Environmental assessment of two different logging methods in coppice

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Introduction: the importance of wood biomass

No-renewable resources vs Renewable resources

Sustainable perspective

Wood biomass

EU Directive 2009/28EC:
“mandatory target of a 20% share of energy from renewable sources in overall Community energy consumption by 2020”

Estimate: 42% of total renewable energy will be obtained by wood biomass
What about the environmental profile of wood biomass?

Renewable ≠ zero emissions

Wood is a renewable material, but its production implies impacts.
What about the environmental profile of wood biomass?

Renewable ≠ zero emissions

Wood is a renewable material, but its production implies impacts

How is the environmental profile of wood extracted from coppices under traditional management?
Aim of the study

To assess the environmental impacts due to forest operations in traditional coppices in central Italy

Flat / low steep terrains

Steep / very steep terrains

SWS
Short Wood System

WTH
Whole Tree Harvesting

BY MEANS OF LIFE CYCLE ASSESSMENT
Life Cycle Assessment

**Inputs**
- Electricity
- Wood
- Water
- Machines
- Fuels
- Lubricants
- Heat

**Use**
- Disposal and/or recover
- Raw materials extraction
- Raw materials processing and transport
- Final product manufacturing and packaging

**Outputs**
- CO$_2$
- Heat
- SO$_2$
- PM$_{10}$
- PM$_{2.5}$
- NO$_x$
- Electricity
- CH$_4$

UNI ISO 14040
System boundaries – SWS on “Flat / low steep terrain”

Ground-based extraction of cut-to-length firewood on 'flat/low steep' terrain by tractor and bins (SWS)

- Fossil fuels production
- Machine production
- Lubricants production

Felling and Processing

Forest Operations

SWS1 to SWS2: Extraction

SWS2 to SWS3: Loading

SWS3 to SWS4: Transport

Firewood

Avg slope: 22% - 96.1 t/ha of fresh firewood (1 m length)
System boundaries – WTH on “steep / very steep terrain”

Aerial extraction of whole tree on ‘steep/very steep’ terrain by cable-yarder (WTH)

- Fossil fuels production
- Machine production
- Lubricants production

Machines

Fuels

Transport of workers

Chain oil

Emissions

Average slope: 51% - 98.3 t/ha of fresh wood:
- 75.6 t firewood
- 22.7 t chips
Life Cycle Inventory

Primary data

From work studies:
- Productivities ($PMH_0$);
- Fuel and lubricants consumption;
- Transport of workers;
- Machine characteristics;
- Wood volumes processed

Secondary data

Only for background processes
From ecoinvent© database

SimaPro

Recipe V1.12

7 Impact categories
### Results

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Legend:
- Chipping
- Processing
- Felling
- Transport
- Loading
- Extraction
- Felling and Processing
Due to high fuel consumptions and higher use of raw materials, wood extraction is an environmental hotspot. Discussion points include:

- High energy requirements
- Heavy machines
- Lower productivities
- Higher use of raw materials

Exception: 'Felling and processing' in POF is due to gasoline.

Transport of workers:
- Around 15% in SWS
- Around 10% in WTH
Scenario:
Variations in gas exchanges after soil compaction

Soil compaction effects considered:

- CH₄ Less absorption
- Higher emissions of N₂O

(Tepee et al., 2004)

Compacted surface  →  SWS: 30%  -  WTH: 13.5%  (Lucci, 1987)

CH₄ = 23 CO₂eq  (IPCC, 2001)  N₂O = 296 CO₂eq

SWS: +10% CO₂eq  WTH: +3% CO₂eq
Conclusions

The importance of understanding the impacts of wood as renewable material

LCA as an useful tool for the environmental assessment of forest operation

SWS apparently better than WTH

Ergonomics

BUT

Risks for workers

Productivity

Operating on different conditions

Future developments: needs of deeper investigations on soil emissions
Thank you for your attention

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