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Sustainable Management of Energy Wood Chips Sector: Case Study of the Regional Park "Caps et Marais d'Opale"

Gilles Goncalves[a]*, Eric Masson[b], Xuemin Wei[a]

[a]*Univ. Artois, EA 3926, Laboratoire de Génie Informatique et d'Automatique de l'Artois (LGI2A), Béthune, F-62400, France*
[b]Univ. Lille, EA 4477, Laboratoire Territoires Villes Environnement Société (TVES), Villeneuve d'Ascq, F-59655, France

Abstract

We propose in this paper a two-phase methodology to design a supply chain network for managing the energy wood chips sector. Firstly, a GIS based spatial analysis is made to estimate all the data (offer, demand, potential locations for warehouse) of the network. Then an optimization phase takes place to solve the location-allocation problem in order to minimize economic cost indicator and CO2 emissions. The methodology has been applied for the case study of the regional park "Caps et Marais d'Opale" using three different strategic scenarios of development. A comparison is made in order to evaluate each selected sustainable criteria.

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*Keywords:*Energy wood; GIS; optimization; location and allocation problem

1. Introduction

"Parcs naturels régionaux" (PNR) in France are large populated areas which are recognized for the distinctiveness of their natural, cultural and rural heritage, and which have elected to protect and develop this heritage through sustainable development.

The Nord-Pas-de-Calais region is one of the most populated part of Europe situated in the north of France close to the Belgium border. This region also has three regional natural parks (PNR) that have been preserved from the demographic development. These parks cover over 25% of the region and they are named PNR Avesnois in the

* Corresponding author. . Tel.: (33) 3.21.63.71.69 ; fax: (33) 3.21.63.71.21
E-mail address: gilles.goncalves@univ-artois.fr

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South-East, PNR Caps-et-Marais-d'Opale (PNR CMO, i.e. our case study) in the North-West and PNR Scarpe-Escaut in the East middle part of this region.

Hedgerows and woodlands are very present in these PNR compare to other places in the region that are fully dedicated to cities or crop production. This wood resource can be view as an alternative and renewable energy for private customers and municipalities especially for those who have to heat medium sized building (small industries, farm buildings, castles, town halls…). Such buildings can benefit from a renewable fuel heating using either woodchips or wood pellets. The advantage of woodchips is the direct cost whereas the advantage of wood pellets is the controlled fuel value. Woodchips have been traditionally used as solid fuel for heating or in energy plants to generate electric power from renewable energy. The use of woodchips in automated heating systems is based on a robust technology.

In this study, we only consider the development of woodchips produced by the regular cutting of hedgerows for heating systems. We also focus on the PNR-CMO which is composed of 152 municipalities spread on over 130.000 hectares (figure 1). The question asked by the PNR-CMO managers was to help them in developing the woodchips sector in a sustainable way or in other words to motivate farmers to enhance their hedgerows resources by encouraging small communities and individuals to shift their heating systems for this renewable energy.

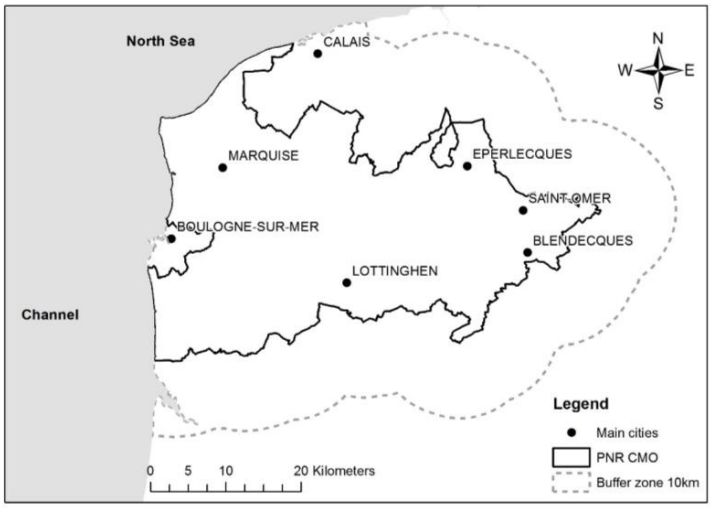

Figure 1: Location of the case study including a 10 km buffer zone for calculations (data: PNR CMO, 2015; BDTopo® IGN, 2013).

To answer the territorial aspect of this problem, a spatial analysis has been performed in order to define the location of potential storage facilities at a strategic level (i.e. the PNR territorial level). This location issue should answer the question of creating a new renewable energy network including the natural resource (i.e. the hedgerow), the transportation network (road are only considered regarding to the spatial clustering of resources and customers) and potential customers (private or public). This has led us to build a Geographical Information System (GIS) database to apply a spatial analysis methodology to provide the PNR CMO managers and various stakeholders with a multi criteria spatial decision tool. Then in a second step, there was a need to choose between different scenarios in order to fine tune the final best location according to the transportation cost that represent the major issue in the business building of such a renewable energy system.

The paper is organized as follows. In the next section, the generic methodology is presented then a focus on the PNR-CMO is made. A GIS spatial analysis used to provide data for the supply network design is described in the third and fourth section. Lastly, final conclusions are drawn in the last section.