

ASSESSMENT OF THE AVAILABILITY OF FOREST BIOMASS FOR BIOENERGY PRODUCTION IN SOUTHWEST PORTUGAL

Ana Cristina Gonçalves, Adélia Sousa, Isabel Malico

Introduction

The World's wood pellet production is steadily growing, being Europe the largest wood pellet producer and consumer (61% of the World's production). In 2014, Portugal was the 7th largest producer in the World, and the 5th in Europe.

The shortage of raw material is one of the major obstacles found in the Portuguese pellets market. By far, the highest potential of biomass residues for pellets production in Portugal comes from forestry, therefore, accurate quantification of forest biomass resources are important and needed. They help supporting bioenergy national and corporate policy decisions.

This study evaluates the availability of forest biomass residues of maritime pine in a management unit with about 1000 ha, in a Geographical Information System (SIG) environment. The above ground biomass (W) residues were estimated for 2004, 2007, 2011 and 2015.

Materials and Methods

The study area is a management unit with an area of 1033 ha; 944 ha of forest, mainly maritime pine. It is located in the Grândola municipality, about 120 km from Lisbon. For the study area, three images were acquired, two from the satellite Quickbird (May 2004 and September 2007) and one from the satellite WorldView-2 (June 2011) with a spatial resolution of 0.7 m and 0.5 m, respectively (Fig. 1). These images were converted to surface reflectance, atmospheric and geometrically corrected and orthorectified.

- Based on the 3 satellite images, the crown horizontal projection (CHP) was obtained using the multi-resolution segmentation method (Fig. 2).
- A square grid of 45 m x 45 m (2025 m²) was applied, and W for 2004, 2007 and 2001 was estimated with the allometric function: $W_{ps}=4.8692 \times CHP_{ps}$.
- The estimation of W , per grid, in 2015 was done considering a mean biomass annual increment of 1.4 t/ha.

To determine the amount of pellets than can be produced from the residual biomass generated in the study area, the production data of a Portuguese pellets factory in Mortágua was used (overall production efficiency of 45% and 7800 working hours per year). It was considered that the humidity of the biomass received by the pellets plant is on average 50% and that the LHV of the pellets is 15.6 GJ t⁻¹.

Results

From 2004 to 2007 and from 2007 to 2011 there was a reduction of W , due to the cuts made to prevent dissemination of pinewood nematode and to two forest fires (with a total area of 63.2 ha) (Fig. 3a). From 2011 to 2015 there was an increase of W , mainly due to the growth of the young maritime pine individuals, that are less affected by the nematode. The W_{res} available is directly proportional to W , thus it is in the adult stands that the larger amounts of residues are produced (Fig. 3b). Considering a similar rate of cuts and other silvicultural operations within the three periods considered, from 2004 to 2007, 2007 to 2011 and 2011 to 2015, the estimated quantity of residues is 672 t/year, 132 t/year and 235 t/year, respectively (from Tab. 1). The contribution of this biomass to the production of pellets in a large scale factory located in the vicinity of the study area is presented in Tab. 2.

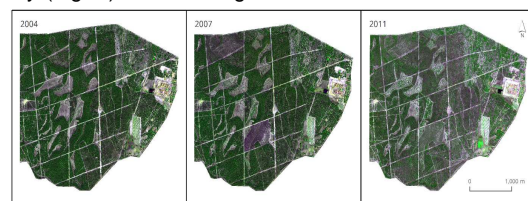


Fig. 1 – Color composite of satellite images (RGB – RedNIRGreen).

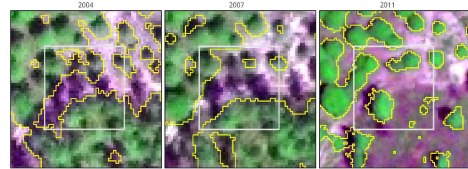


Fig. 2 – Illustration of crown projection (yellow line) over a color composition (RGB - RedNIRGreen) for the three sets of data.

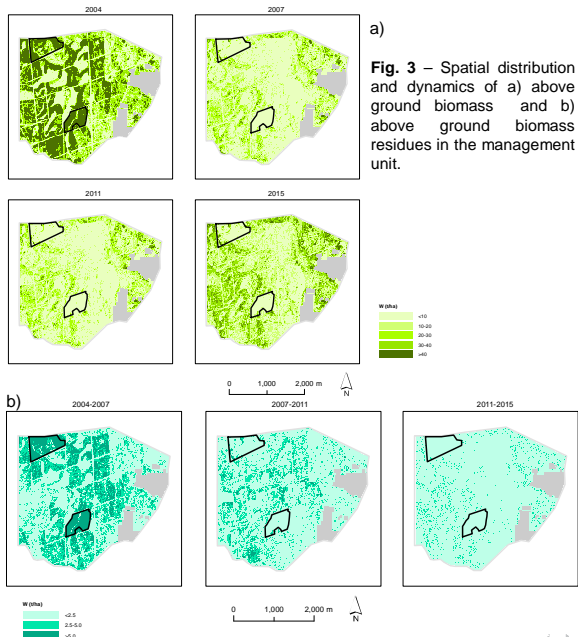


Fig. 3 – Spatial distribution and dynamics of a) above ground biomass and b) above ground biomass residues in the management unit.

Tab. 1 – W and W_{res} in the study área.

Above ground biomass (W)		
Year	Total [t]	Per unit area [t/ha]
2004	25782.3	27.4
2007	12351.1	13.1
2011	9711.3	10.3
2015	14972.0	15.9
Residues (W_{res})		
	Total [t]	Per unit area [t/ha]
2004-2007	2686.2	2.9
2007-2011	528.0	0.6
2011-2015	941.6	1.0

Tab. 2 – Pellets production potential.

	Amount of pellets produced	
	Mass [t]	Energy [GJ]
2004-2007	2417.6	37714.2
2007-2011	475.2	7413.1
2011-2015	847.4	13220.1

Conclusions

The pellets plants recently installed in Portugal need large amounts of wood. The cuts made to prevent dissemination of pinewood nematode were a major source of wood for the industry, but they contribute to a W_{res} shortage in the medium term.

The forest stands of maritime pine, if managed for wood production, do not yield large amount of residues. In the future, other management options need to be considered, so that a larger amount of residues can be obtained.

Acknowledgments

The authors would like to thank the forest producers for allowing plot installation. Paulo Mesquita is acknowledged for satellite image processing. The work was financed by Programa Operativo de Cooperação Transfronteiriça Espanha-Portugal (POCTEP), project Altercexa – Medidas de Adaptación y Mitigación del Cambio Climático a Través del Impulso de las Energías Alternativas en Centro, Alentejo y Extremadura (Ref. 0317_Altercexa_I_4_E and 0406_ALTERCEXA_II_4_E), project TrustEE - innovative market based Trust for Energy Efficiency investments in industry (Project ID: H2020 – 696140), and National Funds through FCT – Fundação para a Ciência e a Tecnologia under the projects UID/AGR/00115/2013 and UID/EMS/50022/2013.



Departamento de Engenharia Rural e de Física,
Universidade de Évora, Escola de Ciências e Tecnologia,
Largo dos Colegiais, 7000 Évora, Portugal

