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GEDEON
Management of forest logging wastes

Types and quantities of wastes generated by logging activities

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Contents

1 List of wastes

"A waste is […] any residue of a production, transformation or use process, any substance, material, product or more generally any movable good that is discarded or that its holder intends to discard." (Art. L.541-1 of the French *Code de l'environnement*).

This definition implies that everything related to the use of equipment (metal, used tyres, etc.) should be considered as wastes, but that the organic wastes produced during logging (crowns, bark, etc.) are also in this category. These wastes are traditionally left on the ground. They could be used for energy production but are also of ecological importance for the return of minerals to the soil.

The GEDEON project addresses non-plant wastes only.

An exhaustive list of all the wastes generated by forest logging activities has been drawn up, making us of the experience of several specialised garages and field operators **(Annex 1)**.

The wastes recorded are grouped in the main categories used by collection businesses (distinction between two categories is based on the opportunity for sorting before collection).

Hazardous wastes
Aerosols
Electrical parts / electronic components (WEEE)
Soiled packaging
Used oil
Miscellaneous fluids
Soiled items
Batteries and accumulators
Solvents/detergents
Miscellaneous hazardous wastes
Non-hazardous wastes
Unsoiled packaging
Waste metal
Used tyres
Glass
Miscellaneous non-hazardous wastes

The main categories of wastes generated by logging work.
End-of-life vehicles are not included

Some wastes result from the use and maintenance of specialised machines such as harvesters, forwarders and skidders. These wastes are used oil, miscellaneous fluids, solvents and detergents, soiled packaging and equipment, used tyres and scrap metal.

To these are added the wastes produced by woodcutters. These generally consist of metals (chainsaw guide bars and chains).

In parallel, much waste is related to conventional business activity. These are WEEE (waste electrical and electronic equipment), batteries and miscellaneous packaging.

One of the features of forests is the extensive use of aerosol paint sprays in cans for marking felling areas and timber.

2 Estimate of the quantities in France

2.1 Methodology

2.1.1 Gathering data from a sample of businesses

We used the practical experience of businesses and forestry operators to evaluate the quantities of wastes generated in forest logging. A sample of businesses was formed in several regions of France throughout the study zone.

A questionnaire was sent out by post. This was based on the list of wastes that we had drawn up by activity: manual tree felling, mechanised felling, hauling using a forwarder or a skidder, and a general category for wastes not related to a particular activity. The businesses questioned were to estimate the annual quantity of each type of waste and also the frequency of waste production. Several questions also concerned the fleet of machines, the number of employees and the fate of the wastes. Reminders by telephone and visits to businesses were useful for obtaining missing data and made it possible to explain certain replies.

The businesses interviewed in the Lorraine region were mainly one-man logging operations sometimes with several activities such as manual cutting and extraction of their own production. Some also use modified agricultural tractors, with a small number of hours of use in forests. In the south and south-west zone, the businesses interviewed tended to possess a fleet of several forestry machines.

Our basis for calculation therefore consisted of:

- **30 businesses**: 21 forestry work businesses, 8 forestry operators and 1 forestry school.

- **76 forestry machines**: 27 harvesting machines, 25 forwarders, 16 skidders and 8 agricultural tractors operating in forests.

- **50 woodcutters**

The questionnaire data were subsequently validated and completed by a bibliographical study based on AFOCEL forestry operation manuals and machine manufacturers' recommendations (service frequency, etc.).

2.1.2 Extrapolation to the whole of France

Calculation assumptions

Analysis of the questionnaire gave average quantities of wastes per woodcutter and by type of machine. Extrapolation of these data to the whole of France was performed using information provided by the Caisse Centrale de la Mutualité Sociale Agricole and data from the agriculture Ministry recording the number of workers and businesses operating in forest logging.

AFOCEL regularly monitors the fleet of forestry machines[1].

The basis for calculation used (data for early 2004) is as follows:

- **4,630 forestry operators**: some of these purchasers of cutting areas only operate as timber traders, working as clients who subcontract exploitation to others.

- **9,900 forestry works businesses:** these perform exploitation for a forestry operator or a sawmill.

- **9,000 woodcutters**: France has 11,000 woodcutters but some are 'pluriactive'. Calculation based on average annual production of 3,200 m^3 per cutter and a hand-cut harvest of 29 million m^3 gives the equivalent of 9,000 full-time woodcutters.

- **3,520 forestry machines**: 540 harvesting machines
  1,230 forwarders
  1,400 skidders
  350 agricultural tractors used in forests

9,000 woodcutters

540 harvesting machines

1,230 forwarders

1,400 skidders

[1] Laurier J.P., 2005. *Bûcheronnage mécanisé en France: enjeux et perspectives à l'horizon 2010*. Ed. AFOCEL, 12 pp.

2.2 Results

Analysis of the questionnaires gives the quantity of each waste in the most easily quantifiable units. For example, in litres for oil, cans for aerosol paints and kg for mechanical parts and metals.

The last column gives an estimate of the weight of each waste in tonnes per year (the coefficients used are shown in **Annex 2**).

The quantities of some wastes are so small (at the scale of a small business) that they cannot be quantified.

This is the case of:

- pots of paint/remnants of paint
- used button cells
- out-of-date fire extinguishers
- palettes
- glass

Other wastes—sometimes in large quantities—are very difficult to quantify as they are produced on specific occasions, in the case of breakdown and exceptional repairs, the replacement of large apparatus, etc.

This concerns:

- electrical and electronic parts (WEEE)
- cleaning fluids for washing units
- solvents/detergents
- business office furniture
- miscellaneous plastics
- end-of-life plant

'Non-significant' and 'non-measurable' categories were used in the next calculations. Only the most frequent, easily quantifiable wastes were used as the basis for our estimates.

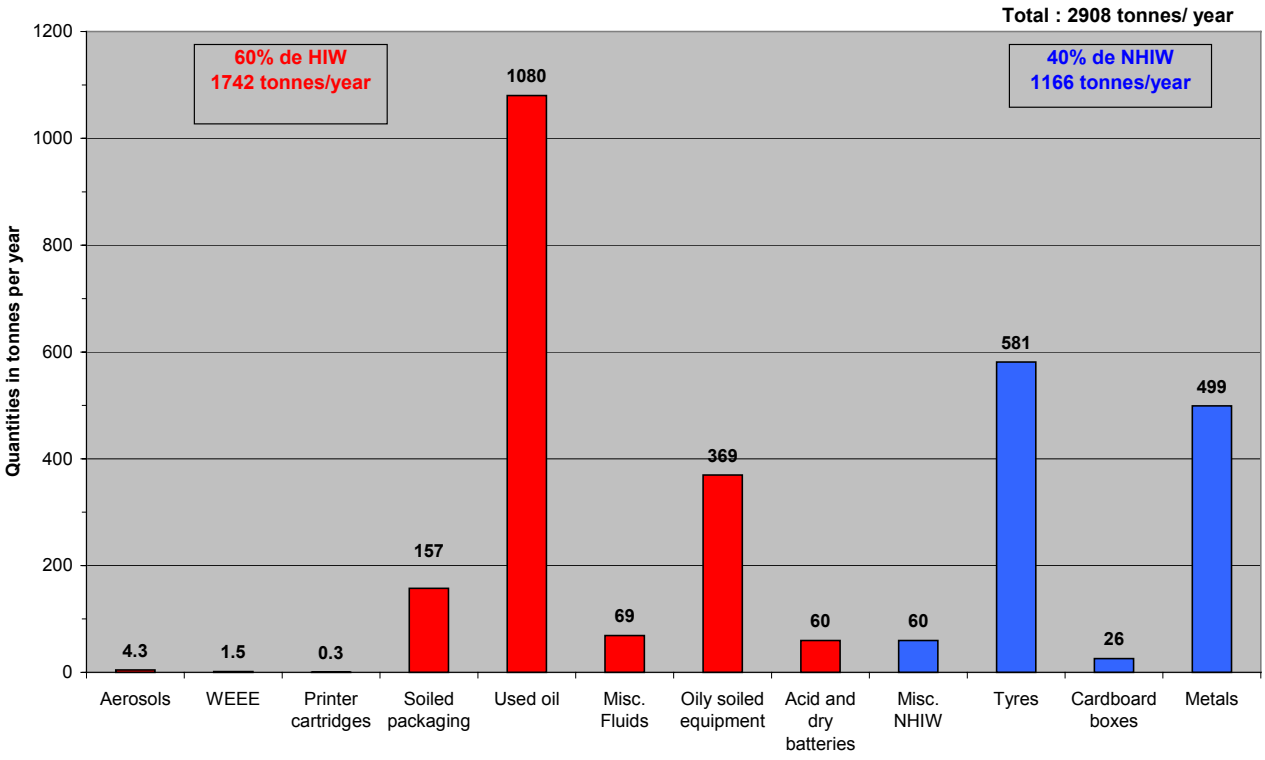
A synthesis in table form is provided in **Annex 3**: annual estimate of the quantities of wastes produced by logging activities in the initial unit of measurement (Table 1) and then converted into tonnes (Table 2).

2.2.1 Analysis by type of waste

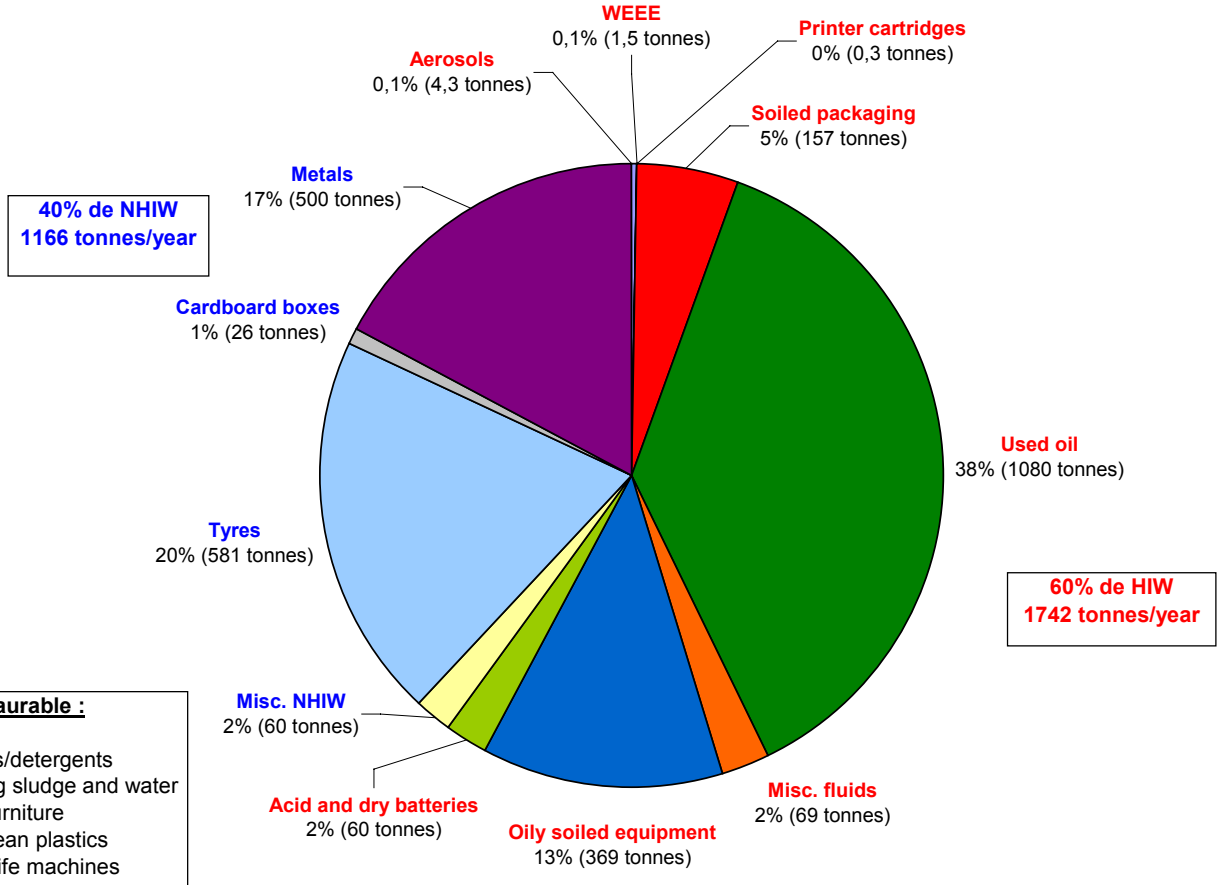
Forest logging generates nearly 3,000 tonnes of wastes per year in France. Of this, 60% (1,750 tonnes) is hazardous industrial waste (dangerous for man or the environment). Disposal of these wastes is by specialised channels.

It was not possible to estimate some categories for lack of easily measurable data from businesses, but these consist mainly of non-hazardous industrial wastes (clean plastics, office furniture, end-of-life plant, etc.).

BREAKDOWN OF THE TYPES OF WASTE PRODUCED ANNUALLY IN LOGGING IN FRANCE



BREAKDOWN OF THE TYPES OF WASTE PRODUCED ANNUALLY IN LOGGING IN FRANCE



Not meaurable :

Solvents/detergents
Washing sludge and water
Office furniture
Misc. clean plastics
End-of-life machines

Used oil was found to be the main category of waste in logging activities, with 1,100 tonnes generated per year, that is to say 37% of all wastes.

The three other main categories of wastes are tyres (580 tonnes), scrap metal (500 tonnes) and soiled equipment (370 tonnes of hoses, oily rags, etc.). These four categories of wastes alone form 85 to 90% by weight of all the wastes generated by logging activities.

Although the sector produces a large number of different wastes, most consist of three or four categories.

2.2.2 Observations concerning the main types of wastes

Used oil

- Engine, differential and gearbox oils

Oil changes are often performed on-site at regular intervals but these vary considerably—from 150 to 500 hours of use—according to the machine. There is a general trend for longer intervals between engine oil changes, so the quantities of this waste should decrease in the future. It is estimated that 190 litres per year is recovered from a harvester, 150 litres from a forwarder and 140 litres from a skidder.

- Used hydraulic oil

Here, distinction should be made between oil consumption and recovery as waste. Indeed, harvesters and forwarders use large amounts of oil—estimated at about 600 litres (and sometimes more than 1000 litres) for a harvester and about 350 litres for a forwarder. But much less oil is actually recovered as breakdowns and site problems lead to losses of oil that cannot be recovered. Furthermore, the annual oil change recommended by manufacturers is not always performed as some machine operators consider that breakdown oil losses over the year are enough to make do without an oil change. Oil consumption is then just a complement to maintain the level in the circuit. It can be estimated that hydraulic oil recovery totals about 350 litres from a harvester, 200 litres from a forwarder and 70 litres from a skidder.

- Chain oil:

This concerns wood cutters and harvesters. Annual consumption is substantial at an estimated 10 million litres of chain oil in France[2]. However, this is non-recoverable waste as it is spread over the whole cutting area during felling work. This oil is not taken into account in this study.

A well-organised used oil collection sector now exists in France.

[2] Nguyen Thé N., 2001. *Utilisation des huiles biodégradables en exploitation forestière*. AFOCEL FIF 624, 6 pp.

Tyres

Tyres are infrequent waste but the unit weight of tyres (about 120 kg according to tyre size) makes them an important category in waste management, with 500 to 600 tonnes per year.

Considerable differences are observed according to the type of machine:

- harvesters: tyres are a practically non-existent waste as their lifetime is often similar to that of the machines. Wear is much smaller than those of other types of plant (less movement, no loads carried, etc.). It is estimated that tyres should be replaced approximately every 5,000 hours of machine operation (6 x 6 or 8 x 8).
- forwarders: used tyres are a slightly more common waste as businesses may own old machines. Tyre change is scheduled every 4,000 h for a 6 x 6 or 8 x 8 and every 3,000 h for a 4 x 4. Our survey leads to estimating about 1.5 used tyres per forwarder per year.
- skidders: tyre change is scheduled every 3,000 hours and consumption is estimated to be about 2 tyres per skidder per year.

Tyres and inner tubes are theoretically taken back by distributors free of charge.

Metals

- Chainsaw guide bars

This concerns manual and mechanised tree cutting. Consumption of guide bars is very variable in manual tree cutting. A cutter may use from 1 to 10 per year, depending on the work he does and the type of guide used. Some cutters use guides with sprocket noses; this lengthens the lifetime of the bar and only the sprocket is changed when it is worn or broken. According to our survey, a woodcutter uses an average of 5 guide bars per year. Differences are much smaller in mechanised felling; a harvesting machine uses an average of 14 guides per year.

- Chainsaw chains

Consumption also varies considerably according to the woodcutter's work, with an average of 22 chains per year, making a ratio of 1 guide to 4 chains. A harvester uses about 40 chains per year, giving a ratio of 1 guide to 3 chains.

- Other waste metal

Several origins of wastes are found under this heading in addition to chainsaw chains and guides. It is very difficult to estimate the quantities as some result from mechanical failures. These wastes are thus not generated with a particular frequency. Some mechanical failures may result in a considerable weight of ferrous waste. The quantity of wastes is also related to the age of the machine. Indeed, numerous parts (jacks, etc.) must be replaced when the machine has reached a certain age (about 3 years for harvesters and forwarders). Some of these wastes also consist of skidder cables, slings and chains, with an estimated total of more than 100 kg per skidder per year. In this category, the wastes generated by woodcutters consist of old files, small tools and the replacement of small chainsaw parts and also old chainsaws kept for spare parts and that then become waste.

Soiled materials

- Hydraulic hoses

These are from harvesters, forwarders and to a lesser extent from skidders. A hydraulic hose requiring replacement is a common occurrence on forest sites. The presence of hydraulic oil in hoses makes them dangerous waste. Sizes (length and diameter) vary considerably according to the position of the hose in the machine, but the felling head and grapple hoses are the most exposed and those that require replacement most frequently. A 1 m long felling head hose weighs about 3 kg. It is estimated that consumption is some 60 hoses per year for a harvester, 25 per year for a forwarder and fewer than 1 per year for a skidder.

- Grease cartridges

All forest machines have numerous lubrication points. Some, like the felling head and the forwarder grapple, must be greased daily. Consumption of grease cartridges is thus substantial in forest logging and although empty cartridges are light (about 30 grams) they form dangerous waste. It is estimated that a harvester requires about 150 grease cartridges per year, a forwarder 85 and a skidder 40.

- Oily rags

This mainly refers to rolls of cellulose used for wiping or cleaning oily parts. Burning is forbidden as they are dangerous wastes. It is difficult to assess the quantity used and we refer to the number of rolls per year. However, some operators prefer rags and it is impossible to estimate the quantity of these.

Consumption is on the scale of 22,000 rolls of cellulose, that is to say the equivalent of about 70 tonnes per year for forest exploitation as a whole.

- Oil and gas oil filters

Machine circuits have several filters of various sizes (ranging from a few cm to 70 cm) and are generally replaced at each oil change. Consumption (waste in this case) is estimated to be about 15 filters per machine per year, with few differences according to the type of machine.

Aerosol spray cans

This mainly concerns paint sprays for marking purposes. They are used for marking the boundaries of stands, the trees to be felled and for log cuts. This category also includes penetrating oils and lubricants but whose quantities are almost negligible in comparison with cans of spray paint.

All field crews use them, but the largest consumers are woodcutters and harvester operators.

We estimate that some 30,000 aerosol spray cans are used annually for logging activities, that is to say the equivalent of 4 tonnes of wastes. This estimate does not include other users (various forest organisations, schools, managers, etc.) that also make considerable use of spray paints.

Batteries

The most commonly used batteries are 12V (or possibly several 6V batteries). Batteries are similar to tyres in terms of waste. Recovery channels usually exist and the quantity also varies according to the type of machine. Batteries are generally replaced in harvesters and forwarders every 1.5 years on average, whereas they are changed every year in skidders.

Miscellaneous hazardous and non-hazardous industrial wastes

- Air filters

Air filters are non-hazardous waste because of their composition and the absence of contact with hydrocarbons. They are not replaced automatically at each oil change but usually during major services. It is estimated that a forestry machine uses about 2 air filters per year, with few differences according to the type of machine.

- Cooling liquid

Cooling circuits are rarely emptied; this tends to be done in case of certain failures. Many operators just top up the levels. As for oils, the persons questioned often confused the notions of consumption and recovery. However, the quantity is about 15-20 litres per year, whatever the machine.

Palettes

Palettes are infrequent waste in forest logging. Most deliveries of goods on palettes are to large businesses and garages. As a waste, palettes are often subsequently used for another purpose.

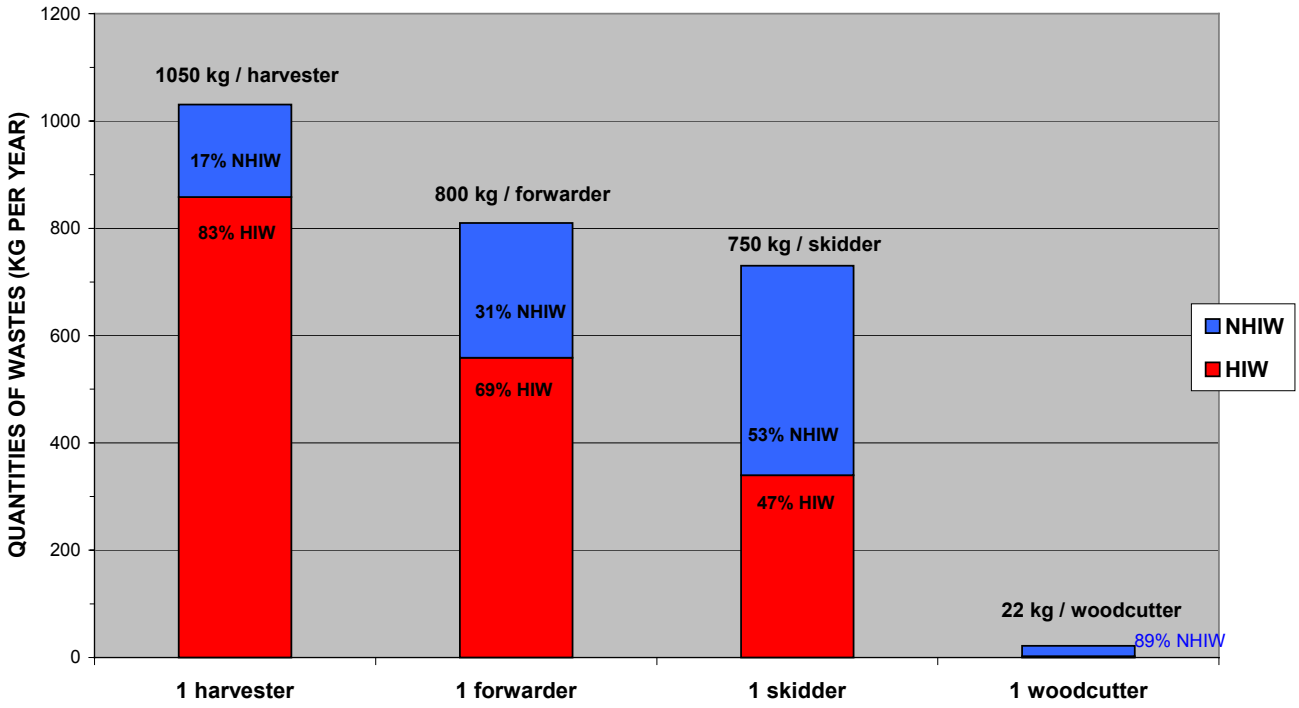
Alkaline batteries, soiled drums with capacity of less than 200 l, paper and cardboard packaging

It is difficult to estimate the quantities of these wastes that are often disposed of by businesses with domestic refuse. The figures observed during our survey are very certainly an underestimation of the quantities actually used in forest logging.

2.2.3 Analysis by type of activity

We addressed the four main types of logging in France: manual woodcutting, mechanised woodcutting, haulage with forwarders and skidders. The other types of haulage (agricultural tractors, cables, masts and cableways, etc.) were not analysed for lack of data.

AVERAGE ANNUAL WASTE PRODUCTION BY ACTIVITY



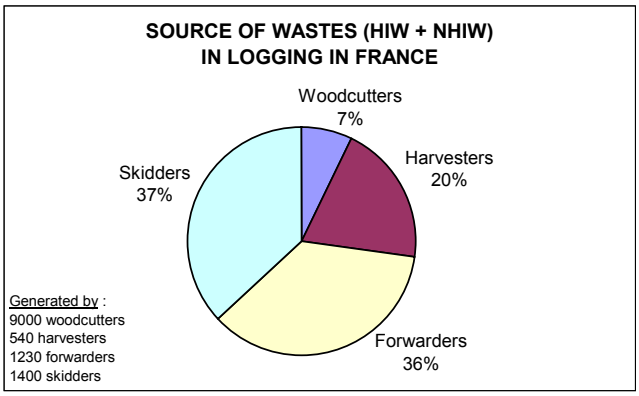
This chart shows the relation between the type of mechanisation and the quantity of wastes generated.

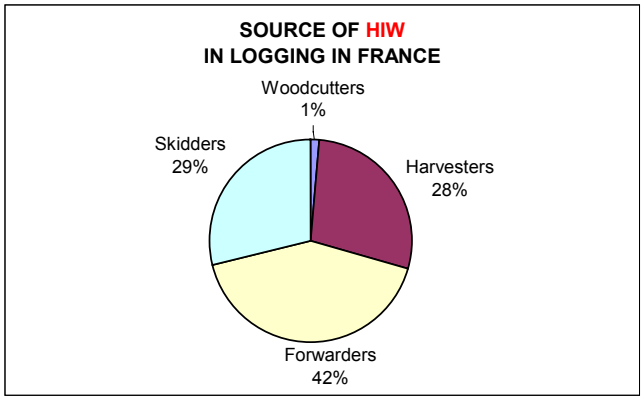
Whereas a woodcutter generates only 22 kg of wastes per year, a harvesting machine produces more than a tonne. However, average production by a harvester is the equivalent of 5.3 woodcutters. So 1 tonne of wastes per harvester per year should be compared to 117 kg in manual woodcutting. Haulage machines produce slightly smaller quantities. The figures for forwarders (800 kg per year) and skidders (750 kg per year) are much the same.

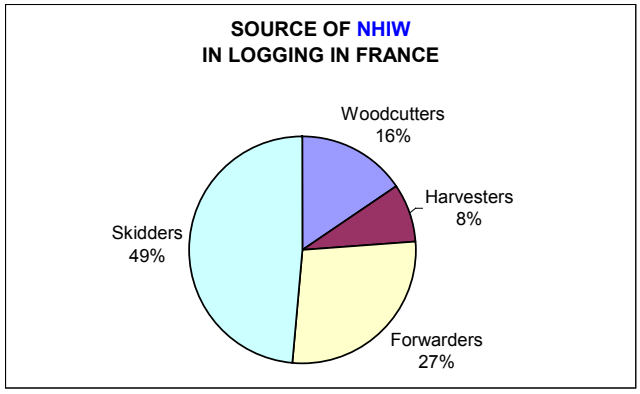
Another effect of the mechanisation of forestry operations is the increase in the proportion of hazardous industrial wastes in wastes as a whole.

They are by far the largest in mechanised felling (over 80%) and haulage using forwarders. The proportions are almost balanced in haulage using skidders as the hydraulic circuits require less oil and a quantity of metal wastes (cables, slings, etc.) specific to this operation. The trend is reversed in manual felling where hazardous wastes form only 10% of the wastes produced, that is to say hardly 2.5 kg per year. The absence of oil changes, hydraulic circuits and tyres is responsible for this very small quantity of wastes. It should nonetheless be remembered that chain oil is not counted as it is dispersed and cannot be recovered;

however, the quantities used annually are enormous with an average of 500 litres per woodcutter and 1000 litres per harvesting machine.







The charts by sector above have been produced by weighting individual quantities with the number of woodcutters (9,000 full-time equivalent) and the fleet of forestry machines in France (3,500 at the beginning of 2004).

A quarter of the wastes are from felling (manual and mechanised) and three-quarters from haulage, shared fairly equally between forwarders and skidders.

The distribution is very different when distinction is made between hazardous (HIW) and non-hazardous wastes (NHIW). Although there are 9,000 woodcutters in France, they produce only 1% of total hazardous wastes. Extraction operations account for nearly 75% of the hazardous industrial wastes generated by logging activities.

When NHIW are analysed alone, manual woodcutting does not produce much in comparison with the fleet of forestry machines. The technologically most advanced machines (harvesters and forwarders) produce small amounts of NHIW. Extraction using skidders (1400 skidders in France today) is the main source of NHIW production, accounting for nearly 50% of the total.

Quantities of wastes produced annually in France

Individually

	1 woodcutter	1 harvester	1 forwarder	1 skidder
HIW	2.5 kg	858 kg	559 kg	340 kg
NHIW	19.5 kg	173 kg	251 kg	391 kg
Total wastes	22 kg	1,031 kg	810 kg	731 kg

The sector as a whole

	Woodcutters	Harvesters	Forwarders	Skidders
HIW	22 tonnes	464 tonnes	688 tonnes	475 tonnes
NHIW	176 tonnes	93 tonnes	309 tonnes	546 tonnes
Total wastes	198 tonnes	557 tonnes	997 tonnes	1,021 tonnes

Used oily hoses draining into a recipient before removal to a collection point. Waste specific to harvesters and forwarders.

2.2.4 Analysis by type of activity and m^3 wood produced

It is also interesting to relate waste production to the volume of wood produced by each forestry activity.

Our figures are based on the following production of wood in the round:

- harvester: 17,000 m^3 per year
- forwarder: 15,000 m^3 per year
- skidder: 10,000 m^3 per year
- woodcutter: 3,000 m^3 per year

Waste production in the logging sector as a whole in France is 2,908 tonnes for production of 43.4 million m^3 of unbarked wood, i.e. 67 g wastes produced per m^3 wood exploited.

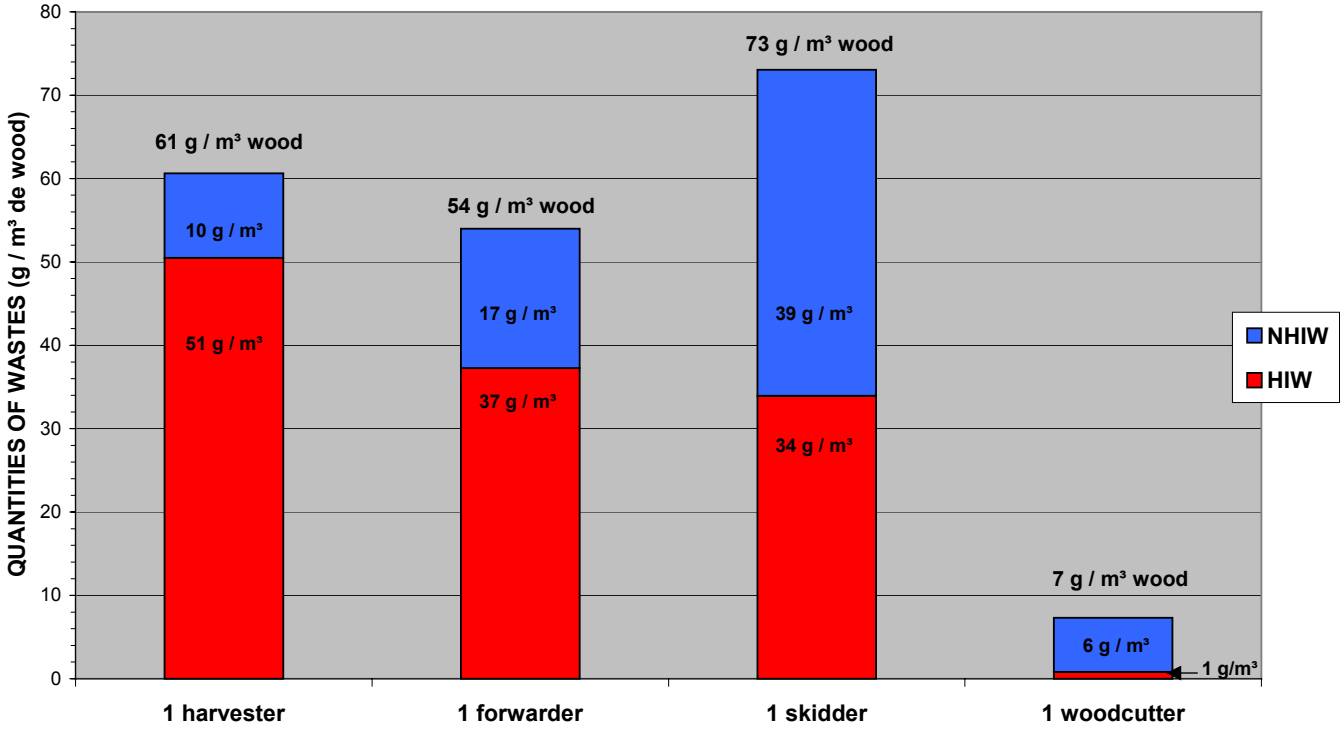
The graph below shows once again that mechanisation generates substantial production of wastes but with a smaller ratio than when operations are considered by activity:

- 1,050 kg wastes per year produced by a harvester and 22 kg by a woodcutter, a ratio of 1:48,
- 61 g wastes per m^3 of wood exploited by a harvester and 7 g when exploited by a woodcutter, a ratio of1:9.

The high productivity of felling machines therefore reduces the difference in waste production in comparison with manual woodcutting.

When waste production is calculated per m^3 of wood, it is seen that haulage with a skidder generates the most waste. Nevertheless, most of the waste is non-hazardous.

AVERAGE WASTE PRODUCTION PER M³ WOOD PRODUCED FOR EACH ACTIVITY

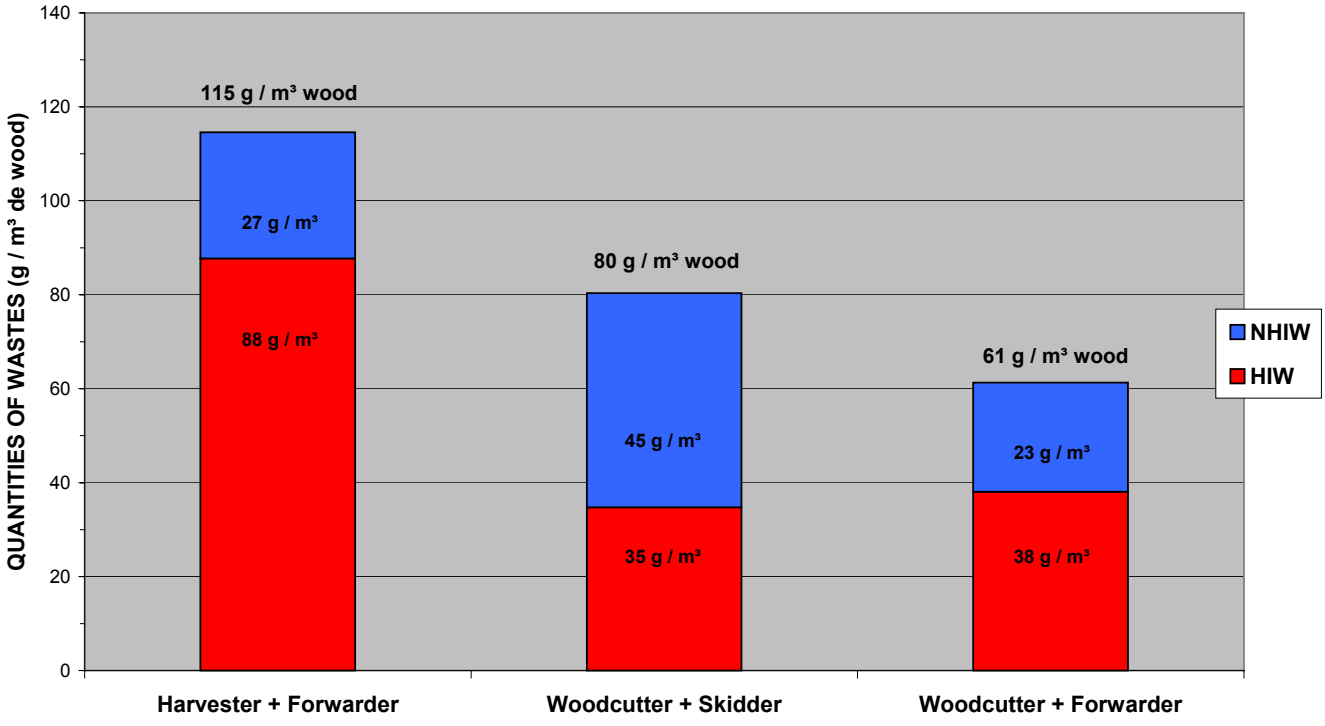


Several activities can then be combined.

Forest logging in France is centred mainly on three exploitation scenarios:

- mechanised felling in short wood with extraction by forwarder,
- manual woodcutting in short wood with extraction by forwarder,
- manual woodcutting in long wood with extraction by skidder.

AVERAGE WASTE PRODUCTION PER M³ WOOD PRODUCED FOR EACH LOGGING SCENARIO



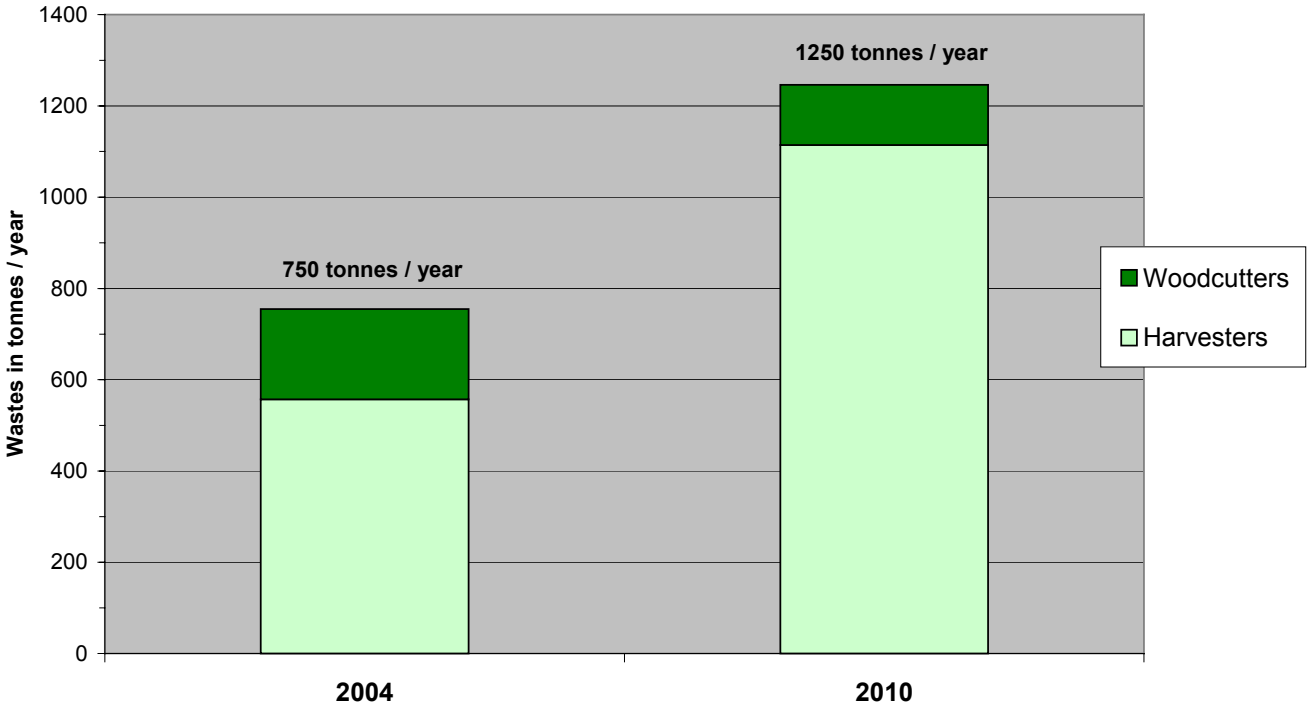
The differences are smaller once again with the 'Harvester + Forwarder' scenario generating only 1.4 times the waste produced by a 'Woodcutter + Skidder' combination and 1.9 times as much as 'Woodcutter + Forwarder'.

2.3 Development prospects in France

Currently, 24% of all harvesting is mechanised (including 44% of conifers). The last study by AFOCEL[3] shows that the harvesting of 67% of conifers and 32% of deciduous trees could be mechanised by 2010, taking mechanisation to 51% overall. For this, 1,100 machines would be operating in France in 2010—twice the present number. The quantity of wastes produced by mechanised woodcutting would therefore increase from 550 tonnes to 1,100 tonnes.

In return, the number of woodcutters will decrease, with 3,000 jobs disappearing between 2004 and 2010. The number of woodcutters should therefore fall from 9,000 to 6,000 in full time equivalent. Waste production would then decrease from 200 to 130 tonnes.

Prospects for future trends in wastes in woodcutting in France



The trend in haulage in recent years has been the exploitation of short wood. The number of skidders has decreased steadily to the benefit of forwarders. This trend should not have a strong impact on the total quantity of wastes produced as forwarders and skidders produce much the same quantity of wastes. However, waste types will be different as the proportion of HIW is larger when forwarders are used rather than skidders.

The total number of haulage machines should not vary much as the harvest is comparatively stable and productivity increases slowly.

[3] Laurier J.P., 2005. *Bûcheronnage mécanisé en France: enjeux et perspectives à l'horizon 2010*. Ed. AFOCEL, 12 pp.

3 Estimate of quantities in the European Union

3.1 Calculation method

Several approaches can be used to estimate the quantities of wastes produced in the European Union countries.

The most accurate method is based on the direct calculation of quantities of wastes by a precise number of each type of machine and the number of woodcutters. Although this data is known for several European countries, it is unfortunately not available for most countries.

Another method is based on extrapolating the quantities of wastes calculated for France for the wood harvest in each country. Here, it is essential to take the degree of mechanisation of harvesting into account, that is to say the share of production cut by harvesters. Indeed, it has been seen that mechanisation generates a much larger quantity of wastes per unit than woodcutters and, above all, a much higher proportion of hazardous wastes. This method is easier to use as the data (wood harvest and proportion of mechanisation) are available for the whole of the European Union. However, it is less accurate because no distinction is made between different types of machines—especially for haulage—when the hypothesis used is that wood extraction methods are the same as in France, which is far from being the case.

We combined the two methods in order to optimise the calculations. The first method was used for the countries for which precise data concerning the fleet of machines and the number of woodcutters are available, that is to say Sweden, Finland, Austria, Czech Republic, Ireland and Spain.

Country	Harvesters	Forwarders	Skidders	Agricultural tractors	Cables	Woodcutters
Finland	1,700	1,500	0	1,000	0	300
Sweden	2,000	2,700	10	0	0	250
Austria	150	150	200	600	300	4,000
France	540	1230	1,400	350	18	9,000
Czech Rep.	60	130	1,000	800	110	5,000
Ireland	164	144	50	0	6	40
Spain	300	275	500	750	7	3,500

The French coefficients by type of machine were applied to these countries:

- harvester: 178 kg non-hazardous waste and 872 kg hazardous waste per year,
- forwarder: 248 kg non-hazardous waste and 552 kg hazardous waste per year,
- skidder: 397 kg non-hazardous waste and 353 kg hazardous waste per year,
- agricultural tractor: 82 kg non-hazardous waste and 229 kg hazardous waste per year,
- woodcutter: 20 kg non-hazardous waste and 2 kg hazardous waste per year,
- extraction by cable: no data (the 600-700 cables in Europe were not included in the estimate).

Scandinavia was handled a little differently as the number of hours of use of machines is on average 33% greater than in France as machines are used for two and even three shifts. The quantities of wastes generated by harvesters and forwarders have therefore been suitably weighted.

The second method was applied to the other countries using FAO harvest data[4] and the results of a Finnish study on the degree of mechanisation[5] (Annex 4). The degree of mechanisation makes it possible to calculate the proportions of the total harvest performed by harvesters or by woodcutters.

Next, we applied the French exploitation scenario coefficients:

- harvester + forwarder: 27 g non-hazardous wastes per m^3 and 88 g hazardous wastes per m^3
- woodcutter + forwarder, skidder or tractor: 23 g non-hazardous wastes per m^3 and 35 g hazardous wastes per m^3.

[4] FAO, 2005. *State of the World's Forests 2005* (2004 harvest data)
[5] Karjalainen, Asikainen, Llavsky, Zamboni, Hotari, Roser, 2004. *Estimation of energy wood potential in Europe*. Finnish Forest Research Institute 43 pp.

3.2 Distinction between groups of countries

Some countries have similarities in the forestry sector with regard to forest stands, exploitation conditions, exploitation methods or degrees of mechanisation. It is therefore interesting to assemble them in different groups.

Distinction is made between 6 groups of countries for the European Union as a whole:

Scandinavia	
Estonia	High proportion of forest cover
Finland	High rate of mechanisation
Sweden	Resource consisting mainly of conifers
Central and western Europe	
Germany	Medium degree of forest cover
Austria	Mechanisation developed in easily exploitable conifer zones
Belgium / Luxembourg	Numerous types of forests and very variable exploitation conditions
France	
Czech Republic	
Slovenia	
North-west Europe	
Denmark	Low degree of forest cover
Ireland	Fairly highly developed mechanisation
The Netherlands	Above all forests of conifers for production or recreation purposes
The United Kingdom	
Eastern Europe	
Hungary	Medium degree of forest cover
Latvia	Exploitation still very traditional, mechanisation in progress
Lithuania	Numerous types of forest and very variable exploitation conditions
Poland	
Slovakia	
Iberian peninsula	Medium to high degree of forest cover (NW of peninsula)
Spain	Mechanisation developed above all in the NW production zones
Portugal	Eucalyptus and Maritime Pine form the main forest production resource
	A large, low production, little-exploited Mediterranean zone
Southern Europe	
Cyprus	Medium to low degree of forest cover
Greece	Low level of mechanisation or none at all
Italy	Frequently little-productive forests in Mediterranean zones
Malta	with difficult exploitation conditions

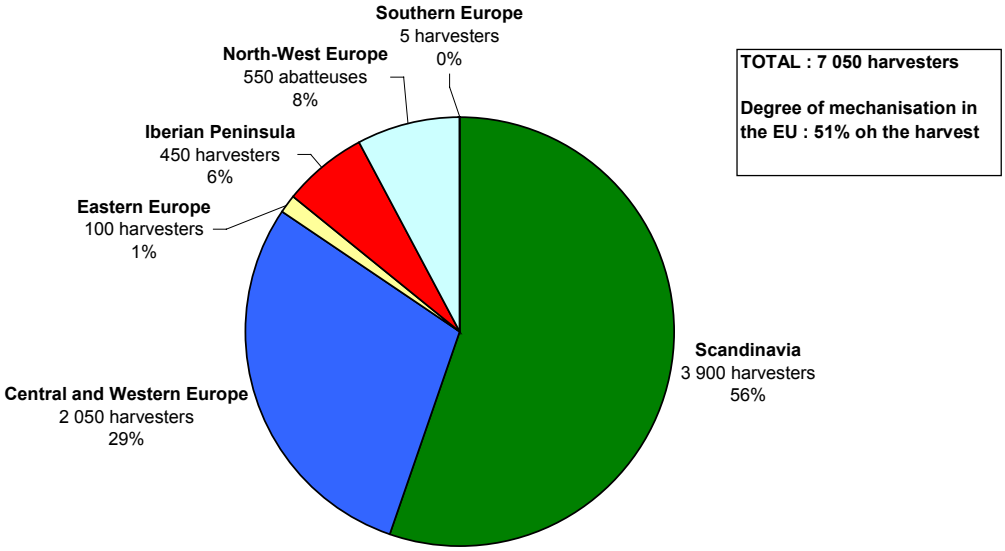
The two graphs below show the present situation in the European Union as regards the development of mechanisation, the main factor in waste production in forest logging.

Scandinavia has reached the maximum stage in the mechanisation of its wood harvest and has more than half of the harvesters in Europe and only 3% of the total number of woodcutters.

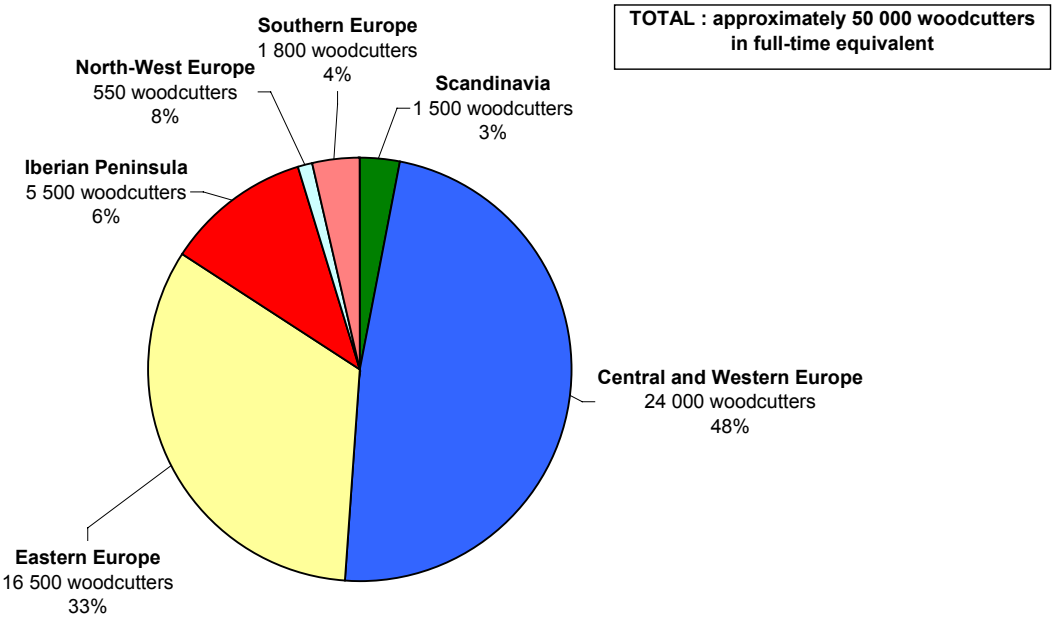
In contrast, the Eastern Europe group is only at the beginning of harvest mechanisation. About 100 harvesters are operated there (1% of the European fleet) and manual woodcutting is still the main activity.

The situation is an intermediate one in the Central and Western Europe group of countries where zones that are difficult to exploit (mountains, deciduous trees, etc.) still require large numbers of woodcutters.

DISTRIBUTION OF HARVESTERS IN THE EU



DISTRIBUTION OF WOODCUTTERS IN THE EU
in full-time equivalent



3.3 Estimation of the quantity of wastes

The results of the calculations are shown in the table below.

Forest logging in the 25 EU countries probably results in the production of some 26,000 tonnes per year. However, it is more prudent to consider a range of **25,000-30,000 tonnes of waste per year.** This includes 70% considered as hazardous in the European nomenclature.

Estimate of the quantities of wastes produced in Europe (tonnes per year)
Mixed estimate based on the fleet of machines (*) or the degree of mechanisation

Groups of countries	Country	Non-hazardous wastes	Hazardous wastes	Total
Scandinavia	Estonia	242	616	858
	Finland*	981	3,303	4,283
	Sweden*	1,368	4,306	5,674
	Total	**2,591**	**8,224**	**10,815**
Central and western Europe	Germany	1,025	2,195	3,219
	Austria*	273	430	702
	Belgium / Luxembourg	113	331	444
	France*	1,166	1,742	2,908
	Czech Republic*	606	670	1,276
	Slovenia	31	54	84
	Total	**3,212**	**5,421**	**8,633**
North-west Europe	Denmark	23	54	77
	Ireland*	66	223	288
	Netherlands	17	33	50
	United Kingdom	210	652	862
	Total	**315**	**962**	**1,277**
Eastern Europe	Hungary	90	157	246
	Latvia	318	490	808
	Lithuania	122	175	297
	Poland	642	948	1,590
	Slovakia	140	204	344
	Total	**1,312**	**1,973**	**3,285**
Iberian peninsula	Spain*	452	769	1,220
	Portugal	218	446	663
	Total	**669**	**1,214**	**1,884**
Southern Europe	Cyprus	0	0	0
	Greece	14	20	34
	Italy	83	123	206
	Malta	0	0	0
	Total	**97**	**143**	**239**
TOTAL	**EU-25**	**8,195**	**17,937**	**26,132**

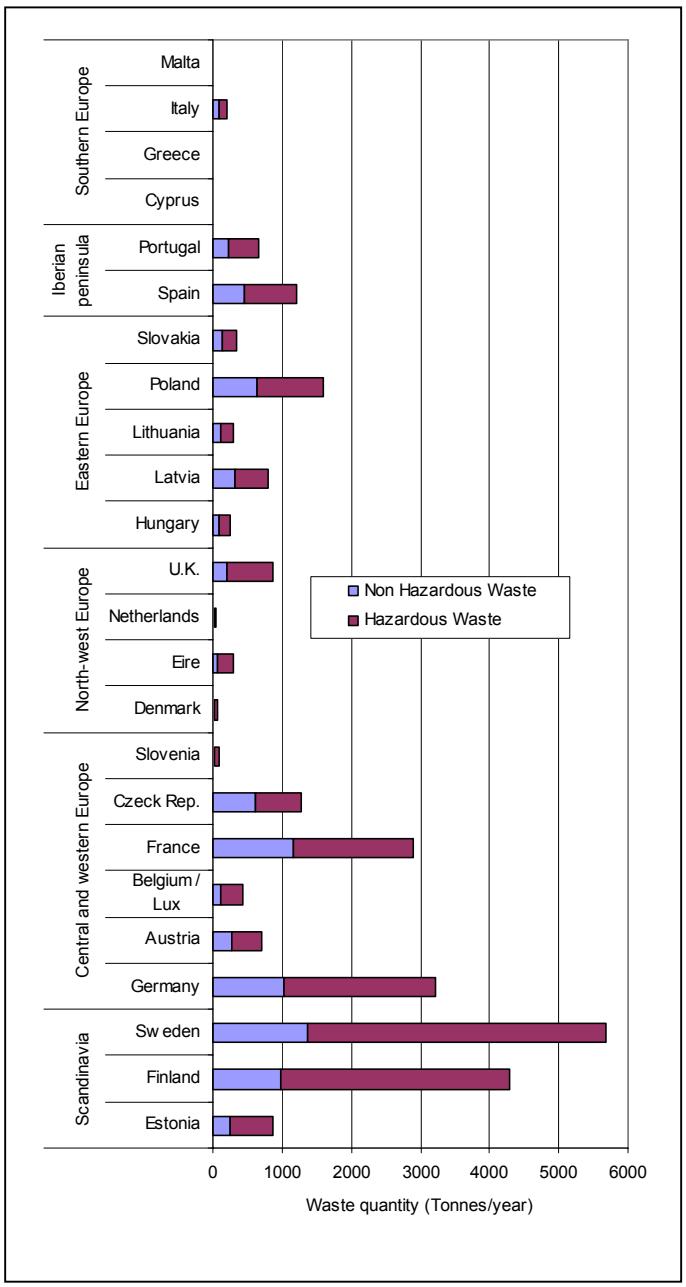
The European average is slightly over 1,000 tonnes per country per year but with marked differences between countries.

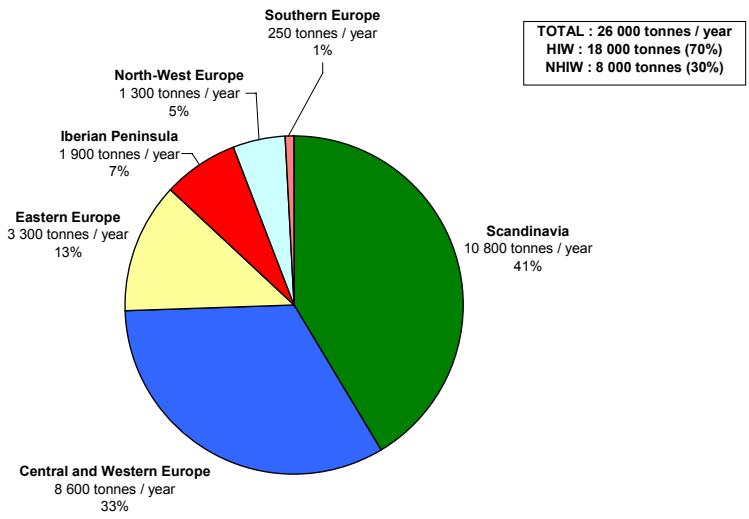
Four countries produce two-thirds of the wastes: Sweden, Finland, Germany and France. They are also the four leading wood producer countries in Europe.

Sweden and Finland generate 38% of the wastes. The two countries have large harvest (35% of the European total) and operations are almost entirely mechanised (> 95%), with high rates of use of machines. A high proportion of wastes (over 75%) is in the hazardous category.

Germany and France are respectively the third and fourth European wood producers but have a much smaller degree of mechanisation (35% and 25% respectively) and hence produce a smaller proportion of hazardous wastes (60%). Three countries produce more than 3,000 tonnes of wastes per year (Sweden 5,700 tonnes, Finland 4,300 tonnes and Germany 3,200 tonnes). Six countries produce less than 100 tonnes of waste per year (Slovenia, Denmark, the Netherlands, Greece, Cyprus and Malta).

Conversely, the East European group of countries, where harvesting is still mainly manual, accounts for 17% of European round wood production but generates only 13% of total wastes (3,300 tonnes per year, of which 60% is hazardous) because of the small degree of harvest mechanisation.





The quantities of wastes generated annually in the 6 main groups of countries

The quantitites of wastes generated annually in the 25 EU countries

4 Conclusion

Like any other sector of activity, Forest logging generates wastes. The quantity is estimated to be about 3,000 tonnes per year in France, of which 60% is considered hazardous according to European nomenclature. Hazardous wastes consist mainly of used oil, packaging and items soiled by oil or grease and aerosol spray paint cans. At the European level, the estimate is some 30,000 tonnes per year, of which 70% consists of hazardous wastes, but with marked differences between countries (from less than 100 tonnes per year in certain countries to 5,000 tonnes per year in Sweden).

Hazardous wastes are generated mainly by forestry machines. The degree of forest mechanisation—that is to say the proportion of harvesting performed using harvesters—greatly affects the quantities of wastes produced and the proportions of non-hazardous and hazardous wastes. More generally, distinction is made between countries according to the size of the fleet of machines for harvesting (harvesters) and haulage (forwarders and skidders).

However, mechanisation should not be perceived as being negative. The quantities of wastes produced should first of all be weighted by the much greater productivity of the machines. In addition, France has a fleet of some 550 harvesters whereas there are more than 10,000 woodcutters. Finally, mechanisation also contributes to progress in ergonomic terms because it reduces the arduousness of the work and replaces an increasing shortage of labour.

What are the future trends? The general movement is towards the development of the mechanisation of harvesting operations. This results in an increase in the quantity of wastes, with a greater proportion of hazardous wastes.

This trend should be more significant in the 'Eastern Europe' group of countries. The modernising of exploitation techniques will also lead to changes in wood extraction methods. The use of light forwarders generating more wastes than agricultural tractors should become widespread.

At the European level, there should not be a very significant change in the quantities of wastes produced as the main wood-producing countries (Scandinavia), that are also those producing the largest amounts of wastes, have already reached their maximum degree of mechanisation.

It is interesting to observe the large amount of wastes generated by machines because it makes it easier to define the waste collection and management actions to be implemented. Priority should be awarded to hazardous wastes, and hence to the wastes produced during the maintenance and repair of machines.

5 Annexes

Annex 1. List of the wastes generated by logging activities

Annex 2. Coefficients used for measuring wastes

Annex 3. Table synthesising estimates of wastes generated per year

Annex 4. Forestry in the 25 European Union member states

Annex 1. List of the wastes generated by logging activities

Class	Category	Type of waste	UE nomenclature ref.
Hazardous wastes (HW)	Aerosols	Aerosols (+ misc. penetrating grease, etc.)	14 05 04
	WEEE	Electrical parts / electronic components WEEE	16 02 00
		Discarded office and electronic equipment WEEE	16 02 14, 20 01 35* or 20 01 36
		Harvester and office printer cartridges	08 03 99
	Soiled packaging	200-litre metal or plastic oil drums (clean or dirty oil)	16 05 03
		Metal or plastic oil containers (clean or used oil) smaller than 200 litres	16 05 03
		Discarded paint cans and residual paint	20 01 27
		Antipollution kit (absorbent powder)	15 02 02
	Used oil	Used readily biodegradable oil	13 01 12
		Hydraulic oil	13 01 00
		Engine and gearbox oils	13 02 00
		Sludge from steam cleaning of oil/water separators	13 05 02
	Misc. fluids	Brake fluid	16 01 13
		Engine cooling fluid	16 01 14
		Oily water from washing unit	13 05 07
	Soiled items	Grease cartridges	15 01 10
		Oily, absorbent cloths	15 02 02
		Used oil and gas oil filters	16 01 07
		Soiled greasy hoses	16 01 99
	Batteries and accumulators	Batteries and accumulators	16 06 05
		Used lead starter batteries	16 06 01
		Used alkaline batteries	16 06 04
		Used button cells	16 06 03
	Solvents/ detergents	'Axis DP' detergent	16 10 02
		Miscellaneous solvents (household waste)	20 01 13
		Miscellaneous solvents (degreasing machine, etc.)	14 06 03
Non-hazardous wastes (NHW)	Miscellaneous	PPE accessories (helmet, mask, ear defenders)	20 01 39
		Discarded fire extinguishers	16 05 05
		Air filters	16 01 99
		Office furniture	20 03 07
		Composite parts : gaskets and belts	16 01 99
		Miscellaneous plastic (bumpers, casings, etc.)	16 01 19
		Office waste bin	20 03 01
		Clothes, shoes, safety trousers, etc.	20 03 07
	Packaging	Wooden packaging, palettes	15 01 03
		Paper and cardboard packaging	15 01 01
		Clean plastic and polystyrene packaging	15 01 02
	Waste metal	Cables	02 01 10
		Old plant (end-of-life vehicle)	16 01 04
		Chainsaw chains	02 01 10
		Grapple	02 01 10
		Chainsaw guide bar	02 01 10
		Mechanical parts / waste metals from workshop	02 01 10
		Exhaust pipe	02 01 10
	Tyres	Used tyres and inner tubes	16 01 03
	Glass	Glass	16 01 20

Annex 2. Coefficients used for measuring wastes

Category	Type of waste	Unit of measurement	Coefficient in kg
Hazardous industrial wastes (HIW)			
Aerosols	Aerosols (+ misc. penetrating grease, etc.)	Unit	150 g/empty paint can (450 g full)
WEEE	Electrical parts / electronic components	Kg	-
Miscellaneous	Harvester and office printer cartridges	Unit	70 g/inkjet cartridge
Soiled packaging	200 l metal oil drums	Unit	20 kg/empty 200 l drum
	Plastic oil drums smaller than 200 l	Unit	200 g/ 2 l can (chainsaw mixture), 300 g/ 5 l can, 1kg/ 20 l can, 1.2kg/ 30 l can
Used oil	Hydraulic oil	Litre	1 kg/litre
	Engine and gearbox oils	Litre	1 kg/litre
Misc. fluids	Engine cooling fluid	Litre	1 kg/litre
Soiled items	Grease cartridges	Unit	30 g/empty cartridge
	Oily, absorbent cloths	Roll of cellulose	3 kg/roll
	Used oil and gas oil filters	Unit	2 kg/filter
	Soiled greasy hoses	Unit	3 kg/ 1m felling head hose
Batteries and accumulators	Used lead cell starter batteries	Unit	22 kg/battery
	Used alkaline batteries	Unit	3.3 g/battery
Non-hazardous industrial wastes (NHIW)			
Miscellaneous	PPE accessories	Unit	600 g/complete helmet
	Air filters	Unit	2 kg/filter
	Clothes: shoes, safety trousers, etc.	Unit	1.5 kg/shoes; 1.2 kg/safety trousers; 500 g/oilskin
Tyres	Used tyres and inner tubes	Unit	120 kg/tyre (162 kg/new Michelin 600-34 tyre, 116 kg/new Michelin 600-26.5 tyre)
Cleaning packaging	Paper packaging, cardboard boxes	Unit	very variable, estim. average 500 g/box
Waste metal	Cables	Metre	1kg/metre
	Chainsaw chains	Unit	350 g/chainsaw chain 600 g/harvester chain
	Chainsaw guide bars	Unit	1 kg/chainsaw guide bar 3.2 kg/harvester guide bar
	Mechanical parts / workshop waste metals	Kg	-

Annex 3.

ESTIMATE OF WASTES PRODUCED ANNUALLY BY FOREST EXPLOITATION IN France

PER UNIT OF MEASUREMENT

Class	Category	Type of waste	Nomenclature ref.	Unit of measurement	Woodcutter		Harvester		Forwarder		Skidder	
					per woodcutter	9000 woodcutters	per harvester	540 harvesters	per forwarder	1230 forwarders	per skidder	1400 skidders
Hazardous wastes (HIW)	Aerosols	Aerosols (+ misc. penetrating grease, etc.)	14 05 04	Unit	2	18000	3	1620	3	3690	3	4200
	WEEE	Electrical parts / electronic components WEEE	16 02 00	Kg	0	0	1	540	0.5	615	0.25	350
	Soiled packaging	200 litre metal or plastic oil drums (clean or dirty oil)	16 05 03	Unit	*0*	*0*	2	1080	2	2460	2	2800
		Plastic oil containers (clean or used oil) smaller than 200 litres	16 05 03	Unit	*0.25*	*2250*	5	2700	5	6150	5	7000
	Used oil	Hydraulic oil	13 01 00	Litre	0	0	370	199756	207	254709	70	97486
		Engine and gearbox oils	13 02 00	Litre	0	0	189	102323	151	185511	137	191814
	Misc. Fluids	Engine cooling fluid	16 01 14	Litre	0	0	19	10391	17	21029	26	36721
	Soiled items	Grease cartridges	15 01 10	Unit	0	0	149	80515	85	104140	39	54492
		Oily, absorbent cloths	15 02 02	Roll of cellulose	0.7	6300	4.6	2484	4.6	5658	4.6	6440
		Used oil and gas oil filters	16 01 07	Unit	0	0	15	8198	16	20111	14	19137
		Soiled greasy hoses	16 01 99	Unit	0	0	58	31224	26	32295	0.7	924
	Batteries and accumulators	Used lead starter batteries	16 06 01	Unit	0	0	0.7	375	0.7	832	0.9	1300
		Used alkaline batteries	16 06 04	Unit	0.5	4500	1	540	1	1230	1	1400
Non-hazardous industrial wastes (NHIW)	Miscellaneous	PPE accessories (helmet, mask, ear defenders)	20 01 39	Unit	0.6	5464	NS	NS	NS	NS	NS	NS
		Air filters	16 01 99	Unit	0	0	2.3	1246	1.9	2397	2.5	3558
		Clothes, shoes, safety trousers, etc.	20 03 07	Unit	4	36000	1.6	844	1.6	1933	2.4	3306
	Tyres	Used tyres and inner tubes	16 01 03	Unit	0	0	NS	NS	1.5	1845	1.9	2650
	Packaging	Paper and cartboard packaging	15 01 01	Unit	1.5	13500	11	5940	11	13530	11	15400
	Waste metal	Cables	02 01 10	Metre	0	0	0	0	0	0	119	166320
		Chainsaw chains	02 01 10	Unit	22.5	202643	40	21468	0	0	0	0
		Chainsaw guide bar	02 01 10	Unit	5.3	47964	14	7681	0	0	0	0
		Mechanical parts / waste metals from workshop	02 01 10	Kg	1.2	10636	92	49680	60	74187	31	43400

IN TONNES

Class	Category	Type of waste	Nomenclature ref.		Woodcutter		Harvester		Forwarder		Skidder	
					per woodcutter	9000 woodcutters	per harvester	540 harvesters	per forwarder	1230 forwarders	per skidder	1400 skidders
					in kg	in tonnes	in kg	in tonnes	in kg	in tonnes	in kg	in tonnes
Hazardous wastes (HIW)	Aerosols	Aerosols (+ misc. penetrating grease, etc.)	14 05 04		0.3	2.7	0.45	0.24	0.45	0.55	0.45	0.63
	WEEE	Electrical parts / electronic components WEEE	16 02 00		0	0	1	0.54	0.5	0.62	0.25	0.35
	Soiled packaging	200 litre metal or plastic oil drums (clean or dirty oil)	16 05 03		*0*	*0*	40	21.6	40	49.2	40	56
		Plastic oil containers (clean or used oil) smaller than 200 litres	*16 05 03*		*0.05*	*0.45*	*1*	*0.54*	*1*	*1.2*	*1*	*1.4*
	Used oil	Hydraulic oil	13 01 00		0	0	370	200	207	255	70	97
		Engine and gearbox oils	13 02 00		0	0	189	102	151	186	137	192
	Misc. Fluids	Engine cooling fluid	16 01 14		0	0	19	10	17	21	26	37
	Soiled items	Grease cartridges	15 01 10		0	0	4.47	2.4	2.55	3.1	1.17	1.6
		Oily, absorbent cloths	15 02 02		2.1	19	13.8	7.5	13.8	17.0	13.8	19.3
		Used oil and gas oil filters	16 01 07		0	0	30	16	32	40	28	38
		Soiled greasy hoses	16 01 99		0	0	174	93.7	78	96.9	2.1	2.8
	Batteries and accumulators	Used lead starter batteries	16 06 01		0	0	15.4	8.3	15.4	18	19.8	29
		Used alkaline batteries	*16 06 04*		*0.00165*	*0.01*	*0.033*	*0.018*	*0.033*	*0.041*	*0.033*	*0.046*
Non-hazardous industrial wastes (NHIW)	Miscellaneous	PPE accessories (helmet, mask, ear defenders)	20 01 39		0.36	3.3	0	0	0	0	0	0
		Air filters	16 01 99		0	0	4.6	2.5	3.8	4.8	5	7.1
		Clothes, shoes, safety trousers, etc.	20 03 07		4	36	1.6	0.9	1.6	1.9	2.4	3.3
	Tyres	Used tyres and inner tubes	16 01 03		0	0	*0*	*0*	180	221	228	318
	Packaging	Paper and cartboard packaging	15 01 01		0.75	6.8	5.5	3.0	5.5	6.8	5.5	7.7
	Waste metal	Cables	02 01 10		0	0	0	0	0	0	119	166
		Chainsaw chains	02 01 10		7.9	71	24	13	0	0	0	0
		Chainsaw guide bar	02 01 10		5.3	48	45	25	0	0	0	0
		Mechanical parts / waste metals from workshop	02 01 10		1.2	11	92	50	60	74	31	43
				HIW	**2.5 kg**	**22 tonnes**	**858 kg**	**464 tonnes**	**559 kg**	**688 tonnes**	**340 kg**	**475 tonnes**
				NHIW	**19.5 kg**	**176 tonnes**	**173 kg**	**93 tonnes**	**251 kg**	**309 tonnes**	**391 kg**	**546 tonnes**
				Total wastes	**22 kg**	**198 tonnes**	**1031 kg**	**557 tonnes**	**810 kg**	**997 tonnes**	**731 kg**	**1021 tonnes**

Annex 4. Forestry in the 25 European Union member states (2004 data)

Country groups	Country	Annual round wood production Million m^3 unbarked	Degree of mechanisation %
Scandinavia	Estonia	9.6	55%
	Finland	53.9	97%
	Sweden	68.4	98%
Central and western Europe	Germany	42	35%
	Austria	15.3	18%
	Belgium / Luxembourg	4.3	80%
	France	37.2	24%
	Czech Rep.	15	7%
	Slovenia	2.2	0.7%
NW Europe	Denmark	0.9	50%
	Ireland	2.8	95%
	Netherlands	0.7	25%
	United Kingdom	7.9	90%
E Europe	Hungary	3.8	15%
	Latvia	13.7	5%
	Lithuania	5.3	0%
	Poland	27.8	2%
	Slovakia	6.1	0.7%
Iberian peninsula	Spain	15.3	30%
	Portugal	9	30%
S Europe	Cyprus	0.01	0%
	Greece	0.6	0%
	Italy	3.6	2%
	Malta	NS	0%
TOTAL	**25**	**343.2**	**51%**