation of a system of forest management with a modern organizational form which follows world developments and adapts them to conditions in Croatia. In Croatia, forest manage-

ment is a leading scientific discipline which utilizes the latest and the most modern technologies in forestry.

## 2.1 Data base

There are several data bases in Croatian forestry, of which the most important are BAZA EGT HR of the Forest Research Institute in Jastrebarsko (Bekić et al. 1992), his fund containing data on the forest fund of the State Enterprise "Croatian Forests" and Hydro-pedological Base of the Forest Institute in Jastrebarsko.

## 2.2 Remote sensing

A photographic interpretation key was drawn up for individual tree species and for degrees of damage by using infrared colour aerial photographs (CIR) (Pernar 1994). The relationship between the degree of damage in pedunculate oak, determined by aerial photographs, and the colour of recordings per components, provided strong correlative links which can be shown with linear regression equation. Analyses showed that data do not differ from terrestrial data. The photographic interpretation key enables a completely objective photointerpretation of infrared colour aerial photographs used in damage assessment in pedunculate oak trees and stands.

The degree of forest tree and stand damage was assessed with the ICK interpretation of aerial photographs in beech-fir forests. The level at which satellite photographs in

Croatia are used today was described, and guidelines for their introduction and use in the Croatian forestry were given (Kalafadžić et al. 1993).

Kalafadžić and Kušan (1993) consider the possibility of obtaining information on forests from artificial earth satellites.

Scientists have used CIR aerial photographs for manifold applications: for example, for determining forest condition in large areas (Kalafadžić and Kušan 1990), for forest damage assessment (Kalafadžić et al. 1989a, 1989b, 1990a, 1990b, 1991, 1993, Kušan et al. 1994, Pernar 1994, Kušan and Pernar 1996), for estimating structural elements in a stand (Benko 1993, 1997, Benko et al. 1996a, 1996b, Benko and Szivovicza 1998), Kušan and Pernar 1996), for digital photographic interpretation (Kalafadžić and Kušan 1988, Benko and Biljecki 1998), for the application of satellite photographs (Benko et al. 1993, Kušan and Lampek 1994, Lampek and Kušan 1994, Kušan et al. 1997), and others.

## 2.3 Geographic information systems

The foundation of the Yugoslav GIZIS project (geographic and land information system) in 1987 marks the beginning of GIS in Croatia. The founding members of the project were, along with five institutions from Slovenia, INA-Projekt, the "Ruđer Bošković" Institute, Faculty of Geodesy, Infosistem, Faculty of Forestry and INA-EOP, all from

Zagreb. When the representative office of the ESBI company, the GISDATA, was founded in Croatia, the market was open for GIS programme packages, and a more systematic study of GIS technology began. So far, a number of institutions have obtained GIS programme packages, and several have made pilot projects in the following fields: horticulture, war damage, spatial categorization with regard to site quality, spatial planning.

Several examples of GIS technology application have been made in the Croatian forestry so far:

- the GIS model for NPŠO “OPEKA” (Kušan et al. 1992a),
- the GIS model applied in forest management (Kušan and Kalafadžić 1992),
- the GIS model applied in forest exploitation (Kušan et al. 1992b),
- pilot-project for the application of GIS technology in grouping forests in Croatia for the needs of seed production (Benko et al. 1993).

The application of GIS on forestry as one of the layers for a global problem solution was presented through the use of satellite photographs. (Benko et al. 1993).

Pernar (1997) made a grid GIS model for the National Park “Risnjak”, composed of 30 thematic layers with attributive data bases.

Proposals for the introduction of GIS into forestry were given by Ananić et al. (1994), Kušan (1996), Benko et al. (1993), and Kušan and Kalafadžić (1994).

## 2.4 GPS

The GPS was first used for forest mapping in karst regions in the course of drawing up programmes of forest management. The first results were presented at a seminar on forest management, but they have not been published yet.

## 2.5 Networking

Of all network systems, the most developed is the one of the State Enterprise “Croatian Forests”, connecting about 600 personal computers in forest stations, forest management offices and forest headquarters. Data are exchanged via e-mail, and are based on modem communication with switch telephone lines.

# 3 Application

## 3.1 Modelling and simulating

A regression model for the assessment of pedunculate oak stand volume in aerial photographs was made by Kušan and Krejčić (1993), Benko (1997), and Benko et al. (1996), and that for the evaluation of Aleppo pine volume by Benko et al. (1997).

Lukić et al. (1988) dealt with the simulation of pedunculate oak development, while Čavlović (1996) simulated system dynamics in planning the management of even-aged forests.

### 3.2 Mapping

Digitalization and scanning have lately been used for forest and forestland mapping. A digitalized pedological map was drawn up for the forests along the river Drava in north-west Croatia (Mayer and Bušić 1996), a compilation of digital and scanned layers of the management map was made for the Borik park forest (Benko et al. 1997), a pedological, phytocoenological and typological map of a section of forests around Pakrac was digitalized for the needs of forest zoning (Benko et al. 1993), mapping of land use by interpreting satellite photographs of a narrow area in Lonjsko polje was conducted (Kušan and Lampeš 1994), and most recently, the first digital orthographic map in Croatia was drawn up covering a narrow section in the west of Island Korčula (Benko and Biljecki 1998).

### 3.3 Forest inventory

So far, no forest and forestland inventory has been made in Croatia at the national level. For the moment, the system of forest management involves partial inventories carried out in management units every 10 years. Forests and forestland are divided into about 650 management units, each of about 500–5,000 ha in size, depending on terrain configuration, complexity, ownership, historical background, tradition and accessibility of forests. Each year, inventories and management is carried out in about 1/10 of management units.

Kalafadžić and Kušan (1991), together with numerous other authors, propose improvements in forest inventories in Croatia based on the experience of other countries and the results of the latest research and new technologies.

### 3.4 Forest damage

A systematic forest damage assessment is carried out terrestrially every year in bioindication points distributed according to the Gauss-Kruger network. Lately, forest damage assessment has been conducted using the CIR aerial photographs, but only in small areas. The problem was studied by Kalafadžić et al. (1989a,b, 1990a,b,c, 1991, 1993a,b, 1994), Kalafadžić and Kušan (1990, 1989), Kušan et al. (1994), Pernar (1994), Kušan and Pernar (1996).

### 3.5 Data availability and potential users

The results of research and their application are stored in the IBM compatible personal computers, mostly in the Windows programmes. A part of the data is available to all Internet users through the Croatian Academic network CARNet. The rest is being prepared and adapted for inclusion into these network systems.

The SE "Croatian Forests" data base was made in FOX programme package, while the one of the Forestry Institute (BAZA EGT RH) was made in Access (MS Office 97). Both data bases are continually complemented with new and old data

(BAZA EGT HR) collected in the last 30 years.

The potential users are all scientific institutions, and other governmental institutions and organizations, state companies and all those interested in the matter.

## 4 Discussion

In the turbulent course of the last eight centuries, starting from the first written documents on forests in these regions, forestry has developed into a modern, well-organized discipline, accompanied and supported by scientific thought and study. On its long path, it has encountered numerous obstacles and been exposed to various foreign influences. Despite all this, it has managed to fulfil its manifold goals: the satisfaction of people's needs for timber and forestwood, the preservation of its identity, and the maintenance of natural ecosystems. As natural ecosystems account for over one third of the Croatian territory, they provide a fundamental and permanent source of forests and forestland for future generations to use in their various forms. Sustainable management, as the principal and permanent aim of forest management, and stable systems, contribute to meeting the needs of all those living in these areas.

New technologies in data collecting, storing and communicating are growing in use on a daily basis. There are certain difficulties in their mass application, but so is the case in all transitional countries. The availability of information, know-how and research results through various

communication systems, the formation of expert staff, and the transfer of the former into practice, will enable the creation of a new system of forest management. This will be a long-term and slow process, affected by various elements in economic policy, but it will provide a sound groundwork to the benefit of all.

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