Selective and traditional forest management options for black pine forests in central Italy: Impacts on ecosystem services

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Mapping and Assessment of Ecosystems and their Services - Science in action

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Scientific background

❖ Peri-urban forests:

- play an important multifunctional role supplying many benefits to the society i.e., ecosystem services

- affected by multiple anthropogenic pressures: soil compaction, housing fragmentation and infrastructure development (Tzoulas et al. 2007, Blood et al. 2016), leading to alteration of their structure and composition

- affected also by forest management practices. Benefits of management options can be valued in terms of ecosystem services provision (De Groot et al. 2010).
Aim of the project and study

- Aim of FoRESMit: to define guidelines of good silvicultural practices for the restoration of peri-urban degraded coniferous forests in Italy and Greece with native broadleaved species, improving their ecological stability, biomass increment, and climate change mitigation potential;
- Impact analysis of two alternative forest management schemes in terms of ecosystem services provision;
- Trade-offs and synergies analysis between biomass use for energy and other ecosystem services: recreation (cultural), climate change mitigation (regulating) and provision of habitat (supporting) in a case study in Italy (Tuscany).

Project LIFE14 CCM/IT/905 (2015-2019)
“Recovery of degraded coniferous Forests for environmental sustainability Restoration and climate change Mitigation”
The study site is the peri-urban forest of Monte Morello, near the metropolitan area of Florence.

Mixed conifer plantation established in 1960-68 for protection purpose, with never thinned stands. Main species: black pine and Calabrian pine.

Weak stability, high density, tree slenderness, superficial or rocky soil.
Monte Morello – silvicultural treatment options

- **Selective (Innovative) thinning:**
  Positive Selection
  Thinned 30-40% of basal area: with the cut are harvested all crown-volume competitors trees, standing dead trees and logs of 1 and 2 decay class with dbh>20 cm

- **Traditional thinning:** (thinning from below):
  Negative Selection
  Cut 15-25% of basal area: with the cut are harvested small and leaned trees and standing dead trees

- **No thinning:** control plots
Monte Morello ecosystem service assessment

- Biophysical assessment of four types of ecosystem services: bioenergy (provisioning services), recreation (cultural services), climate change mitigation (regulating services) and provision of habitat (supporting services) generated with the selected and traditional thinning

- Trade-offs between bioenergy (provisioning services) and other three ecosystem services:
Assessment of bioenergy production

- Quantification of volume of woody biomass (living and non-living) in the two silvicultural treatments (m³ ha⁻¹).

- Whole-tree harvesting system, summer 2016. 18 sample plots (531m²): 6 plots for each silvicultural treatment (selective, traditional, no thinning).

- Assessment of woodchips quantity and price in the two silvicultural treatments (€ m⁻³).
Biophysical assessment of habitat provision

- Quantification of deadwood habitat in forest after the two treatments considering:
  - fauna habitat trees: standing dead trees with a diameter > 30 cm (Mason et al., 2005). Biophysical indicator: number of trees ha\(^{-1}\)
  - lying deadwood belonging to the 4th and 5th decay class (Bütler et al., 2013). Biophysical indicator: m\(^3\) ha\(^{-1}\)
Biophysical assessment of climate change mitigation

- CO$_2$ emission reduction potential from deadwood
  - Analysis of CO$_2$ emissions from deadwood after silvicultural treatments by laboratory incubation of deadwood samples and GC (gas chromatography detection). Biophysical indicator: kgCO$_2$ ha$^{-1}$
Recreation: survey design and administration

- Summer 2016: administration of a face-to-face interview to 201 visitors in the forest and analysis of the preferences accorded to the different forest situations after treatments.
- 15 questions (2 open-ended and 13 closed-ended questions) divided in four themes:
  1. Personal information: gender, age, education, occupation, distance between place of residence and Monte Morello peri-urban forest.
  2. Recreational use of forest - visitor's habits: frequency of visits in Monte Morello, reason to visit (hiking, relaxing into the nature).
  3. Benefits provided by peri-urban forest: importance of tourism-recreation, biodiversity, air quality improvement; protection from natural hazards, timber and fuelwood provision, local jobs creation.
Recreation: survey design and implementation

4. Preferences and perceptions towards the peri-urban forest: on tourist facilities, characteristics of forest stand, and silvicultural treatments.

The options were:

- Status quo scenario: currently the Monte Morello peri-urban forest is not actively managed, the standing dead trees and the lying deadwood are not removed: **Photo A**
- Traditional thinning scenario: **Photo C**
- Selective thinning scenario: **Photo B**
Recreation: survey design and implementation

- Analytical Hierarchy Approach to assess and quantify the preferences for management options

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Data analysis

- Calculation using the eigenvalue method

Starting from

\[
A = (a_{ij}) = \begin{pmatrix}
\frac{w_1}{w_1} & \frac{w_1}{w_2} & \ldots & \frac{w_1}{w_n} \\
\frac{w_2}{w_1} & \frac{w_2}{w_2} & \ldots & \frac{w_2}{w_n} \\
\vdots & \vdots & \ddots & \vdots \\
\frac{w_n}{w_1} & \frac{w_n}{w_2} & \ldots & \frac{w_n}{w_n}
\end{pmatrix}
\]

To obtain \( \lambda_{\text{max}} \) = largest Eigenvalue of matrix A and vector of weights W

- Consistency test:

\[
CI = (\lambda_{\text{max}} - n)/(n - 1)
\]

\[
CR = CI / RI, \text{ where } CR \leq 0.1
\]
Woody biomass production: quantity and price

Harvested wood

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<tr>
<th>Type of treatment</th>
<th>Traditional</th>
<th>Selective</th>
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<tr>
<td>m³/ha</td>
<td>60</td>
<td>120</td>
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Economic value of woodchips

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<th>Type of treatment</th>
<th>Traditional</th>
<th>Selective</th>
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<tbody>
<tr>
<td>€/ha</td>
<td>911</td>
<td>1301</td>
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Habitat provision

Habitat trees

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<thead>
<tr>
<th>Type of treatment</th>
<th>Number/ha</th>
</tr>
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<tbody>
<tr>
<td>Selective</td>
<td>12</td>
</tr>
<tr>
<td>Traditional</td>
<td>6</td>
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Decayed logs

<table>
<thead>
<tr>
<th>Type of treatment</th>
<th>Volume/m³/ha</th>
</tr>
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<tbody>
<tr>
<td>Selective</td>
<td>64.44</td>
</tr>
<tr>
<td>Traditional</td>
<td>70.72</td>
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Climate change mitigation

![Bar chart showing C-\(\text{CO}_2\) emissions from deadwood]

- Traditional: 4.8
- Selective: 4.3

Type of treatment

kg/ha
Recreation

- The results of pairwise comparison show that the visitors of Monte Morello forests prefer the image of forest after the selective thinning (priority score 0.5034) followed by the image of forest after the traditional thinning (priority score 0.2873)
Ecosystem services’ impact from selective and traditional thinning
Conclusions

- Combined interpretation of the results suggests that the selective (innovative) thinning could be a viable option for the forest management of the Monte Morello peri-urban forests.

- Different set of ecosystem services could be used dependent on the specific characteristics of the forest management options in different areas.

- Further investigation will be focused on the economic valuation of ecosystem services as well as their trade-offs and synergies related to the selective thinning.
Thank you for the attention

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