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# CURRENT WORKING TECHNOLOGIES FOR DRAFTING FOREST MANAGEMENT PLANS

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***Key words: thinnings, optimal structure, function, forest management objectiv***

## ABSTRACT

***Keywords: time rule, production norm, forest management planning, forest management plans***

This paper identifies the technology and working methods used to develop drafts of forest management plans, with therequired activities – executed using modern technologies and existing equipment –being indicated. Each operation in the drafting is described in detail, including the working technologies, organisation of the workplaces, training units, measurement units, instruments and equipment, working conditions with specific influence factors, and elements that contribute to the updating of working methodologies in the drafting and increase labour productivity.

## 1. INTRODUCTION

In the last three decades, major changes have been made in forest management planning that have been closely linked to developments recorded across several areas, especially calculation techniques, the theory of relational databases, database management systems, geographic information systems (GISs) and the evolution of equipment, software, etc.

The entire process of data collection and the development of forest management plans is part of a normal process of adapting to the realities of the moment andremovingnovel elements from various fields of activity.

For the processing of field data, specific software products have been developed and adapted in tandem with developmentsin computing techniques. In 1992, an informatics product – AS – Forest management plans version 3.3 – was developed, which carried out the computer-aided design of forest management on IBM PC-compatible computers. It was configured in MS-DOS version 4.1, which could be used on a personal computer.This was a redesign of the previous version (3.2) that could be used on a Juniormicrocomputer (Seceleanu, 1992).

This product was used as long as it was possible to operate using existing operating systems (from 1992 to 2005),up to the appearance of Windows 95. When the operating system became incompatible with the forest management planning software, the software had to be redesigned to be compatible with the operating systems existing after 2005. As a consequence, the informatics product AS2007 – Forest management plans was produced,developed for Visual Fox Pro. This was compatible with Windows 95 through Windows Vista (Lazar et al., 2009).The facilities provided by this new software enabled a developed database to be obtained, which could contain a greater number of reports, with the direct consequence of shortening the period of development of forestry management plans.

Also, GIS studies based on accumulated knowledge have, since 2001, enabledthe archiving of GIS databases in forest management plans;

the first plan developed using GIS was in Brăneşti Forest District (FD). The forestry maps obtained using the GIS technique for the plan were made usingdigitisationinAutocad MAP, the topologies usedArcInfo Workstation and the GIS side using ArcView 3.1 C512 (Achim, 2013). The GIS database included spatial information taken from the maps used in forest management and descriptive information taken from the field.

The implementation of GIS in forest management planning has provided several benefits, including reducing the time needed to produce and update the maps, reducing the time involved in updating the database, obtaining accurate and standardised information andallowing quick access to information.

Based onthesetechnology-influencing aspects, we here present the current working technologyfor developing forest management plans, which has replaced the classic technology used before the introduction of GIS techniques.

The need to identify the existing operations results from the need to update time and production norms, whichhave direct implications for increasing productivity in the management planning stage.

## 2. MATERIAL AND METHOD

In order to identify the activities carried out by personnel during the drafting of forest management plans, and to study the work time in such a way that the recorded data would lead to the development of time and production norms for developing forest management plans, it was necessary to use appropriate technical methods. Thus, for the identification of activities related to this phase, observation and photography of the working day were employed. The photography involved two steps – preparation and photograph-taking.

The preparation involved choosing the workersabout whom the observations were to be made, and explaining to them the purpose and importance of the observations.They had to work at a normal pace, following their working methodology, and completea working conditions sheet.The photography involved recording an entire activity being performed by the chosen worker during regular work hours.

Each activity was recorded on photograph sheets, using a clock and a timer to record the times and duration of each work element.

The observations were made,using the subunits of the National Institute for Research and Development in Forestry ‘Marin Drăcea’, in Braşov, Craiova, Bistriţa, Roman, Timisoara, Pitesti and Oradea (Fig. 1).

In all the subunits of the institute, there are specialised, collective workers who carry out forest planning, and it was intended that all of them would be involved in the implementation of the project. In this way, the representativeness of the results was ensured at the national level.

## 3. RESULTS AND DISCUSSIONS

Eight operations were indentified inthe activity of drafting forest management plans, as compared to nine (according to the previous procedures that existed before implementing the GIS system) (Table 1).


**Fig. 1 Subunits of the National Institute for Research and Development in Forestry 'Marin Drăcea'**

**Table 1**

Operations indentified for drafting forest management plans (numbered points in the second column are referred to in the text below by their numbers)

| **Classic writing, work operations** | **Current writing, work operations** | |
|---|---|---|
| Drafting forest management plans | Drafting forest management plans | Works using GIS techniques |
| 1. Graphical reports, classic technology | 1.Graphical reports, modern (digital) technology | |
| 2. Cubic calculations, classic technology, manual calculations or dedicated software | 2. Cubic calculations, modern technology, dedicated software | |
| 3. Transposition the parcel and subparcel from the old plans to the new ones using photography or photocopying | 3. Transposition the parcel and subparcel from the old plans to the new ones using scanning and vectorising | |
| 4. Assemble reports on the basic plans using classic methodology | 4. Assemble reports on the basic plans using modern (digital) methodology | |

| | | |
|---|---|---|
| 5. Classical method using a planimeter | - | Analytical determination of surfaces |
| 6. Draw the old map, classically | - | Developmaps using GIS techniques |
| 7. Automated data processing using the AS3 – Forestry software product | 5. Automated data processing using the AS2009 –Forestry software product | |
| 8. Draft the forest management plan on Yield Management Unit (YMU), writethe manuscript | 6. Preparationfor the second Conference on Forest Planning | |
| | 7. Draft the forest management plans on YMU, write on PC | |
| 9. Guidance for, and reception and approval of, the forest management plan draft | 8. Guidance for, and reception and approval of, the forest management plan draft | |

Below are brief descriptions of each indentified operation, and the differences between the classic technology and that used after the implementation of GIS.

**1. Graphical reports** are currently producedin the office by a technician or engineer, using GPS equipment, a PC computer and printer.The unit of measurement is 1000 reported points. In the classic system of drafting forest management plans, the graphical reports were produced by a designer or technical designer, using a spacer, a rapporteur, millimetre paper and calc paper, and the unit of measurement was also 1000 reported points (Ministry of Forest Waters and Environmental Protection - MFWEP, 1999). The current working technology is radically different and improved due to changes in field data collection equipment and the replacement of topographic compasses with GPS technology.

Observations for the graphical reports were made in 19 forestry areas/experimental bases (Table 2), where:

- the production units (YMUs) had different surface sizes (from 935.3 ha to 6352.65 ha);
- the layout units had different surface sizes, to illustrate the diversity of situations;
- the YMUs in which a variable number of field measurements were carried out also captured the quantity of work performed per territorial unit;
- various specialised software packages, compatible with the GPS equipment, wereused for the measurements;
- topographic measurements were made using Trimble and Garmin GPS devices.

**Table 2**

Elements of YMU characterisation observed for the graphical reports

| No | INCDS (NIRDF) | Observed data from forest district's forest management plans | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Forest district/ | Yield management unit (no.) (UP) | Surface of Yield management unit (ha) | No. forest management units (ua)/ Yield management unit (UP) | Surface of average forest management unit /PU | No. of measured and reported points | No. of measured ua`s | Tip of device used for measurement | Software |
| 1 | Braşov | Maneciu | IV | 3274,18 | 321 | 10,2 | 1082 | 246 | Garmin 64S | Softuri specializate |
| 2 | Braşov | Azuga | I | 935,3 | 190 | 4,92 | 1300 | 152 | Garmin 64S | Softuri specializate |
| 3 | Braşov | Fagaras | II | 3115,09 | 365 | 8,53 | 1440 | 107 | Garmin 78S | Softuri specializate |
| 4 | Bistriţa | Mălini | I | 2951,52 | 209 | 14,12 | 1855 | 78 | GPS Garmin | Softuri specializate |
| 5 | Bistriţa | Cluj | III | 935,61 | 193 | 4,85 | 4260 | 132 | GPS Garmin | Softuri specializate |
| 6 | Bistriţa | Dragomirești | II | 3696,78 | 624 | 5,92 | 6030 | 151 | GPS Garmin | Softuri specializate |
| 7 | Craiova | Orşova | I | 2245,88 | 254 | 8,84 | 1986 | 180 | Garmin | Softuri specializate |
| 8 | Craiova | Orşova | V | 4339,25 | 348 | 12,47 | 2294 | 210 | Trimble | Softuri specializate |
| 9 | Craiova | Orşova | VI | 3144,54 | 295 | 10,66 | 2302 | 190 | Garmin | Softuri specializate |
| 10 | Craiova | Drăgănești Olt | I | 1084,6 | 498 | 2,18 | 910 | 323 | Trimble | Softuri specializate |
| 11 | Craiova | Drăgănești Olt | II | 1323,91 | 455 | 2,91 | 956 | 315 | Trimble | Softuri specializate |
| 12 | Oradea | Dobrești | VI | 1211,82 | 307 | 3,95 | 304 | 16 | Garmin | Softuri specializate |
| 13 | Oradea | TârguLăpuș | I | 2381,98 | 763 | 3,12 | 7928 | 426 | Garmin | Softuri specializate |
| 14 | Oradea | Ilia | II | 2665,93 | 617 | 4,32 | 1908 | 96 | Garmin | Softuri specializate |
| 15 | Roman | Brăila | IX | 704,2 | 132 | 5,33 | 728 | 32 | GPS Garmin | Softuri specializate |
| 16 | Roman | Bârlad | I | 1228,57 | 415 | 2,94 | 2200 | 88 | GPS Garmin | Softuri specializate |
| 17 | Roman | Tomnatic | I | 6352,65 | 728 | 8,75 | 5380 | 269 | GPS Garmin | Softuri specializate |
| 18 | Timișoara | Păltiniș | I | 2812,54 | 372 | 7,56 | 2423 | 372 | Garmin Montana 650 | Softuri specializate |
| 19 | Timișoara | Valea Mare | II | 2290,98 | 288 | 7,95 | 3781 | 288 | Garmin Montana 650 | Softurispeci alizate |
| 20 | Pitesti | Rusca | XIII | 1217,02 | 370 | 3,29 | 1225 | 185 | GPS Montana | Softuri specializate |
| 21 | Pitesti | Amaradia | III | 3647,26 | 689 | 5,29 | 1382 | 50 | GPS Montana | Softuri specializate |
| 22 | Pitesti | Curtea de Arges | IV | 1683,83 | 407 | 4,14 | 1123 | 47 | GPS Montana | Softuri specializate |
| | **Total** | | | **43513,8** | **8840** | | **52797** | **3953** | | |

**2. Cubic calculations** are performed in the office by a designer (technician or engineer) using a PC, specialised software, a field notebook, a notebook with the centralisation of the sheet points and a printer.The unit of measurement used is the number of development units.In the classic system of drafting forest management plans, cubic calculations were performed manually by a technician, using a field notebook, a notebook with the centralization of the sheet points and a sheet of cubic calculations. The unit of measurement was also the number of development units (MFWEP,1999).The technology has been much improved by using specialised software.

Observations for the cubic calculations were made in 19 forestry areas/experimental bases (Table 3), and:

- the observations were made in 21 YMUs in different geomorphological areas of the country;

- the observations were carried out in forestry units where the trees were inventoried by statistical land integral procedures (wire by wire);
- the standscomprised a variable number (1–5) of species, so that the influencing factors having a significant impact on the calculation of the time and production normscould be identified, analysed and selected;
- forestry units made up of a variable number of trees were analysed;
- a single specialised software was used for the automated calculation of the volumes of the inventoried trees;
- observations were made on a total of 704 stands, with the total number above 420000 trees.

**Table 3**

Elements characterisingthe YMUs observed for use in the cubic calculations

| No | INCDS (NIRDF) | Observed data from forest district's forest management plans | | | | | | | | | No. of forest management units that were subject to observations (photographed) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Forest district/ | Yield management unit (no.) (UP) | Surface of Yield management unit (ha) | No. forest management units / Yield management unit | Average area of forest management unit (ha) | No. of inventoried stands / Yield management unit | No. tree species / inventoried forest management units and in which observations were made | No. trees / inventoried forest management units and in which observations were made | IT product (software) used for volume calculations | |
| 1 | Braşov | Azuga | VI | 2070,7 | 205 | 10,1 | 13 | 1-2 | 40-500 | Program cubaj specializat | 13 |
| 2 | Braşov | Maneciu | V | 924,18 | 135 | 6,85 | 29 | 1-2 | 200-400 | Program cubaj specializat | 29 |
| 3 | Braşov | Fagaras | II | 3115,09 | 365 | 8,53 | 35 | 1-3 | 100-1200 | Program cubaj specializat | 35 |
| 4 | Bistriţa | Mălini | I | 2951,52 | 209 | 14,12 | 31 | 4 | 29820 | Program cubaj specializat | 31 |
| 5 | Bistriţa | Cluj | III | 935,61 | 193 | 4,85 | 16 | 9 | 18768 | Program cubaj specializat | 16 |
| 6 | Bistriţa | Drago-mirești | II | 3696,78 | 624 | 5,92 | 71 | 9 | 25970 | Program cubaj specializat | 71 |
| 7 | Craiova | Orşova | III | 3536,23 | 646 | 5,474 | 54 | 1 | 158 | Program cubaj specializat | 54 |
| | | | | | | | | 2 | 8072 | | |
| | | | | | | | | 3 | 14568 | | |
| | | | | | | | | 4 | 18636 | | |
| | | | | | | | | 5 | 1443 | | |
| 8 | Craiova | Orşova | VII | 3534,34 | 318 | 11,114 | 37 | 1 | 389 | Program cubaj specializat | 37 |
| | | | | | | | | 2 | 5810 | | |
| | | | | | | | | 3 | 5588 | | |
| | | | | | | | | 4 | 13788 | | |
| | | | | | | | | 5 | 2518 | | |
| 9 | Craiova | Orşova | IX | 5607,94 | 480 | 11,683 | 36 | 1 | 12667 | Program cubaj specializat | 36 |
| | | | | | | | | 2 | 11383 | | |
| | | | | | | | | 3 | 5573 | | |
| | | | | | | | | 4 | 1984 | | |
| 10 | Craiova | Drăgă-nești Olt | II | 1323,91 | 455 | 2,91 | 23 | 1 | 7430 | Program cubaj | 23 |
| | | | | | | | | 2 | 1697 | | |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | 3 | 1828 | specializat | |
| | | | | | | | | 4 | 4465 | | |
| 11 | Oradea | Dobrești | VI | 1211,82 | 307 | 3,95 | 60 | 1 | 304 | Program cubaj specializat | 13 |
| | | | | | | | | 2 | 2269 | | |
| | | | | | | | | 3 | 13757 | | |
| | | | | | | | | 4 | 5622 | | |
| | | | | | | | | 5 | 2393 | | |
| 12 | Oradea | Târgu Lăpuș | I | 2381,98 | 763 | 3,12 | 90 | 1 | 1197 | Program cubaj specializat | 11 |
| | | | | | | | | 2 | 963 | | |
| | | | | | | | | 3 | 2550 | | |
| 13 | Oradea | Ilia | II | 2665,93 | 617 | 4,32 | 75 | 1 | 2404 | | 15 |
| | | | | | | | | 2 | 1335 | | |
| | | | | | | | | 3 | 2306 | | |
| | | | | | | | | 4 | 1607 | | |
| 14 | Roman | Brăila | IX | 704,2 | 132 | 5,33 | 41 | 1-3 | 6017 | Program cubaj specializat | 41 |
| 15 | Roman | Bârlad | I | 1228,57 | 415 | 2,94 | 42 | 3-4 | 32874 | Program cuba jspecializat | 42 |
| 16 | Roman | Tomnatic | I | 6352,65 | 728 | 8,75 | 126 | 2-3 | 127883 | Program cubaj specializat | 126 |
| 17 | Timi-șoara | Păltiniș | I | 2812,54 | 372 | 7,56 | 27 | 3 | 560 | Program cubaj specializat | 27 |
| 18 | Timi-șoara | Valea Mare | II | 2290,98 | 288 | 7,95 | 30 | 3 | 540 | Program cubaj specializat | 30 |
| 19 | Pitesti | Rusca | XIII | 1217,02 | 370 | 3,29 | 20 | 1,2 | 2250 | Program cubaj specializat | 20 |
| 20 | Pitesti | Amaradia | III | 3647,26 | 689 | 5,29 | 57 | 1,2,3 | 13575 | Program cubaj specializat | 16 |
| 21 | Pitesti | Curtea de Arges | IV | 1683,83 | 407 | 4,14 | 22 | 1,2,3,4 | 10245 | Program cubaj specializat | 18 |
| | **Total** | | | | | | **935** | | | | **704** |

**3.Transpositioning of the parcel and subparcel on the base map (change or create the base map**) is currently performed in the office by an engineer, using a PC, specialised software, the old 1:10,000 topographic plans, the forestry maps, orthophotomaps and a plotter, and the unit of measurement for the base map transposition is $dm^2$. In the classic system of drafting forest management plans, the transposition of parcels and subparcels from the old base maps to the new ones (change the base map) was performed by a worker and a technical designer.The work technology in the classical system was different, with the old plans being transposedusing photography or phocopying, at the same topographical scale as the new plans. The existing informationfrom the new plans was copied ontocalc paper and, using a special table to which the new plans were fixed, the contours of the existing parcels and subparcelsweredrawn using a pen. Then, the parcels and subparcelson the new plans were drawnonto the printed boundaries, and the information wais completed with the number of parcels, subparcels and bourns. The unit of measurement was also $dm^2$ (MFWEP,1999).

Observations on the transposition of the parcel and subparcel to the base map

(change or create the base map) were performed in four forestry areas (Table 4), and included:

- five production units of different surface size (from 935 ha to 3697 ha) and with various areal sizes (from 5.9 ha to 11.8 ha);
- the areas transposed on the base planes ranged from 7 $dm^2$ to FDFăgăraş and 29 $dm^2$ to FDRâşca;
- the transposition of the parcel and subparcel to the base map was carried out on the topographic plans(scale 1:5000), as recomanded by technical forest management norms;
- the observations were made for the 317 units transposed onto the topographic plans.

**Table 4**

Elements characterising the YMUs observed for use in the transposition of the parcel and subparcel

| No | INCDS (NIRDF) station | Observed data from forest district's forest management plans | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Forest district/ Experimental base | Yield management unit (no.) (UP) | Surface of Yield management unit (ha) | No. forest management units / Yield management unit | Average area of forest management unit (ha) | ($dm^2$) | The scale of the assembled plan | No. of transposed forest management units |
| 1 | Braşov | Rasca | V | 2790,7 | 237 | 11,78 | 29,17 | 1:5000 | 73 |
| 2 | Braşov | Fagaras | II | 3115,09 | 365 | 8,53 | 10,246 | 1:5000 | 35 |
| 3 | Braşov | Fagaras | I | 2117,12 | 362 | 5,85 | 7,07 | 1:5000 | 24 |
| 4 | Bistriţa | Cluj | III | 935,61 | 193 | 4,85 | 18,4 | 1:5000 | 96 |
| 5 | Bistriţa | Dragomireşti | II | 3696,78 | 624 | 5,92 | 20,6 | 1:5000 | 89 |
| | **Total** | | | **12655,3** | **1781** | | | | **317** |

**4. Assembling reports and updating information on the basic plans** is now performed in the office by an engineer, using a PC, specialised software, the field reports on the subparcels measuredelectronically or printed out on hard support format, the orthophotoplanes and a plotter, the unit of measurement is the $dm^2$.In the classical system,assembly of the reports on the basic plans was carried out by an engineer,using the kilometre as the unit of measurement.The work technology in the classic system is different, insofar as the graphical reports executed on calc paper overlapped on the base planes through connection points (bourns, roads, borders, valleys, peaks). After this overlapping, by pinching the reported points and then drawing the contour by joining the resulting signs, the base plan was assembled using the reported details (MFWEP, 1999).

Observations for assembling reports and updating information on the cartographic bases were made in 19 forestry areas/experimental bases (Table 5), and included:

- the geomorphology (wetland, plain, hill, mountain) constituted a potential influencing factor in the forestry area in determining time and production norms;
- YMUs with different surface sizes, from 704 ha in YMU IX from FD Braila to 6352 ha in YMU I from Experimental Base Tomnatic;
- report assembly for parcels and subparcels was carried out for both base planes at scales 1:5,000 and 1:10,000;
- oservations on 4926 subparcels assembled on the base planes;
- subparcels assembled on basic measurements from the ground and graphical reports from the office, as well as on information from other sources (orthophotoplanes, the National Cadaster Agency NCAweb portal, etc).

**Table 5**

Elements characterising the YMUs observed for use in assembling reports and updating information on basic plans

| No | INCDS (NIRDF) station | Observed data from forest district's forest management plans | | | | | | | | | No. of assembled forest management units that have been photographed (observed) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Forest district/ Experimental base | Yield management unit (no.) (UP) | Surface of Yield management unit (ha) | No. forest management units / Yield management unit | Average area of forest management unit (ha) | ($dm^2$) | The scale of the assembled plan | No. of forest management units assembled using plotting (measurements) | No. of forest management units with updated boundaries (limits) based on informa-tions other than made measurements | |
| 1 | Braşov | Maneciu | IV | 3274,18 | 321 | 10,20 | 93,00 | 1:5000 | 246 | 0 | 246 |
| 2 | Braşov | Azuga | I | 935,3 | 190 | 4,92 | 14,73 | 1:5000 | 152 | 0 | 152 |
| 3 | Braşov | Faga-ras | II | 3115,09 | 365 | 8,53 | 10,28 | 1:5000 | 107 | 0 | 107 |
| 4 | Bistriţa | Mălini | I | 2951,52 | 209 | 14,12 | 118,06 | 1:.5000 | 78 | 35 | 113 |
| 5 | Bistriţa | Cluj | III | 935,61 | 193 | 4,85 | 37,42 | 1:.5000 | 132 | 97 | 229 |
| 6 | Bistriţa | Dragomireşti | II | 3696,78 | 624 | 5,92 | 24,51 | 1:.5000 | 354 | 0 | 354 |
| 7 | Craiova | Orşova | II | 3501,99 | 620 | 5,65 | 140,08 | 1:5000 | 471 | 85 | 556 |
| 8 | Craiova | Orşova | IV | 5479,68 | 633 | 8,66 | 21,19 | 1:5000 | 450 | 80 | 530 |
| 9 | Craiova | Orşova | X | 1620,29 | 188 | 8,62 | 64,81 | 1:5000 | 96 | 25 | 121 |
| 10 | Craiova | Drăgănești Olt | II | 1323,91 | 455 | 2,91 | 52,96 | 1:5000 | 315 | 35 | 105 |
| 11 | Oradea | Dobrești | VI | 1211,82 | 307 | 3,95 | 48,45 | 1:5000 | 16 | 30 | 116 |
| 12 | Oradea | Târgu Lăpuș | I | 2381,98 | 763 | 3,12 | 95,49 | 1:5000 | 426 | 34 | 139 |
| 13 | Oradea | Ilia | II | 2665,93 | 617 | 4,32 | 108,27 | 1:5000 | 96 | 29 | 129 |
| 14 | Roman | Brăila | IX | 704,2 | 132 | 5,33 | 28,17 | 1:5000 | 32 | 100 | 20 |
| 15 | Roman | Bârlad | I | 1228,57 | 415 | 2,94 | 47,75 | 1:5000 | 415 | 0 | 415 |
| 16 | Roman | Tomnatic | I | 6352,65 | 728 | 8,75 | 306,75 | 1:5000 | 735 | 735 | 735 |
| 17 | Timișoara | Păltiniș | I | 2812,54 | 372 | 7,56 | 28,13 | 1:10.000 | 372 | 372 | 372 |
| 18 | Timișoara | Valea Mare | II | 2290,98 | 288 | 7,95 | 91,64 | 1:5.000 | 288 | 288 | 288 |
| 19 | Pitesti | Rusca | X | 2405,48 | 512 | 4,70 | 24,05 | 10000 | 74 | 95 | 102 |
| 20 | Pitesti | Amaradia | III | 3647,26 | 689 | 5,29 | 9,11 | 5000 | 103 | 23 | 50 |
| 21 | Pitesti | Curtea de Arges | IV | 1683,83 | 407 | 4,14 | 4,20 | 5000 | 133 | 27 | 47 |
| | **Total** | | | **54219,6** | | | | | **5091** | **2090** | **4926** |

**5. Automated data processing** is performed at the office, by an engineer/technician or programming analyst, using a PC, specialised software, field notebooks, an ecotypical scheme and a printer.The unit of measurement used is the number of YMUs.In the classic system, automated data processing was performing by a worker, and the the unit of measurement used was forest area, YMU and the FD.The working technology in the current system is the same as in the classic one. The current software is AS2009 –Forest management plans, which replaced the previousAS -Forest management plans, version 3.3.

The observations for the automated data processing with specialised software were made in 19 forest areas/experimental bases (Table 6):

- the geomorphology (wetland, plain, hill, mountain) constituted a potential influencing factor in the forestry area in determining time and production norms;
- the production units had different surface sizes, from 704 ha in YMU IX from FD Braila to 6352 ha in YMU I from Experimental Base Tomnatic;
- the time taken to enterdata on forest type (with one-two stand components, three, four stand components or more) ontoparcelar description sheets influenced the duration of these operations;
- theparcelar description sheets contain a description of the land with special designated areas, which involves a small amount of data and information; the time taken toinput these into the forest planning software is variable.

**Table 6**

Elementscharacterising the YMUs observed for use in automated data processing

| No | INCDS (NIRDF) station | Observed data from forest district's forest management plans | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Forest district/ Experimental base | Yield management unit (no.) (UP) | Surface of Yield management unit (ha) | No. forest management units / Yield management unit | Average area of forest management unit (ha) | Forest management units with: | | | Special designated areas (TDS) |
| | | | | | | | 1-2 stand component (s) | 3 stand components | 4 stand components | |
| 1 | Braşov | Rasca | IV | 2255,23 | 229 | 9,85 | 40 | 62 | 85 | 42 |
| 2 | Braşov | Maneciu | III | 1691 | 107 | 15,80 | 31 | 49 | 13 | 14 |
| 3 | Braşov | Azuga | I | 935,3 | 190 | 4,92 | 50 | 31 | 54 | 55 |
| 4 | Bistriţa | Mălini | I | 2951,52 | 209 | 14,12 | 61 | 71 | 43 | 34 |
| 5 | Bistriţa | Cluj | III | 935,61 | 193 | 4,85 | 93 | 37 | 43 | 20 |
| 6 | Bistriţa | Dragomirești | II | 3696,78 | 624 | 5,92 | 296 | 157 | 45 | 126 |
| 7 | Craiova | Orşova | II | 3501,99 | 620 | 5,65 | 210 | 163 | 175 | 72 |
| 8 | Craiova | Orsova | IV | 5479,68 | 633 | 8,66 | 201 | 180 | 193 | 57 |
| 9 | Craiova | DrăgăneștiOlt | I | 1084,6 | 498 | 2,18 | 364 | 86 | 48 | 124 |
| 10 | Craiova | DrăgăneștiOlt | II | 1323,91 | 455 | 2,91 | 405 | 18 | 32 | 106 |
| 11 | Craiova | DrăgăneștiOlt | III | 1228,86 | 613 | 2,00 | 499 | 65 | 49 | 38 |
| 12 | Oradea | Dobrești | VI | 1211,82 | 307 | 3,95 | 42 | 10 | 8 | 24 |
| 13 | Oradea | TârguLăpuș | I | 2381,98 | 763 | 3,12 | 17 | 67 | 6 | 49 |
| 14 | Oradea | Ilia | II | 2662,93 | 617 | 4,32 | 32 | 33 | 30 | 44 |
| 15 | Roman | Brăila | IX | 704,2 | 132 | 5,33 | 109 | 9 | 1 | 13 |
| 16 | Roman | Bârlad | I | 1228,57 | 415 | 2,94 | 272 | 47 | 46 | 50 |
| 17 | Roman | B.E.Tomnatic | I | 6352,65 | 728 | 8,75 | 76 | 25 | 25 | 84 |
| 18 | Timi-șoara | Păltiniș | I | 2812,54 | 372 | 7,56 | 153 | 83 | 69 | 67 |
| 19 | Timi-șoara | Valea Mare | II | 2290,98 | 288 | 7,95 | 43 | 84 | 129 | 35 |
| 20 | Pitesti | Rusca | X | 2405,48 | 512 | 4,70 | 409 | 66 | 37 | 95 |
| 21 | Pitesti | Amaradia | III | 3647,26 | 689 | 5,29 | 23 | 274 | 392 | 51 |
| 22 | Pitesti | Curtea de Arges | IV | 1683,83 | 407 | 4,14 | 78 | 302 | 27 | 71 |
| | **Total** | | | **52466,72** | **9601** | | **3504** | **1919** | **1550** | **1271** |

**6. Preparationfor the second Conference on Forest Planning** is now performed in the office by an forester (engineer/subengineer), using a PC, specialised software, field notebooks, an ecotypical scheme, previous forest management plans, a design theme, the minutes of the acceptance of the

fieldwork, the minutes of the first conference, correspondence from within the forest district, and a printer.The unit of measurement used is the YMU. Previously, the working technology was included in the drafting of the forest management plans perYMU.

The second Conference on Forest Planningis a necessary milestone for anticipating forest management solutions and so,taking into account the work volume involved in the preparation for this, as well as the the technical process of drafting the forest management plans, this has been separated out as a discrete operation. Compared to the work items evaluated by the work norms in 1999, the current situation is distinct.After the year 2000, once the low no. 1/2000 and subsequently the low no. 247/2005, as well as with other forestry or environmental regulations, the categories of data to be analysed have increased significantly (including the situation of the stands included in the catalogue of seed stand reserves and forest genetic resources, the status of stands included in natural protected areas, the status of virgin and quasi-virgin stands).

Observations on the forest management plan for preparing for the second Conference on Forest Planning were made in 19 FDs/experimental bases (Table 7), and include:

**Table 7**

Elements characterising the YMUs observed for use in preparing for the Second Conference onForest Planning

| No | INCDS (NIRDF) station | Observed data from forest district's forest management plans | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Forest district/ Experimental base | Yield management unit (no. and name) (UP) | No of Yield management units/ Forest district | Forest district's managed area (ha) | YMU surface | Average area of forest management unit (ha) | No. of inventoried forest management units/ Yield management unit | No. of positions in 1E table |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| 1 | Braşov | Maneciu | VII Zaganu | 9 | 18737 | 1086 | 7,8 | 38 | 3 |
| 2 | Braşov | Rasca | II Ghizinoaia | 5 | 13519 | 2757 | 12 | 43 | 2 |
| 3 | Braşov | Fagaras | II Fagaras | 2 | 5232 | 3115 | 8,5 | 35 | 12 |
| 4 | Bistriţa | Mălini | I Suha Mare | 5 | 18342 | 209 | 14 | 31 | 76 |
| 5 | Bistriţa | Cluj | III Săvădisla | 4 | 5325 | 193 | 4,9 | 16 | 109 |
| 6 | Bistriţa | Dragomireşti | II Baicu | 7 | 10401 | 624 | 5,9 | 71 | 196 |
| 7 | Craiova | Orsova | I Eliseva | 10 | 35326 | 254 | 8,8 | 37 | 58 |
| 8 | Craiova | Orsova | IV Prisaca | 10 | 35326 | 633 | 8,7 | 68 | 127 |
| 9 | Craiova | Orsova | VII Corbu | 10 | 35326 | 318 | 11 | 39 | 64 |
| 10 | Craiova | DrăgăneştiOlt | III Brebeni | 3 | 3637 | 613 | 2 | 38 | 110 |
| 11 | Oradea | Dobreşti | VI Răcaş | 4 | 5498 | 307 | 4 | 60 | 5 |
| 12 | Oradea | TârguLăpuş | I Valea Mare | 6 | 7307 | 763 | 3,1 | 90 | 1505 |
| 13 | Oradea | Ilia | II Burjuc | 6 | 13108 | 617 | 4,3 | 75 | 149 |
| 14 | Roman | Brăila | IX Bran | 11 | 9405 | 132 | 5,3 | 41 | 48 |
| 15 | Roman | Bârlad | I Bârlad | 6 | 9785 | 415 | 2,9 | 42 | 203 |
| 16 | Roman | Tomnatic | I Demăcuşa | 2 | 6813 | 728 | 8,8 | 126 | 44 |
| 17 | Timişoara | Păltiniş | I Goleţ | 6 | 10772 | 372 | 7,6 | 27 | 2 |
| 18 | Timişoara | Valea Mare | II Groşi | 3 | 5696 | 288 | 8 | 30 | 3 |
| 19 | Pitesti | Rusca | X Uzlina | 7 | 10083 | 12 | 4,7 | 12 | 3 |
| 20 | Pitesti | Amaradia | III Balota | 4 | 7291 | 57 | 5,3 | 57 | 3 |
| 21 | Pitesti | C de Arges | IV Zigoneni | 4 | 8084 | 18 | 4,1 | 18 | 5 |
| | **Total** | | | | **275015** | | | | **2727** |

- the geomorphology (wetland, plain, hill, mountain) constituted a potential influencing factor in the forestry area in determining time and production norms;
- the YMUswere of different surface sizes, from 704 ha in YMU IX from FD Braila to 6352 ha in YMU I from Experimental Base Tomnatic;
- the YMUswith average forestry units had variable areas, from 2 ha in YMU III Brebeni from FDDraganestiOlt to 14.12 ha in YMU I Suha Mare from FDMalini;

- the YMUs where the inventory numberwas variable influenced the duration of the analysis of the calculated volumes and their entry into the database;

**Table 7 (continuation)**

| Observed data from forest district's forest management plans | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| No. of Seed Stands | No. of forest management units that are situated within protected areas | No. of natural protected areas | No. of forest management units considered in the virgin and quasi-virgin stand categories | No. of functional categories/ Yield management unit | No. of working circles (SUP's) | The working cirlce'sassignated code (SUP) | No. of the printed lists | Average area of forest management unit/ Forest district (ha) |
| 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 |
| 1 | 140 | 1 | 12 | 9 | 5 | A, E, G, K, M | 16 | 10,39 |
| 0 | 0 | 0 | 0 | 6 | 3 | A, K, M | 16 | 9,78 |
| 1 | 349 | 3 | 93 | 14 | 4 | A, E, K, M | 16 | 7,2 |
| 1 | 4 | 1 | 2 | 8 | 4 | A, E, K, M | 15 | 13,06 |
| 0 | 1 | 1 | 0 | 6 | 2 | A, M | 15 | 4,7 |
| 0 | 84 | 2 | 0 | 4 | 3 | A,E,M | 15 | 8,9 |
| 0 | 197 | 3 | 0 | 10 | 3 | A,M,E | 12 | 8,91 |
| 0 | 576 | 4 | 0 | 11 | 3 | A,M,E | 12 | 8,91 |
| 0 | 55 | 3 | 0 | 8 | 3 | A,M,E | 12 | 8,91 |
| 0 | 0 | 0 | 0 | 3 | 3 | A, Q, M | 21 | 2,32 |
| 5 | 290 | 2 | - | 11 | 4 | A, M,E, K | 16 | 5,07 |
| 0 | 99 | 2 | - | 11 | 3 | A, E, M | 16 | 3,82 |
| 0 | 300 | 3 | - | 8 | 5 | A, E, M, O, Q | 16 | 5,5 |
| 0 | 132 | 3 | 0 | 4 | 5 | E,M,X,Y,Z | 45 | 3,18 |
| 3 | 167 | 4 | 0 | 8 | 6 | A,E,K,M,O,Q | 47 | 4,66 |
| 18 | 709 | 2 | 7 | 11 | 5 | A,B,K,M,E | 47 | 8,14 |
| 0 | 0 | 0 | 0 | 5 | 2 | A, M | 13 | 6,69 |
| 0 | 288 | 3 | 0 | 3 | 2 | A, M | 13 | 7,67 |
| 3 | 402 | 3 | 0 | 7 | 4 | K,M,X,Z | 104 | 3,96 |
| 3 | 0 | 0 | 0 | 5 | 3 | A,K,M | 62 | 4,2 |
| 2 | 0 | 0 | 0 | 5 | 3 | A,K,M | 62 | 5,51 |
| **37** | **3793** | **40** | **114** | **157** | | | **591** | |

- the forest management plans of the YMUs where the data volumes were recorded in Stand Component Table (EL) tables, regarding the movement of surfaces during the period of application, significantly influenced the development of the forestry plan;
- other elements influenced the time taken, including the number of seed stand reserves, the number of stands included in natural protected areas, the number of virgin and quasi-virgin stands, the number of management subunits the stands were assigned to for their differentiated management, according to the ecological, economic and social objectives of the forests;
- the number of lists/reports calculatedby the specialised software for data processing that need to be introduced into the forest planning projects.

**7. Drafting forest management plans for theYMUs**is currently performedin the office by an engineer/subengineer, using a PC, specialised software, field notebooks, an ecotypical scheme, previous forest management plans, a design theme, the minutes of the acceptance of the fieldwork, the minutes of the approval of the fieldwork, the minutes of the First Conference of Forest Planning, the minutes of the Second Conference onForest Planning, the correspondence within the forest district, and a printer.The unit of measurement used is the YMU. Classically, the system for drafting the forest management plansfor theYMUsinvolved writing a manuscript.

Observations for drafting the forest management plans on the YMUs were

made in 19 FDs/experimental bases (Table 8):

- the geomorphology (wetland, plain, hill, mountain) constituted a potential influencing factor in the forestry area in determining time and production norms;
- the YMUs had different surface sizes, from 704 ha in YMU IX from FD Braila to 6352 ha in YMU I from Experimental Base Tomnatic;
- theYMUswith average forestry units had variable areas, from 2 ha in YMU III Brebeni from FD DraganestiOlt to 14.12 ha in YMU I Suha Mare from FDMalini.
- the YMUs where the number of protected natural areas varied influenced the duration of the analysis of the protected objectives of the management measures from the management plans, and their implementation in the forest management plans;

**Table 8**

Elements characterising the YMUs observed for use in drafting forest management plans forYMUs

| No | INCDS (NIRDF) station | Observed data from forest district's forest management plans | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Forest district/ Experimental base | Yield management unit (no. and name) (UP) | No of Yield management units/ Forest district | Forest district' s managed area (ha) | No. of forest management units/ Yield management unit | Average area of forest management unit (ha) | No. of natural protected areas | No. of forest management units considered in the virgin and quasi-virgin stand categories | No. of functional categories/ Yield management unit | No. of working circles (SUP' s) | The working cirlce' sassignated code (SUP) |
| 1 | Braşov | Fagaras | II Fagaras | 2 | 5232,21 | 365 | 8,53 | 3 | 93 | 14 | 4 | A, E, K, M |
| 2 | Braşov | Azuga | VI Obarsia Azugii | 3 | 4204,49 | 205 | 10,1 | 1 | 13 | 8 | 3 | A, E, M |
| 3 | Braşov | Maneciu | VII Zaganu | 9 | 18736,54 | 140 | 7,76 | 1 | 12 | 9 | 5 | A, E, G, K, M |
| 4 | Bistriţa | Mălini | I Suha Mare | 5 | 18341,78 | 209 | 14,12 | 1 | 2 | 8 | 4 | A, E, K, M |
| 5 | Bistriţa | Cluj | III Săvădisla | 4 | 5325,49 | 193 | 4,85 | 1 | 0 | 6 | 2 | A, M |
| 6 | Bistriţa | Dragomireşti | II Baicu | 7 | 10401,04 | 624 | 5,29 | 2 | 4 | 7 | 3 | A,E, M |
| 7 | Craiova | Orsova | III BaiaNoua | 10 | 35326,16 | 646 | 5,47 | 4 | 0 | 10 | 3 | A, M, E |
| 8 | Craiova | Orsova | VI Radu | 10 | 35326,16 | 295 | 10,66 | 3 | 0 | 7 | 2 | A, M |
| 9 | Craiova | Orsova | IV Prisaca | 10 | 35326,16 | 633 | 8,66 | 4 | 0 | 11 | 3 | A, M, E |
| 10 | Craiova | DrăgăneştiOlt | III Brebeni | 3 | 3637,37 | 613 | 2 | 0 | 0 | 3 | 3 | A,Q, M |
| 11 | Oradea | Dobreşti | VI Răcaş | 4 | 5493,12 | 307 | 3,95 | 2 | 0 | 11 | 4 | A, M,E, K |
| 12 | Oradea | TârguLăpuş | I Valea Mare | 6 | 7307,33 | 763 | 3,12 | 2 | 0 | 11 | 3 | A, E, M |
| 13 | Oradea | Ilia | II Burjuc | 6 | 13108,4 | 617 | 4,32 | 1 | 0 | 8 | 5 | A, E, M, O, Q |
| 14 | Roman | Brăila | IX Bran | 11 | 9404,51 | 132 | 5,33 | 3 | 0 | 4 | 5 | E,M,X, Y,Z |
| 15 | Roman | Bârlad | I Bârlad | 6 | 9784,81 | 415 | 2,94 | 4 | 0 | 8 | 6 | A,E,K,M,O,Q |
| 16 | Roman | B.E.Tomnatic | I Demăcuşa | 2 | 6812,92 | 728 | 8,75 | 2 | 7 | 11 | 5 | A,B,K,M,E |
| 17 | Timişoara | Păltiniş | I Goleţ | 6 | 10772,24 | 372 | 7,56 | 0 | 0 | 5 | 2 | A, M |
| 18 | Timişoara | Valea Mare | II Groşi | 3 | 5696,26 | 288 | 7,95 | 3 | 0 | 3 | 2 | A, M |
| 19 | Pitesti | Rusca | X Uzlina | 7 | 10083,3 | 12 | 4,7 | 3 | 0 | 7 | 4 | K,M,X,Z |
| 20 | Pitesti | Amaradia | III Balota | 4 | 7291,33 | 57 | 5,29 | 0 | 0 | 5 | 3 | A,K,M |
| 21 | Pitesti | Curtea de Arges | IV Zigoneni | 4 | 8084,05 | 18 | 4,14 | 0 | 0 | 5 | 3 | A,K,M |
| | **Total** | | | | **265695,7** | **7632** | | **40** | **131** | **161** | | |

- other elements influenced the time taken, including the number of virgin and quasi-virgin stands, the number of management subunits assigned to the stands for their differentiated management, framed in relation to the

ecological, economic and social objectives of the forests, and the number of functional categories in which the trees were classified.

**8. Guidance, reception and approval of the forest management plan draft** is now performedin the office by the project manager and aTechnical Comitee for Project Approval's expert, using a PC, specialised software, field notebooks, an ecotypical scheme, previous forest management plans, a design theme, the minutes of the receipt of the fieldwork, the minutes of the approval of the fieldwork, the minutes of the first conference, the correspondence within the forest district, and a printer.The unit of measurement used is the YMU.

Observations for guidance and approval activities specificto drafting the forest management plans per YMU were made in 19 FDs/experimental bases, and included:

- the geomorphology (wetland, plain, hill, mountain) constituted a potential influencing factor in the forestry area in determining time and production norms;
- the YMUshad different surface sizes, from 704 ha in YMU IX from FD Braila to 6352 ha in YMU I from Experimental Base Tomnatic;
- the YMUs were the forestry management unit had variable areas from 2 ha in YMU III Brebeni from FDDraganestiOlt to 14.12 ha in YMU I Suha Mare from FDMalini;
- the YMUs where the number of protected natural areas varied influenced the duration of the analysis of the protected objectives of the management measures from the management plans, and their implementation in the forest management plans;
- other elements influenced the time taken for developing the forestry management plans, includingthe number of virgin and quasi-virgin stands, the number of management subunits assigned to the stands for their differentiated management, framed in relation to the ecological, economic and social objectives of the forests, and the number of functional categories in which the stands were classified.

Comments on the context of the activities included in the drafting of the forest management plans were noted and essential operations were individualised. On this basis, the classic method for drafting forest management planswas compared with the new methodology, as described in the Working NormsforForestry Management Plans (1999 edition).

The differences in technology between the current and classic drafting methods result from:

- emergence of the modern equipment used in forestry management planning (GPS devices) that has led to new methods for field measurements;
- the development of new information products for cubic calculations, which allow the automation of operations for calculating the volumes of exploitable and inventoried trees;
- the emergence of specialised software (AutoCad, ArcEditor 9.x, AutodeskMap 3D 2007, Arc View, Arc Publisher, VP Raster, extension for 3D Analyst) for GIS, which allows its implementation in forest management planning databases, changing the classic procedures for transpositioning parcels and subparcels and assembling graphical reports;

- the creation of a new software(AS2007 – Forest management plans) for processing data and obtaining resultsfor forest management planning, allowing a reduction in the work time needed for drafting plans as a result of the additional amount of data and information that can be processed; and
- the use of PCs and the available software by all performers, allowing direct editing without a hand-written manuscript phase.

The current drafting of forest management plans involves taking information from GIS projects to determineareas values and make forestry maps, and the classic planimetric operations (classic or digital planimetry) and hand-drawing of draft maps is no longer done. GIS analytically determines the topography and creates forestry maps directly on a PC. This technological changehas improved the precision in determining the area occupied by national forest and the accuracy of the thematic maps.

GPS equipment has changed the method of measuring the boundaries of the national forest, leading to improved accuracy of boundary (which is related to the performance of the device) and reducing the amount of work involved. Thisdepends on the availability of the satellite signal and the number of available satellites.

The creation of a new software product (AS2007 –Forest management plans) has allowed a greater amount of information to be obtained andprocessed, with direct consequences for time reduction in developing forest management plans.

In summary, all the classic operations involved in the drafting of forest management plans have been transformed and adapted to incorporate new technologies, the possitive effects of which are evident in the work of forest planning.

## 4. CONCLUSIONS

The operations involved in drafting forest management plans were indentified and validated, using modern technology and equipment that already exists in forest management.For each operation, the work items, job organisation, work formations, measurement units, tools and equipment, working conditions, and factors that contribute to updating the work methodologies were identified.

The observations made by all the working groups from the subunits of the National Institute for Research and Development in Forestry ‘Marin Dracea’were used to develop the time and production norms for the work of drafting forest management plans, and arecharacterised by a uniformity ofnorms at the national level. Observations were made on 19 FDs, in 21 YMUs, located in various geomorphological conditions (plain, wetland, hill, mountain).These had a diverse number of characteristic elements – elements that constituted potential factors of influence over the calculation of time and production norms.

The observationsused for drafting forest management plans were made based on an existing work methodology.

The experimental data obtained will be interpreted and analysed statistically, allowing it to be interpreted on a scientific basis, and will be used for the calculation of time and production norms in a forest management plan.

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