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A Data-Base of historical total volume measurements for 6 important French forest species; first results on volume table fitting

Patrick Vallet - Michel Ravart - Gilles Le Moguédec
LERFOB - UMR INRA-ENGREF 1092
Engref - Nancy FRANCE
July 2002
Outline of the presentation

• Presentation of the database
  • IFN (National Forest Inventory) data
  • Source documents
  • Data checking
  • Final availability

• Presentation of the first results
Outline of the presentation

• Presentation of the database
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• Presentation of the first results
At the national scale

Repartition of the species in France:

<table>
<thead>
<tr>
<th>Broadleaf</th>
<th>Coniferous</th>
</tr>
</thead>
<tbody>
<tr>
<td>Common Oak</td>
<td>Maritime Pine</td>
</tr>
<tr>
<td>11,6 %</td>
<td>8,6 %</td>
</tr>
<tr>
<td>Sessile Oak</td>
<td>Scots Pine</td>
</tr>
<tr>
<td>11,0 %</td>
<td>7,8 %</td>
</tr>
<tr>
<td>Beech</td>
<td>Norway Spruce</td>
</tr>
<tr>
<td>10,4 %</td>
<td>6,4 %</td>
</tr>
<tr>
<td>Chestnut</td>
<td>Silver Fir</td>
</tr>
<tr>
<td>6,0 %</td>
<td>5,6 %</td>
</tr>
<tr>
<td>Hornbeam</td>
<td>Douglas Fir</td>
</tr>
<tr>
<td>5,0 %</td>
<td>2,0 %</td>
</tr>
<tr>
<td>Downy Oak</td>
<td></td>
</tr>
<tr>
<td>4,7 %</td>
<td></td>
</tr>
<tr>
<td>Ash</td>
<td></td>
</tr>
<tr>
<td>2,4 %</td>
<td></td>
</tr>
<tr>
<td>Birch</td>
<td></td>
</tr>
<tr>
<td>2,2 %</td>
<td></td>
</tr>
<tr>
<td>TOTAL</td>
<td></td>
</tr>
<tr>
<td>83,7 %</td>
<td></td>
</tr>
</tbody>
</table>

Source: [www.ifn.fr](http://www.ifn.fr) (Last inventory)
<table>
<thead>
<tr>
<th>Stand Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date: 16/1/14</td>
</tr>
<tr>
<td>Place: Aiguilles</td>
</tr>
<tr>
<td>Essence: P.S.</td>
</tr>
<tr>
<td>Circumference: 22.3 cm</td>
</tr>
<tr>
<td>Height: 14.5 m</td>
</tr>
<tr>
<td>Age: 64 years</td>
</tr>
<tr>
<td>Number of trees: 35</td>
</tr>
<tr>
<td>Diameter at breast height: 35.1 cm</td>
</tr>
<tr>
<td>Height above the ground: 18.2 m</td>
</tr>
</tbody>
</table>

<table>
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<tr>
<th>Tree Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diameter at breast height: 35.1 cm</td>
</tr>
<tr>
<td>Height above the ground: 18.2 m</td>
</tr>
<tr>
<td>Number of branches: 35</td>
</tr>
<tr>
<td>Diameter of branches: 7 cm</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Volume by 1 meter long logs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volume in dcm³ measured with the ruban spécial</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Thick branches ( &gt; 7 cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volume in dcm³</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Thin woods</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight in kg</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Bois Fort</th>
</tr>
</thead>
<tbody>
<tr>
<td>Logs: 1 m, 20 de tour et plus</td>
</tr>
<tr>
<td>Volume in dcm³ measured with the ruban spécial</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Fagots</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volume in dcm³</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volume in dcm³</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Poids en ligne</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight in kg</td>
</tr>
</tbody>
</table>
Availability

- More than 8,500 statement sheets
  - 12 species
  - 27 forests

- Accumulated between 1920 and 1955
Location of the forests

Situation au 1er octobre 1930 des places d’expériences destinées à l’étude des principales essences forestières.
Data checking

• A lot of different ways to make mistakes
  – At the stand level

Example: A set had to be ruled out because the stand was sick
Data checking

• A lot of different ways to make mistakes
  – At the stand level
  – On the summary sheets

Example: In a set, 22 spruces were mixed up with firs
Data checking

• A lot of different ways to make mistakes
  – At the stand level
  – On the summary sheets
  – During the keyboarding

Imagine, 8 500 trees!
Data checking

• A lot of different ways to make mistakes
  – At the stand level
  – On the summary sheets
  – During the keyboarding
  – About the way to perform the measurements

  Problem with the density
  Problem with the needles weight
A classic inventory
Weighting of the bundles
Data checking

• A lot of different ways to make mistakes
  – At the stand level
  – On the summary sheets
  – During the keyboarding
  – About the way to perform the measurements

In order to have a reliable volume table fitting, we did a hard data checking, and every questionable data was ruled out
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Frequency of the observations
For all species

Number of trees: 4306
Circumference: from 9 to 300 cm
Height: from 5.4 to 42.5 m
Frequency by circumference class
For the 6 major species

- Common and sessile oak: 1222 trees
- Silver fir: 762 trees
- Scots pine: 389 trees
- Beech: 1293 trees
- Norway spruce: 309 trees
- Douglas fir: 224 trees
Known information

- **Data about the trees**
  - Forest, specie, date
  - Volumes: total, stem commercial wood (diameter > 7cm), branches commercial wood and thin woods
  - Circumference at breast height
  - Total and commercial wood heights

- **Data about the stand**
  - \( C_0, H_0 \) (sometimes), N, G, Cg, Hg
  - Age
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Amount of thin woods

- Percentage of thin woods vs. total volume
- Number of oaks vs. circumference
Main idea

• A tree is a revolution solid

• Volume for a revolution solid:

\[ v(n) = \frac{1}{4\pi} \times c_{130}^2 \times h \times \frac{1}{(n+1)} \]

\( n = 0 \) : cylinder, \( n = 1 \) : paraboloid, \( n = 2 \) : cone, \( n = 3 \) : neloid

• We studied the form factor: \( f = \frac{1}{(n+1)} \)
The form factor

- It can depend on different variables: circumference, height...
The form factor

- Model:

\[ f = \left( \alpha + \beta \frac{c_{130}}{h} \right) \left( 1 + \gamma c_{130}^2 \right) + \epsilon \]
Applied to the oak
Applied to the oak
Applied to the oak - Residuals
Applied to the oak - Residuals
Applied to the oak - Residuals
Crossed validation - Oak
Crossed validation - Oak
Crossed validation - Oak

Residuals * Predicted, for Champenoux missing
Crossed validation - Oak

Residuals * Predicted, for Blois missing

Predicted Values

- Blois
- Other Forests
Crossed validation - Oak
Crossed validation - Oak

Residuals * Predicted, for Belleme missing

Predicted Values

- Belleme
- Other Forests
Conclusion - Outlook

• We’ve got a reliable database, obtained with a hard ruling out
• The first results of the model seem to be rather good

• We need to check / improve the model, thanks to the appropriate statistic tools
• Then we will apply it to the IFN data
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