Mots clés

- Waste
- Forest logging
- Optimisation

Optimised site location
The example of waste collection points

Waste of all kinds are generated by forest exploitation (see FIF n°712). It is the property of forestry enterprises that must arrange for disposal in conformity with the regulations. For example, appropriate collection solutions must be found for hazardous wastes (used oil, hoses, filters, spray paint cans, etc.) to guarantee such disposal. However, solutions are generally lacking for small quantities such as those generated by the numerous small enterprises performing forestry work.

The GEDEON (Waste management in the forestry logging sector) project funded by the LIFE programme aimed at devising and setting up shared collection solutions for forestry exploitation professionals.

Within this framework, the first task consisted in identifying the sites at which a collection solution should be found, given the proximity of a significant number of enterprises or a large quantity of wastes.

Geographic information systems are excellent analytical tools for addressing this type of question. Specific modules are used to allow for road networks and constraints related to time and geographic remoteness.

This document illustrates the methodology developed within the framework of GEDEON to identify and optimise the positioning of waste collection points. It was illustrated through the example of the SEBSO company that wishes to make a network of appropriate collection points available to its employees and subcontractors.

What are the best places for installing waste collection points in the light of the geographic positions of the enterprises concerned?

Identifying the positions of sources of wastes

The first task consisted in identifying the geographic positions of forestry operators (SEBSO employees or subcontractors) and plotting waste sources.

■ Geographic location of enterprises

All the forest operators were identified and their positions plotted. The address of the headquarter of the companies was used instead of work sites. Indeed, it is considered that operators bring their wastes back from the work sites and store them in their workshops. Collection solutions must be found in the light of this siting.

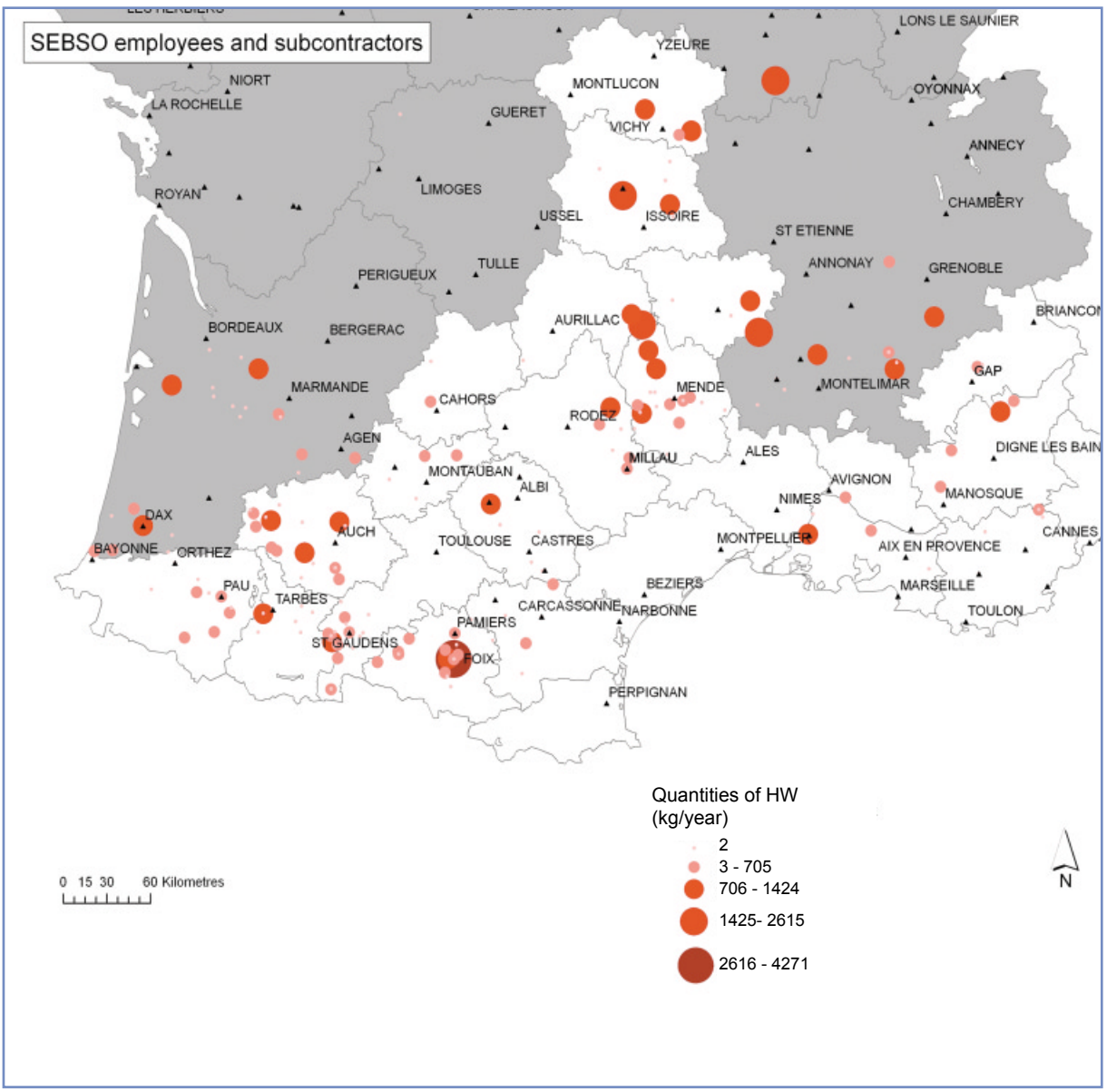
■ Representing sources of waste

The quantities of wastes generated was calculated for each enterprise according to its characteristics (woodcutters or machine operators and the number of machines).

Priority is awarded to hazardous wastes.

Average quantities of wastes generated (kg per year) by each type of operator (source: GEDEON, FIF No. 712), HW: hazardous waste, NHW: non hazardous waste

	Harvester	Forwarder	Skidder	Woodcutter
HW	858	559	340	2
NHW	173	251	391	20
Tot.	1031	810	731	22



Quantities of hazardous wastes generated annually by SEBSO's employees and subcontractors.

Identification of collection points

Identification of locations of collection points for hazardous wastes is addressed. They must be sited close to the headquarter of the enterprises. It is assumed that these points are established in or close to towns or villages. The INSEE[1] geographic database covering the some 36,000 towns and villages in France was used for this.

■ Parameterising journeys

The journey that would be made by operators from their headquarters to the collection point is to be taken into account rather than the distance as the crow flies.

The road system was used for this (IGN[2]'s Route 500® database). This data layer is enriched with traffic speeds on the various categories of road and the time required to travel the various road segments (the hypothesis is based on transport by light vehicles).

Average speeds (kph) used in parameterising the road database (according to Mappy: www.mappy.fr)

Type of road	Speed
Motorway	110
Main road	74
Secondary road	60
Minor road	45

This can be used as a base for calculating the journey time for various routes between operators' headquarters and the various communes in the vicinity.

It was assumed that operators were not inclined to travel for more than 15 minutes to dispose of their wastes.

Performed with the Network Analyst extension of the ArcGIS® software, this analysis led to identify 9,345 communes that are potential sites for the installation of waste collection points.

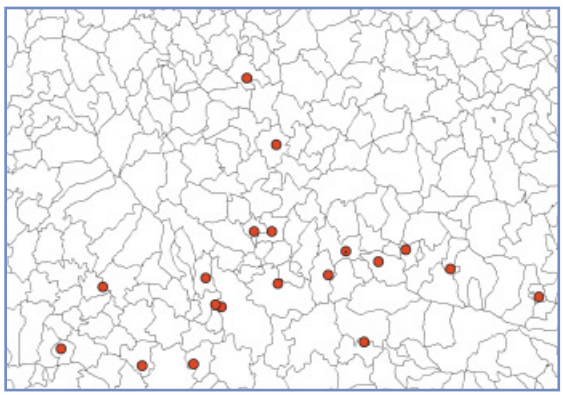
[1] Institut National de la Statistique et des Etudes Economiques

[2] Institut Géographique National

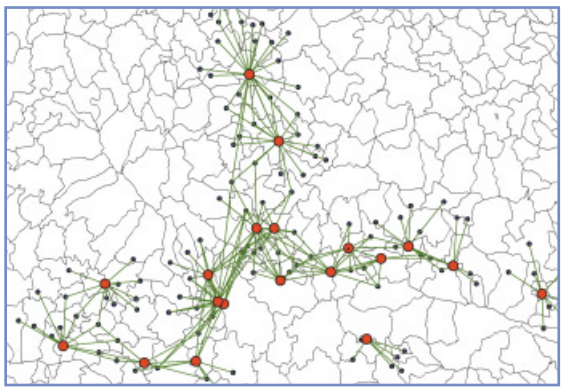
About Route 500® and ArcGis® extension Network Analyst

Network Analyst is a route calculation module in the ArcGIS® GIS software. Linked to a vectorial road database, it can be used to parameterise (speed by road type, traffic direction, preferred manner of driving, etc.) and to perform studies based on road network.

A function generates automatically an Origin/Destination matrix containing information on distance, travelling time and possible transport cost for each pair. In this study, the function was used to compute and display the journey times between 2 operators and the journey times between each operator and the potential sites for waste collection points.



Location of operators.



Towns or villages less than 15 minutes away.

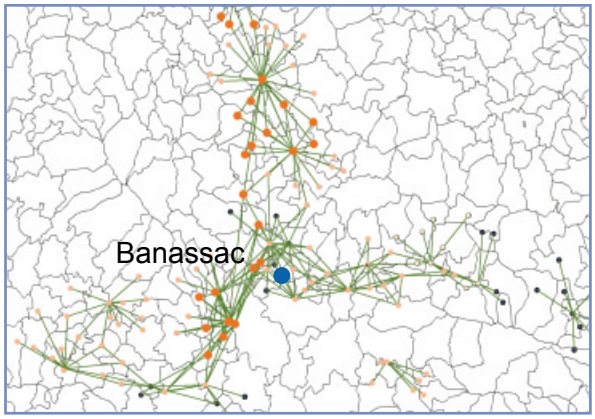
■ Site information and ranking

For each potential point identified, spacial joining was used to show the number of enterprises concerned (located less than 15 minutes away) and the quantities of wastes involved (the total quantities generated by enterprises within 15 minutes of the site).

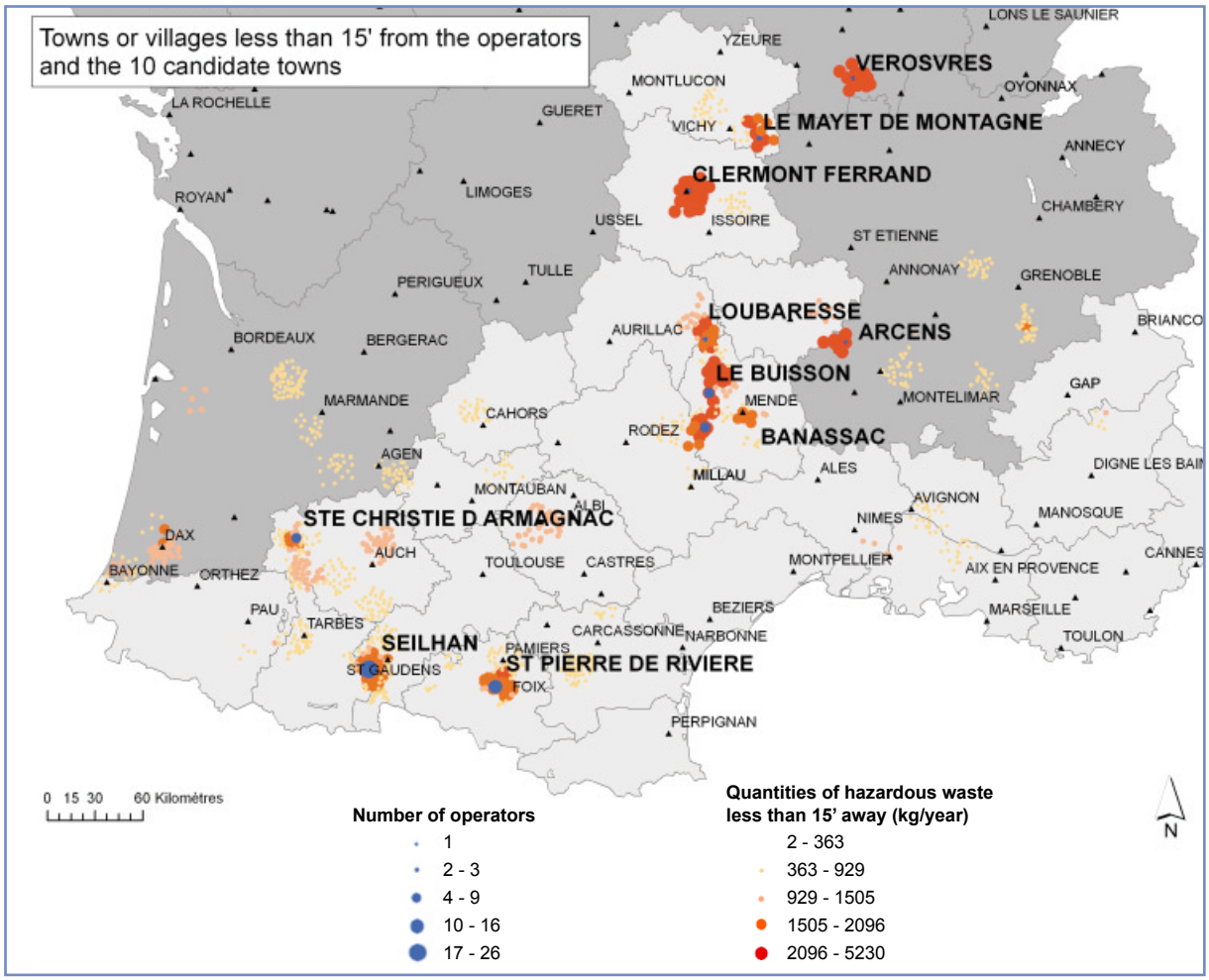
It was then possible to choose the sites for which the largest quantities of wastes and the largest number of operators were concerned.

The commune of Banassac in the Lozère department was chosen in the example (see beside). It serves 10 operators and concerns more than 2 tonnes of hazardous waste annually.

In the same way, for the whole of the SEBSO compagny, ten sites (candidate towns) were chosen (see below).



Site ranking.



Potential sites for the installation of waste collection points. Priority is given to the sites that concern the largest number of operators.

Methodological perspectives to complete the approach

The choise of the ten sites in the SEBSO operating zone was done on an *a priori* basis with arbitrary identification of a number of large groups of operators.

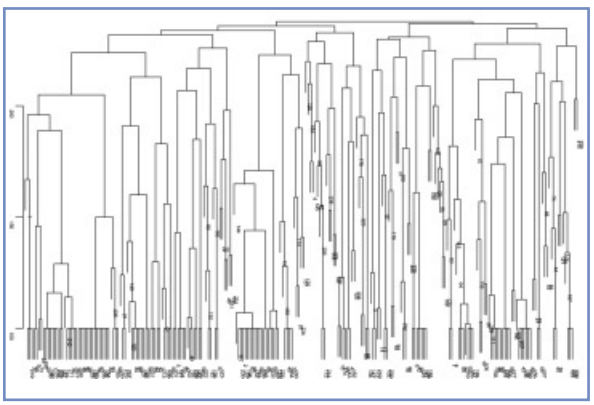
A more detailed approach could have led to make distinctions between subgroups and choose other sites for collection points. It is therefore interesting to see how the choice of these groups could be formalised.

■ A statistical grouping method

We sought to assemble groups of operators. The first stage was proximity analysis. This method aims at two-dimensional projection of the data in a distance matrix. The distances used are the real journey times (allowing for the different types of road) between each operator. They are computed using the ArcGIS® software Network Analyst module. Operators are thus repositioned in relation to each other according to their operational proximity.

It is then possible to use this preliminary proximity analysis to apply automatic classification methods for an objective assembly of groups.

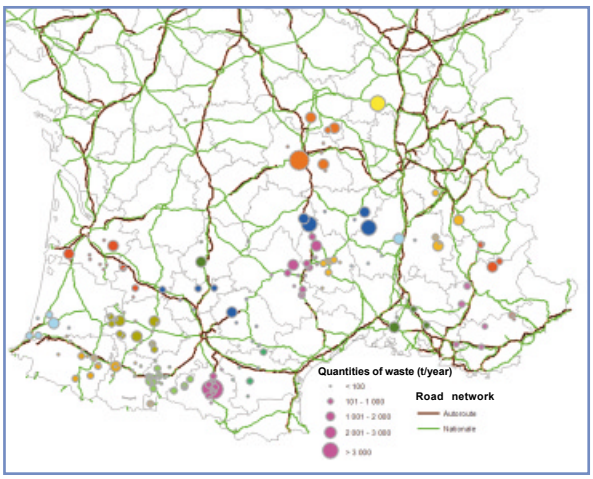
Among hierarchical ascendant classification techniques, the ward's method is robust and can be used to construct compact spherical clusters suitable for spatial analysis. It was applied to the set of data on SEBSO's employees and subcontractors (see below).



Dendrogram resulting from Ward's classification.

■ Used in a GIS

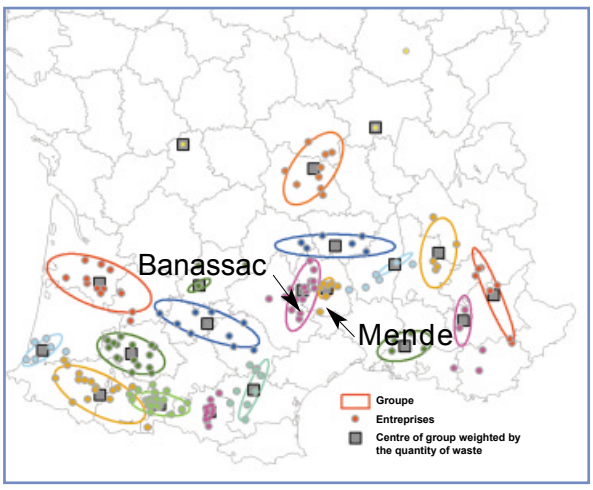
As an example, it was chosen to limit the classification process to 20 groups containing all the operators. The result can be shown in map form by combining the group data and the GIS database.



Geographic representation of the statistical classification.

The grouping conserves a degree of geographic proximity, combined with centring on road routes.

It is then possible to compute a centre of gravity for each group, allowing for quantities of wastes, or to identify the communes that are closest to this.



Representation of the centre of groups, with quantity weighting.

Banassac appeared once again for the group of operators astride the boundary between the Lozère and Aveyron departments. However, another group can be seen around Mende.

CONCLUSIONS AND PROSPECTS

■ Operational application

The methodology developed can be used to go as far as the identification of the collection points (town or village) that best respond to waste management requirements. In a more general manner, it can be used to locate the zones in which a collection solution would be welcomed, given the number of operators in the area and the quantities of wastes generated.

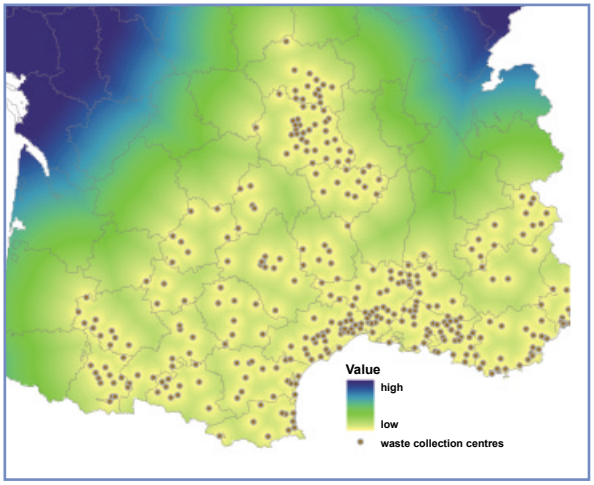
In the example proposed, the map enables SEBSO to perform the rational siting of waste collection sites for its employees and subcontractors.

Three sites (the SEBSO garage in St Gaudens, the SEBSO site in Langeac and the private d'Escrienne garage in Millau) cover the Seilhan and Massif Central zones (see map on page 4). Solutions remain to be found in priority for the Gers (Ste Christie d'Armagnac) and Ariège (St Pierre de Rivière) zones.

■ Methodological prospects

The statistical classification method is a complementary facility as it is a way of better rationalising the forming of groups. It can be applied to operators, as shown above. It could also be considered for application to candidate communes located less than 15 minutes from operators. Here, the aim would be to optimise the choice of collection points according to their number.

Different methodology based on raster technology (representation in image form) would give interesting results. The various constraints to be taken into account are represented as images. It is then possible to combine all the layers in order to generate a single one. Each pixel in the resulting layer has the weighted average value of the preceding layers. The opportuneness of setting up a waste collection unit increases with pixel value.



Raster representation of distances to existing collection sites. Remote zones (green to blue) are shown for which it would be suitable to install a collection facility.

For further information

GEDEON Project site
www.afocel.fr/gedeon/index.htm

PIMOR Y. (2003)
Logistique - Techniques et mise en œuvre ;
Ed. Dunod, 716 p.

With our thanks to TEMBEC SEBSO for providing information

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ISSN : 0336-0261