

Life Cycle Assessment of maritime pine wood

Ana Cláudia Dias, Luis Arroja
University of Aveiro

CESAM & Department of Environment and Planning

COST ACTION FP1303 – 1st Conference
Granjska Gora, 23-24 October 2014



Introduction

Although wood frame construction is not common in Portugal, wood is used in building works both in carpentry and joinery

most important wood
grown in Portugal for
these purposes



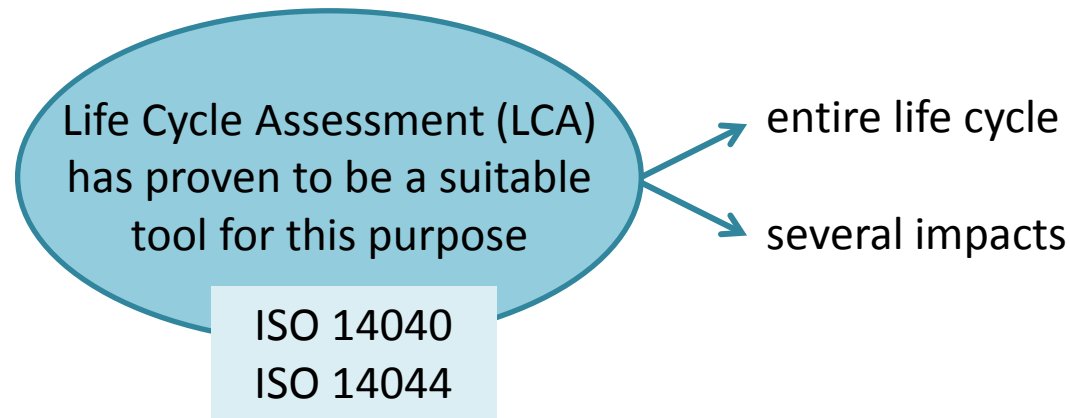
Maritime pine
(*Pinus Pinaster* Ait.)



- 23% of the total forest area in Portugal (714,000 ha)
- About 50% of the total wood harvested in Portugal

Objective

- To quantify the environmental impacts resulting from the production of maritime pine wood in Portugal using Life Cycle Assessment (LCA)



Impacts from
forest operations

+

Impacts from the production
of fuels, lubricants and
fertilizers consumed

Scenarios analysed

- Different intensity levels of forest management exist within the country
- Different equipment can be used to achieve the same goal



3 scenarios, reflecting different management intensities and logging equipment:

Scenario 1



- high intensity management (best management practices)
- logging is accomplished by harvesters and forwarders

Scenario 2



- high intensity management as in Scenario 1
- logging is carried out with more traditional machinery, namely chainsaws and modified farm tractors

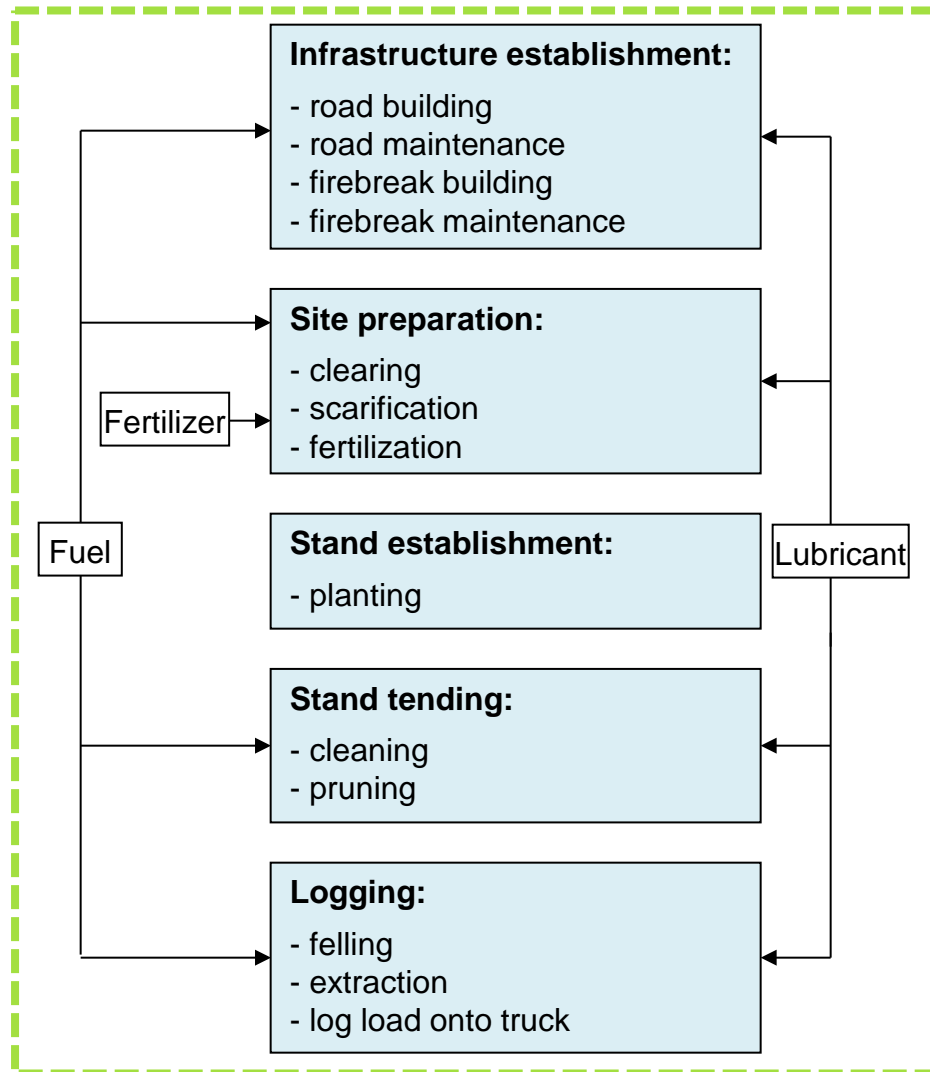
Scenario 3



- low intensity management (only logging operations, natural regeneration)
- logging with chainsaws and modified farm tractors

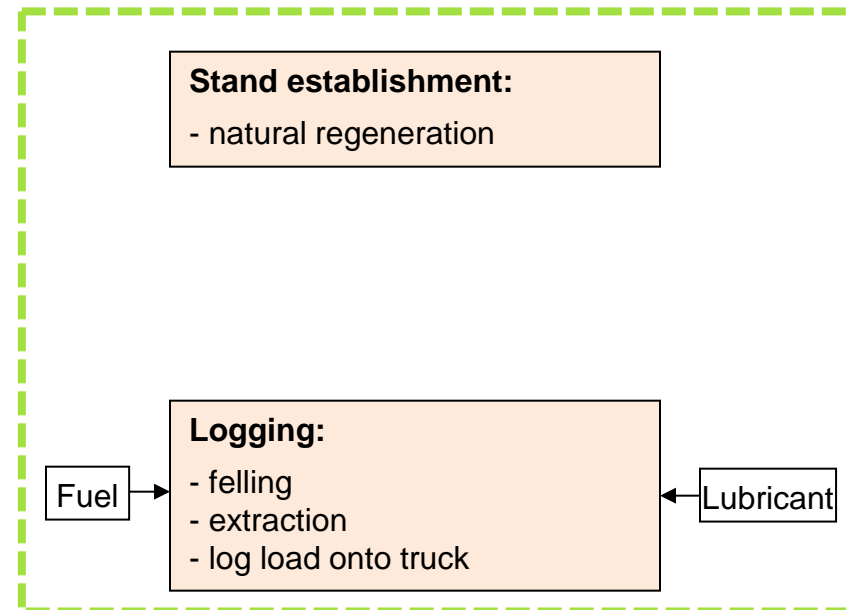
System boundaries

Scenarios 1 & 2



Cradle to gate approach

Scenario 3



Inventory data

- Consumption of fuels, lubricants, fertilizers
 - typical data for maritime pine stands in Portugal
 - for all operations over 1 rotation (45 years)

Example of fuels: - effective work time of each operation
- fuel consumption per hour of each machine

- Emission factors of pollutants to air and water - literature [1,2]
- Production of fuels, lubricants, fertilizers - Ecoinvent database [3]

[1] **Audsley, E. et al.** (1997) Harmonisation of Environmental Life Cycle Assessment for Agriculture. Final Report. Concerted Action AIR-CT94-2028. European Commission, DG VI Agriculture

[2] **EEA** (2009) EMEP/EEA air pollutant emission inventory guidebook 2009. EEA Technical Report 9/2009. European Environment Agency

[3] **Ecoinvent** (2010) Ecoinvent database v 2.2. Swiss Centre for Life Cycle Inventories

Functional unit & impact assessment

- Functional unit:
production of 1 m³ (fresh) of roundwood under bark (ub) ready to be delivered to industry (moisture content ≈ 40%)

- Impact assessment methodology:
midpoint characterisation factors recommended by the International Reference Life Cycle Data System (ILCD) [4]

[4] EC (2012) Characterisation factors of the ILCD recommended life cycle impact assessment methods. Database and supporting information. European Commission

Results

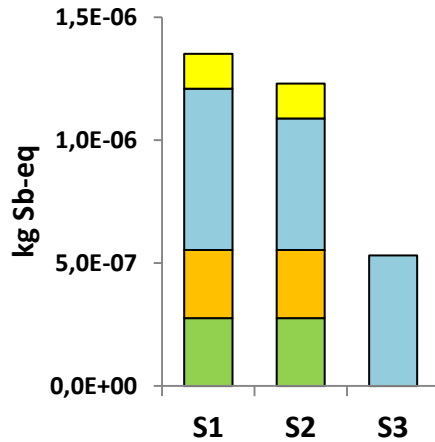
for 1 m³ ub

S1 – high intensity; harvester + forwarder

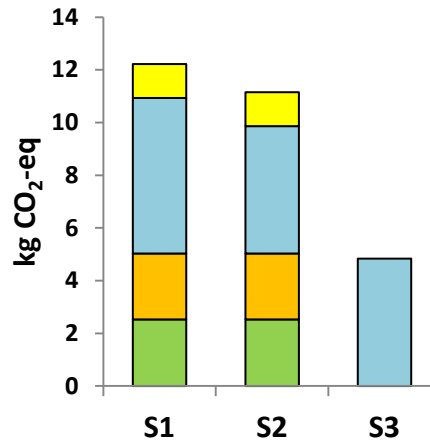
S2 – high intensity; chainsaw + modified farm tractor

S3 – low intensity; chainsaw + modified farm tractor

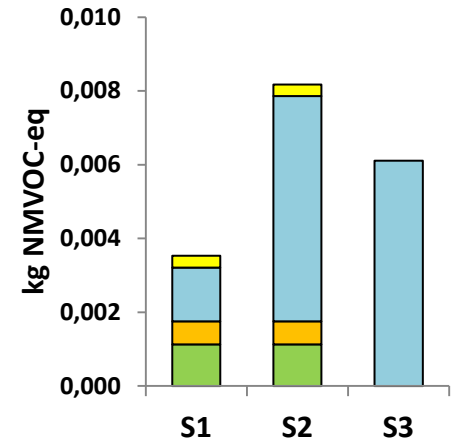
Mineral and fossil resource depletion



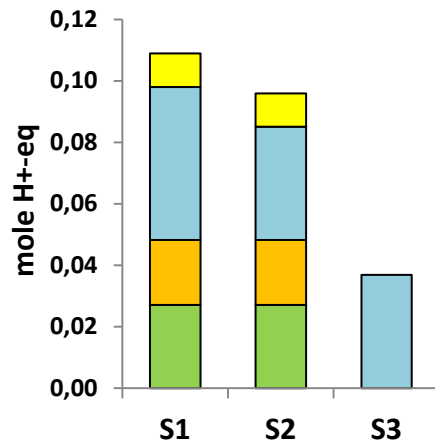
Climate change



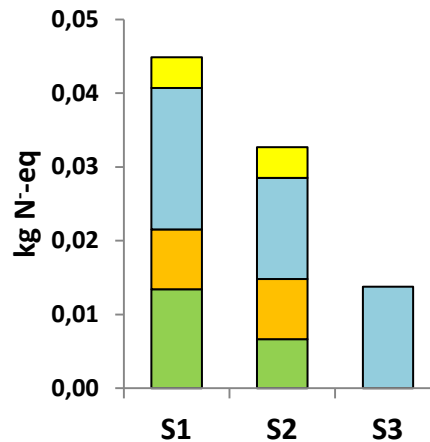
Photochemical oxidant formation



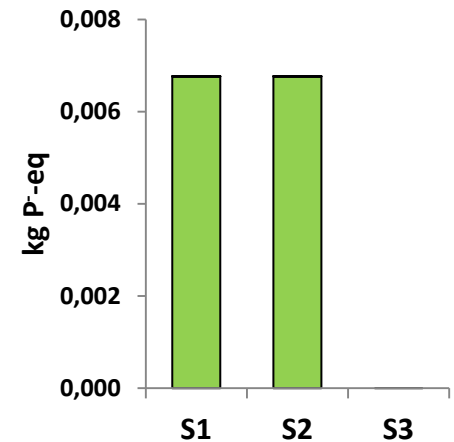
Acidification



Marine eutrophication



Freshwater eutrophication



Infrastructure establishment

Logging

Stand tending

Site preparation

Conclusions

- ✓ This study estimates expected ranges of variation for the impacts associated with the production of maritime pine wood in Portugal and identifies the hotspots
- ✓ As maritime pine is a raw material for several products, these results could be integrated in LCA studies of those products
- ✓ Major hotspots:
 - Logging stage (fuel use)
 - Freshwater eutrophication in S1 and S2: site preparation (fertilizer use)
- ✓ Management scenarios:
 - Low intensity has lower impacts... but the risk of forest fire can be higher...
 - Use of traditional machinery for felling and forwarding has lower impacts, except for POF

Thank you for your attention!

Journal of Cleaner Production 37 (2012) 368–376



ELSEVIER

Contents lists available at SciVerse ScienceDirect

Journal of Cleaner Production

journal homepage: www.elsevier.com/locate/jclepro



Environmental impacts of eucalypt and maritime pine wood production in Portugal

Ana Cláudia Dias*, Luís Arroja

Centre for Environmental and Marine Studies (CESAM), Department of Environment and Planning, Campus Universitário de Santiago, University of Aveiro, 3810-193 Aveiro, Portugal

Science of the Total Environment 472 (2014) 324–337



ELSEVIER

Contents lists available at ScienceDirect

Science of the Total Environment

journal homepage: www.elsevier.com/locate/scitotenv



Divergences on the environmental impact associated to the production of maritime pine wood in Europe: French and Portuguese case studies



Sara González-García^{a,b,*}, Ana Cláudia Dias^a, Gumersindo Feijoo^b, María Teresa Moreira^b, Luis Arroja^a

^a CESAM, Department of Environment and Planning, University of Aveiro, 3810-193 Aveiro, Portugal

^b Department of Chemical Engineering, School of Engineering, University of Santiago de Compostela, 15782 Santiago de Compostela, Spain

Contact: acdias@ua.pt

