APRIL 2017

RIL PRACTICES OF FSC COMPANIES IN CONGO BASIN

SYNTHESIS

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LA RÉFÉRENCE EN MATIÈRE DE BOIS TROPICAL

FOREWORD

In the debate regarding the application of Motion 65 to protect the Intact Forest Landscapes (IFL), FSC-certified concessionaires in the Congo Basin, through the ATIBT, have decided to analyse their reduced impact logging practices, particularly in terms of roads. This report presents the main observations resulting from the analysis carried out by the TEREA consulting company.

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1.1 General information on logging under sustainable management in the Congo Basin

Logging as practiced in the Congo Basin by logging companies consists of **selective harvesting**, where only **between 1 and 3 trees/ha** are harvested in concessions with several dozen (or even hundreds of thousands) of hectares on a rotation that can range between 25 and 30 years.

Forest management is a legal obligation in most of the countries of the Congo Basin that are affected by Motion 65, notably in Cameroon, Gabon and Congo-Brazzaville. This process makes it possible to plan the logging activity by taking into account the following considerations:

- Multi-resource inventories are carried out over the entire surface area to be managed and they allow for an analysis of the state of available resources;
- A management plan consists mainly of the definition of the following 5 major decisions:
  - **The definition of "series"**, i.e. surface areas dedicated to the protection of sensitive environments, the preservation of biodiversity, the use of land by riverside communities, and lastly, production.
  - **The definition of a rotation** (for those certified between 25 and 30 years), which means that a parcel exploited in year Y will only be re-harvested 25 or 30 years later;
  - **The definition of target species**, harvestable species that will serve as a basis for estimating a stable harvest volume;
  - **The definition of Minimum Diameter Cutting Limits** which allow for a reconstitution of all or part of the usable stems of the target species;
  - **The definition of five-year blocks** or Annual Allowable Cuts and their operational order of passage.

The objective of the method is to allow the logged forest time to replenish a harvestable stock during a second pass between 25 and 30 years later, while preserving the sensitive areas from an environmental and social standpoint. Moreover, the planning of logging operations allows, along with the cutting process, for the harvested plots to rest over a period of one rotation.

Logs are extracted via skidding, with the use of bulldozers and/or skidders with tyres. A network of roads for the removal of timber is opened on which the logs circulate with the blocks to a storage park.

1.2 Comparison with other logging systems

It is impossible to argue that logging has no impact on the environment. However, the following paragraphs attempt to demonstrate that logging as practiced by certified companies in the Congo Basin may already meet the definition of Motion 65's "low impact forest management" for the following reasons:

- It is a is a relatively low-impact selective operation (paragraph 1.2.1);
- The intensity of the operation is lower than in other tropical forest basins (paragraph 1.2.2);
- Certification induces a reduction in impacts, in particular with the adoption of RIL practices (paragraph 1.2.3).

For example, a certified logging operation in the Congo Basin can mitigate negative impacts and reinforce positive impacts compared to a non-certified operation and even more so in a context in relation to other land use options which have a greater impact or in an uncontrolled context.

1.2.1 Comparison with the other types of logging methods

Many scientific publications consider that selective logging in tropical forests generates relatively little disruption (Deckker and de Graaf 2003; Medjibe et al. 2011; Schleuning et al. 2011; Picard et al. 2012 in Cazzolla Gatti R. et al., 2014).

Putz et al. (2012) show through a meta-analysis of over 100 publications that selective logging in tropical forests maintains (Illustration 1):

- after a first harvest, around 46% of the inventory of timber that is maintained thereafter,
- 76% of carbon after one rotation,
- 85-100% of mammal, bird, invertebrate and plant species.

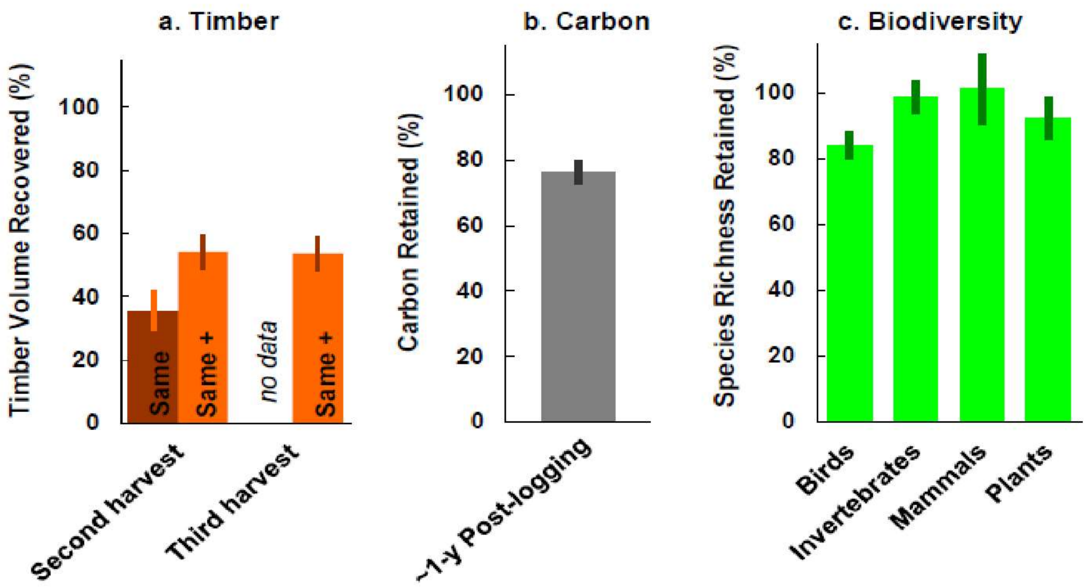


Illustration 1 – Impact of selective logging in tropical forests on timber inventory levels, on carbon inventory levels and on specific richness

In Gabon, a study (Medjibe et al. 2011) concluded that for a forest logging operation with an average intensity of 0.82 trees/ha, there was no observed effect on the specific richness of trees, and that forest aerial biomass declined by only **8.1% compared to the pre-harvest inventory**.

Country	Harvest intensity (m^3/ha)	Above-ground C pre-logging (tC/ha)	C lost from logging (tC/ha)	C retained (%)	Notes	Reference
Gabon	8.1	210	17	92	RIL	Medjibe et al, 2011(a)
Gabon	11.4	194	12	94		Medjibe 2012
Gabon	5.7	190	6	97	RIL	Medjibe 2012
Rep. of Congo	9.6	271	8	97		Brown et al. 2005

** C-stock in estimated total live biomass from remote sensing data.*

It is also important to note that wetlands and peatland areas are excluded from the management plans (and therefore from the harvestable forest area) of concessions. However, a recent publication (Dargie et al., 2017) finds that the central basin of the Congo river is the largest tropical peatland complex, representing an underground biomass equivalent to that of the entire Congo Basin's aerial one. Concessionaires who exclude these areas are therefore excellent stewards of the integrity of these significant carbon stocks.

Moreover, a recent publication (Chaudhary et al., 2016) analyses the impacts on biodiversity richness and economic trade-offs according to the various types of logging operations. It appears that selective harvesting (selective RIL or selective CL) ranks among the types of harvesting that have the least impact on the richness of the various taxonomic groups examined in this publication (Illustration 2).

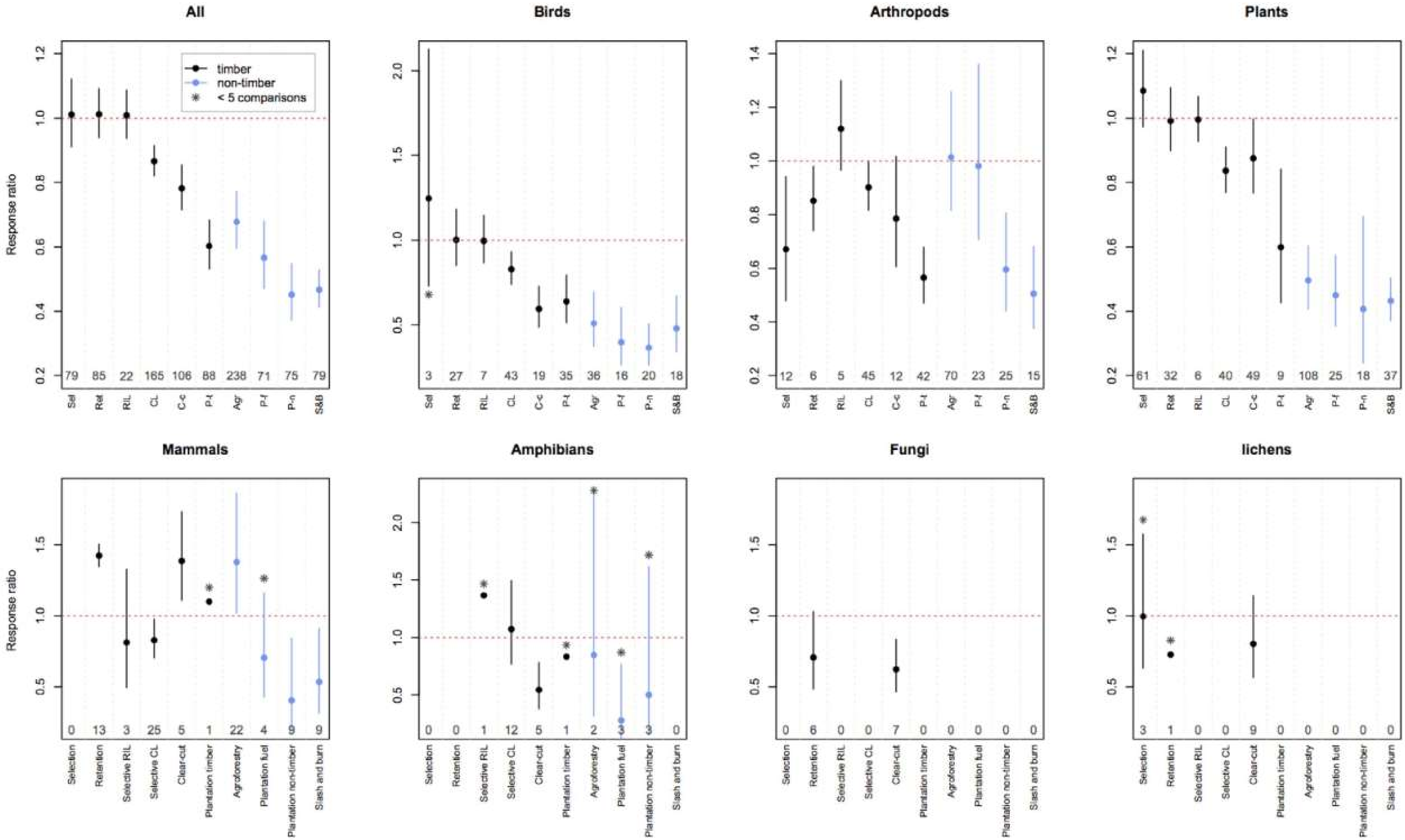
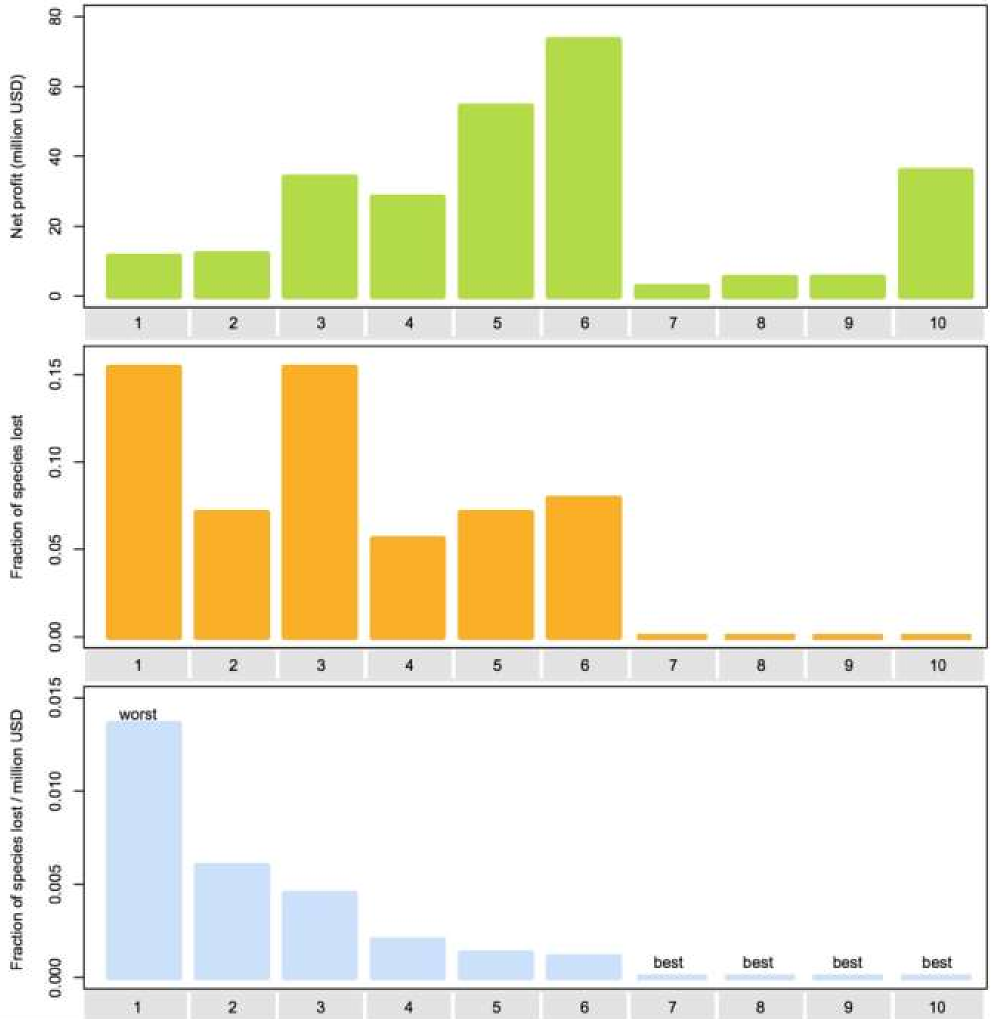


Illustration 2 – Change in the specific richness of various taxonomic groups in response to the 10 most common forest management regimes (Chaudhary et al., 2016)

This publication thus considers that selective harvesting - as practiced in Gabon (whether or not it uses reduced impact logging methods) - is one of the best logging practices that was examined (including other types of selective harvesting) (Chaudhary et al. 2016).



	1	2	3	4	5	6	7	8	9	10
Country	Malaysia	Indonesia	Malaysia	Sweden	Malaysia	Sweden	Gabon	Gabon	Brazil	Canada
Management	Plantation fuel	Selective CL	Plantation timber	Retention	Selective CL	Clear cut	Selective RIL	Selective CL	Selective CL	Selection
Product	*Acacia mangium* (Acacia) logs	various species	*Tectona grandis* (Teak) logs	*Picea abies* (Norway spruce) logs	various species	*Picea abies* (Norway spruce) logs	*Aucoumea klaineiana* (okoumé) logs	*Aucoumea klaineiana* (okoumé) logs	*Swietenia macrophylla* (mahogany) sawnwood	*Thuja plicata* (Western red cedar) sawnwood
Price (USD/m^3)	35	122	140	55	various	55	138	116	220	107
Harvest 1st cut (m^3/ha)	90	54	150	120	117.34	300	4.23	10.68	5	80
Production cost (USD/m^3)	1443*	80.02	1517*	8.07	60.36	6.2	20.9	17.66	15.66	17.5

Illustration 3 – Characterisation of the various types of forestry management systems according to the fraction of species lost and net profits generated (Chaudhary et al., 2016).

1.2.2 Comparison with logging in the other tropical forest basins

As the publications date prior to the implementation of forestry management in the Congo Basin, the intensity of logging was already reduced in terms of per hectare harvesting compared with the other 2 major tropical forest basins (Bertrand, 1986, in Dupuy, 1998):

- 8m³/ha in Africa,
- 13m³/ha in tropical America,
- 27m³/ha in Asia.

The Congo Basin RIL guidebook (FAO, 2003) provides comparable logging figures for the 3 major tropical forest basins, as follows.

Table 1 – Estimate of the impact of logging on tree populations (FAO, 2003)

	Africa	America	S-E Asia
No. of stems harvested/ha	1-3	2-5	6-20
Commercial volume harvested/ha	5-30	10-50	50-150
Proportion of trees damaged	10-15	25-40	50-60

The analyses of certified companies show that we have currently reached a maximum of 1.4 stems/ha and 19 m³/ha. That is to say, below the figures presented above.

Lastly, in their publication, Picard et al. (2012) study the correlation between the number of stems and the proportion of damaged stems of the residual stand in the 3 major tropical forest basins. Illustration 4 shows the results for Africa (black circles), for the neo-tropics (America) (white triangles) and Asia (white circles). It is clear that if certified companies harvest between 1 and 3 stems per hectare, they will have an extremely limited impact on the residual stand.

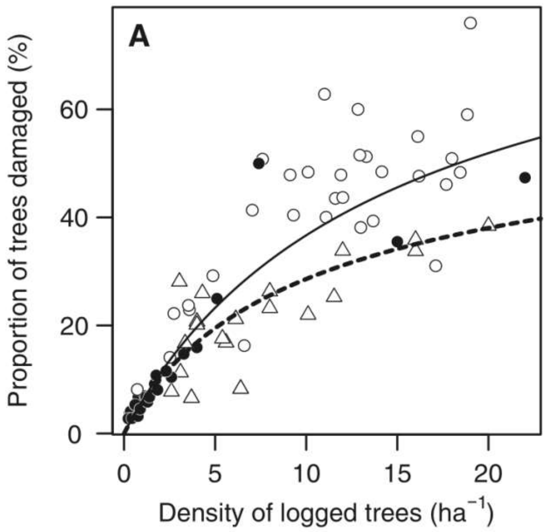


Illustration 4 – Proportion of trees damaged according to the logging intensity

1.2.3 Comparison with non-certified logging

Burivalova et al. (2016) remind us that Feldpausch et al. (2005) in particular demonstrated that practices of certified companies such as RIL practices clearly result in less disturbances in the ground and a lower density of roads and skid trails. This is the result of better planning and sometimes also a lower logging intensity (Medjibe et al. 2013, in Burivalova et al., 2016).

Medjibe and Putz (2012) also explain that numerous scientific publications (Pinard and Putz, 1996; Sist et al., 1998; van der Hout, 1999; Barreto et al., 1998; Healey et al., 2000; Boltz et al., 2001, 2003; Tay et al., 2002; Holmes et al., 2002) demonstrate that compared to conventional selective harvesting, reduced impact logging practices almost halve the damage to residual stands as well as the ground.

Moreover, Burivalova et al. (2016) mention that several publications (Bicknell et al., 2014, Burivalova et al., 2014, Martin et al., 2015) demonstrate that the implementation of RIL practices allow more plant and animal species to be preserved and they also allow for a greater abundance of animals, even after taking into account the effect of logging intensity. Burivalova et al. (2016) also cite the works of Damette & Delacote (2011); Gaveau et al. (2013); Miteva et al. (2015) which demonstrate that forest certification results in less deforestation, which further reduces the impact of logging on biodiversity.

Lastly, Cerutti et al. (2014) demonstrate the many positive impacts of FSC certification, namely:

- certification is regularly associated with better working and living conditions: water supply and access to healthcare are guaranteed, housing, access to electricity and waste management and products are available at acceptable prices;
- the establishment of active local institutions for communication between companies and local populations; they appear to be more legitimate and effective than in non-certified companies;
- the existence of profit-sharing systems, with redistribution that is more effective than those mandated by legal frameworks. These systems are directly linked to an improvement of the local economy.

It should be noted that Cerrutti et al. (2014) emphasise that on the issue of agricultural and hunting practices and the collection of non-timber forest products (NTFPs), certified companies implement procedures and rules to enforce legal provisions, and that this may restrict the exercise of these rights when they are exercised in contradiction with the law.

2. A REVIEW OF CURRENT RIL PRACTICES IN TERMS OF ROADS IN THE CONGO BASIN

2.1 Definitions of reduced impact logging

A thematic sheet on reduced impact logging has been produced in section 4 of the ATIBT guide entitled "Sustainable Management and Recommendations for Certification" (ATIBT 2014). This document retains 2 definitions for the term RIL:

- "A set of measures applicable to logging that **reduce its negative impacts** on the forest and mankind". FAO
- "Timber harvesting operations that have been **intensively planned and are carefully controlled** to minimise their impacts on forest stands and soils". ITTO

These two definitions especially emphasise the three main aspects, which are:

- the minimisation of the impacts linked to timber harvesting operations (FSC principle 6);
- the planning of these operations (FSC principle 7);
- their monitoring (FSC principle 8).

Moreover, it is possible to affirm that, in the Congo Basin, FSC companies have been pioneers in the effective implementation of these practices. For example: CEB-Precious-Woods is the first private company to have adopted a management plan in Gabon, followed by CIB and IFO in the Republic of Congo.

Lastly, the implementation of monitoring activities is almost exclusively a specific feature of FSC companies.

2.2 RIL measures implemented by FSC companies in the Congo Basin

In this study, we will consider the "core" logging activities to be:

- The felling, removal/skidding of timber;
- The cutting/shaping of barrels into blocks prior to transport, with the eventual creation of log yards;
- The evacuation of logs to a storage area; hence the creation of forest roads/tracks;
- The creation of permanent or temporary site facilities.

The themes and practices covered in the Reduced Impact Logging concept implemented in the Congo Basin are numerous. The following table displays the main measures implemented by FSC-certified companies.

Activity	RIL measure	Objective
Planning	Establishment of a long-term management plan (rotation) with protection/preservation series and agricultural series	To ensure the sustainability of operations beyond one rotation To prohibit logging in areas which are important for biodiversity, ecosystem services and proven social interests.
	Identification of High Conservation Values and management plan (FSC specificity)	To reason the management of high values for the preservation of biodiversity, ecosystem services and local and indigenous populations.
	Planning the use of AACs (annual allowable cuts) according to inventories of exploitable resources and the topography	To adapt all of its operations to a thorough inventory of the resource To ensure the traceability of felled timber
	Planning of the forest road network	To adapt the road network (length and type) to the exploitable resource To minimise the space requirements of the road
Felling	Compliance with minimum diameter cutting limits	Minimum diameter cutting limits ensure a minimum replenishment rate of the species to be harvested in a second rotation.
	Controlled felling	To limit risks for the safety of fallers
	Preservation of seed bearing trees and giant trees	To instil prevention in terms of regeneration To limit felling damage
	Rules for watercourse felling (buffer zone or specific procedure)	To limit impacts on watercourses (flow disturbance, erosion, logjams, eutrophication risks, etc.)
	Introduction of a maximum logging intensity threshold	To limit damage to residual stands and the future resource
	Adaptation of the size of log yards to the resource	To limit the space required by log yards by limiting deforestation, while guaranteeing safe conditions for the operating of machinery
	Planning of the skidding network	To optimise skidding lengths and thus minimise the surface impacted by paths
Removal skidding	Identification of crop trees to be protected	To preserve part of the future resource

Activity	RIL measure	Objective
	Prevention of transport over rivers Creation of protected fording and dismantling	To limit the disturbance of watercourses
	Levelling forbidden on skid trails	To limit soil compaction
	High shovel Skidding – Removal if possible (outside of sloped areas)	To limit the impacts on the ground due to the passage of machines
	No vehicles circulating in the event of heavy or prolonged rain	To limit erosion
Opening of roads	Maximum re-use of existing roads	To avoid creating new roads that heavily impact the ground and the vegetation cover
	Road construction standards: limitation of the width of roads, adapting the dimensions of the road network to the season, etc.	To supervise the construction of roads To limit deforestation To adapt the road type to the exploitable resource and the season
	Road construction standards: installation of outlets, aligning of profiles with cross-sections and road lengths, limitation of slopes, etc.	To ensure durable roads that can be reopened during a second rotation To limit erosion phenomena
Creation of river crossing structures	Construction observing standard rules: no contact with banks, limitation of logjams, soil contributions, the crossing of machinery, etc.	To limit the disturbance of watercourses
Post-logging operations	Restoration of parks and quarries	To limit the impacts of deforestation, especially erosion
	Installation of barricades on sloping skidding paths	To limit instances of erosion on sloping skidding paths
	Closure of roads and/or restriction of access	To limit the movement of machinery and illegal activities
Creation and upkeep of site facilities	Access to drinking water, access to healthcare, access to food and basic necessities	To limit risks to workers' health
	Installation of gray water sanitation systems in site facility housing	To limit the potential pollution of gray water and ensure a healthy living environment for workers

Other RIL measures are also implemented in order to minimise the more cross-cutting impacts of logging such as:

- the impact on village farming areas and sacred sites,

- the use of products such as hydrocarbons, oils, etc.
- the production of industrial and household waste,
- easier access to forest areas with a potential increase in poaching and the development of agricultural crop production,
- risks to the safety, health and hygiene of workers.

To address this, the following measures are applied:

- implementation of social measures and consultation platforms;
- implementation of rules regarding the storage, handling and processing of hydrocarbons and oils;
- implementation of an industrial and household waste management plan (according to local possibilities);
- implementation of a provision to limit poaching (patrols, closure of abandoned logging paths, awareness campaign, etc.) and monitoring of agricultural fronts;
- implementation of measures for worker safety (wearing of PPE, training, opening of dispensaries, evacuation procedure, supply of drinking water, construction of housing with effluent management, etc.).

Moreover, companies are setting up monitoring systems to ensure that RIL measures are properly implemented and functioning.

3. THE BEST PRACTICES OF FSC-CERTIFIED COMPANIES IN THE CONGO BASIN

The examples presented hereafter are a summary of the practices of FSC companies in the Congo Basin, and only include companies' main RIL standards. These companies are in a position to present a more complete and detailed description of all the measures they have implemented.

3.1 The classification of forest roads according to companies

An analysis of the various types of roads of FSC-certified companies demonstrates a concern to optimise the openings of roads by adapting the type of road, in particular its length and the width of its right of way, to the resource to be logged and the season, **which ultimately reduces the impacts of these forest roads.**

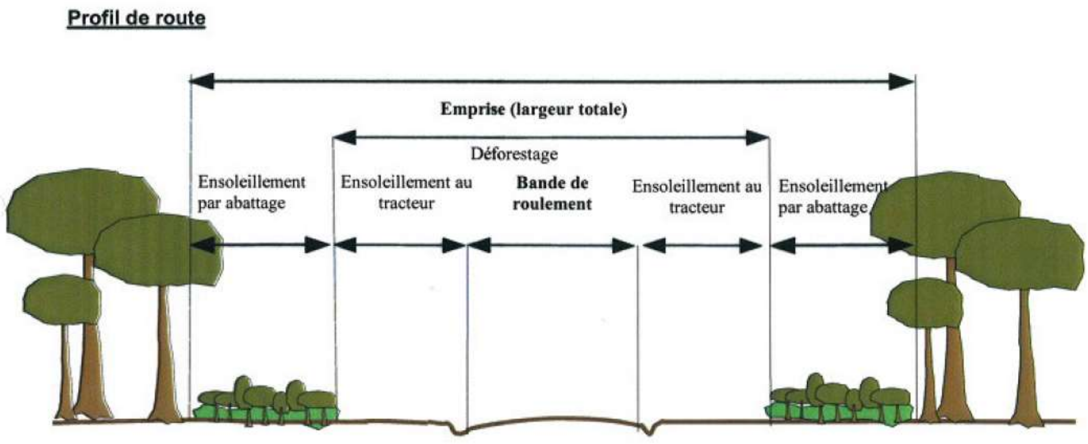
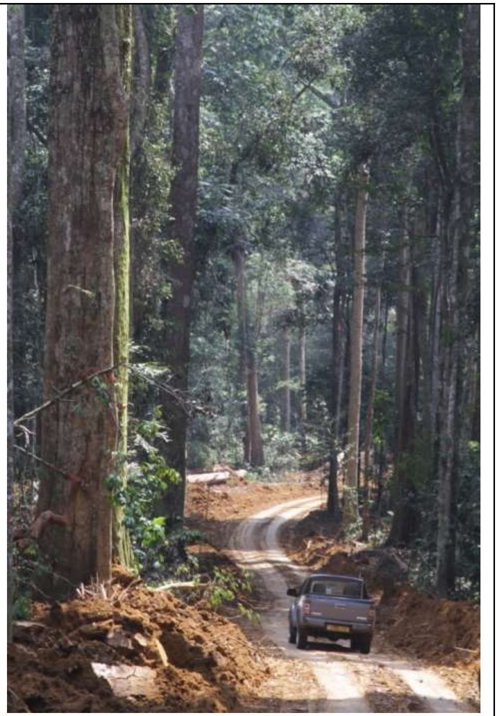


Illustration 5 – Example of a cross-sectional profile of a road in flat terrain

	Duration	Dimensions				Characteristics
		Traffic lane	Min. right of way	Max. right of way	Sun exposure	
Permanent road	Permanent	8-12m	28-35m	35-42m	10-15m	Laterite
Main logging road	Several years	5-10m	20-33m	20-37m	10-15m	Laterite
Secondary logging road	From a few weeks to a year	4-8	10-28m	10-28m	0-15m	Not necessarily laterite

		
Main road	Secondary road	Dry season access road (no direct sunlight)

The variation in the characteristics of the various types of roads within Congo Basin FSC companies is explained by their adaptation to topographic constraints:

- **Companies working in rugged areas** have developed specific procedures for dry season and rainy season roads for which the level of opening may greatly vary. They also include areas where the slopes allow for the evacuation of water, and therefore the need for sunshine, although still significant, can be reduced.

- **Companies working in flatter contexts** resort to sunlight primarily to dry the road, as water drainage via slopes is difficult or non-existent. The notion of road orientation is therefore taken into account: east-west axes require less sunshine (5.5m vs. 10m for north-south axes).

In both cases, the standards implemented in FSC companies aim to regulate the practices used to open up roads, in particular in terms of maximum widths. Indeed, practices used before the arrival of forest management and RIL practices instead tended to have very wide and very sunny roads.

The introduction of these standards has made it possible to reduce the direct impacts linked to the opening of roads: less deforestation and therefore less fragmentation, less areas affected by the passage of machinery, less timber felled and therefore a lesser carbon impact.

3.2 The best practices for the opening-up of new roads

3.2.1 The taking into account of slopes

The taking into account of slopes is fundamental in the best practices implemented by certified forestry companies. In general, these standards guarantee the quality of the road that is created and thus enable the companies to limit the direct impacts of their roads in the long term. Moreover, companies working in rugged areas limit the slopes of forest roads.

Table 2 – Maximum slope levels to observe when planning roads (company in Gabon)

Company in Gabon
Main roads
8% max. slope (exceptionally 10 to 12% if logging truck empty in the upward direction)
Secondary roads
Secondary roads
8% max. slope (exceptionally 10 to 12% if logging truck empty in the upward direction)
Dry season access roads
10% max. slope (exceptionally 12%)

It should also be noted that in zones with relief, companies optimise profiles lengthwise, in order to ensure the evacuation of water (flat or rugged terrain), while avoiding slope breaks that create areas where water stagnates. The profile must have a slighter less inclined slope at the top than at the bottom of the relief, the objective being to prevent the water from the higher flows from catching up with the water from the lower runoffs, which would eventually cross the road and thus weaken the roadway in areas where it would eventually be necessary to install a pipe.

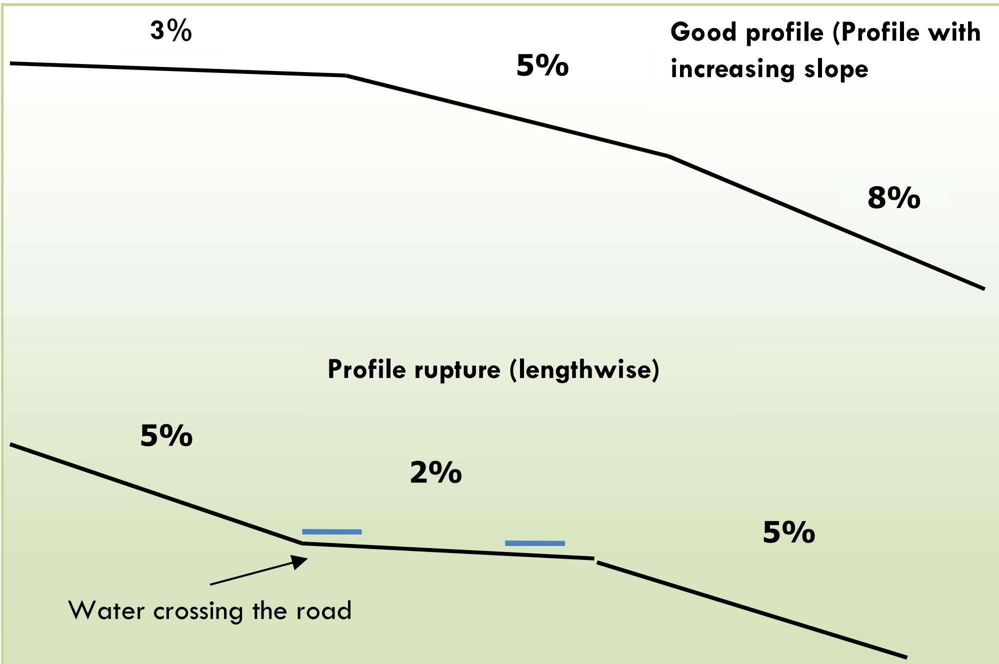


Illustration 6 – Schematic representation of the length of a profile

3.2.2 Levelling work and cross sections

All of the procedures used by FSC-certified companies report several best practices in terms of earthworks and cross-sectional profiles, namely:

- **Make a sufficiently pronounced bulge** in the traffic lane so that water drains toward the gutters (ditches).
- The bulge may vary depending on the erodibility of the road.
- **Compacting** the road prevents water infiltrations.
- Ideally, the opening should take place at least 6 months before the start of operations to facilitate natural compaction.
- Ensure that **lateral gutters** are dug and sufficiently deep to accommodate runoff water.
- Slope management must be carefully considered, with ditches.
- **Install outlets** so that excess water in the pipes is evacuated to the vegetation.
- **A fresh path is fragile.** After shaping, it should not be touched (especially during the rainy season) until it is stabilised. Avoid any unnecessary traffic.
- For hillside roads, [...] one must […] **smoothen out the slopes** with a grader in order to **prevent landslides** and obstructions of the ditches.

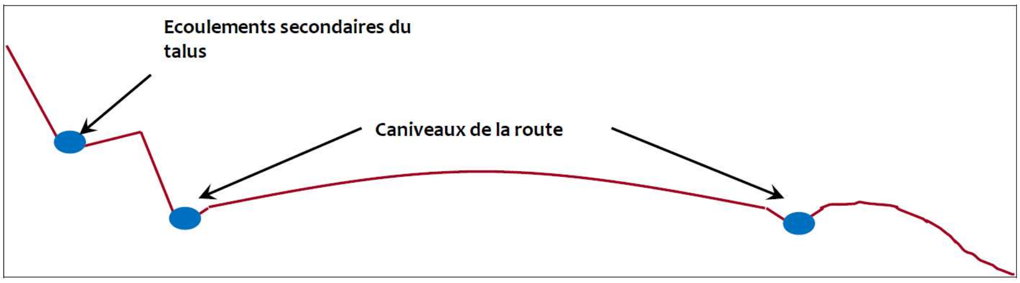


Illustration 7 – Diagram of an optimal cross section (company in Gabon)

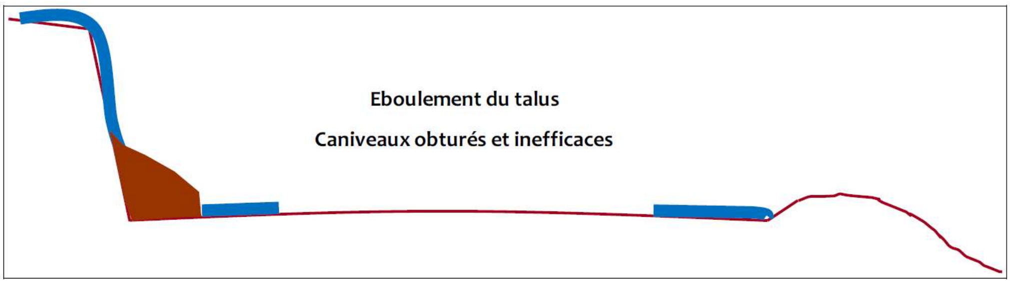


Illustration 8 – Diagram of a poorly designed cross section (company in Gabon)

3.2.3 The installation of drainage structures

In parallel to sunshine, drainage structures guarantee the feasibility of a road. The main drainage structures implemented by FSC companies are:

- **The outlet**

This is a storm drain formed from the gutters along the road which allows it to be drained away from the roadway, directing water towards the surrounding vegetation. The frequency of these drains must vary according to the slope and the type of soil.

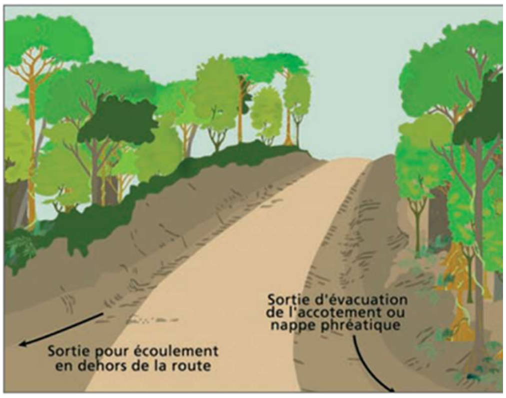


Illustration 9 – Drainage of a road in flat terrain (FAO 2003, EFI regional code)

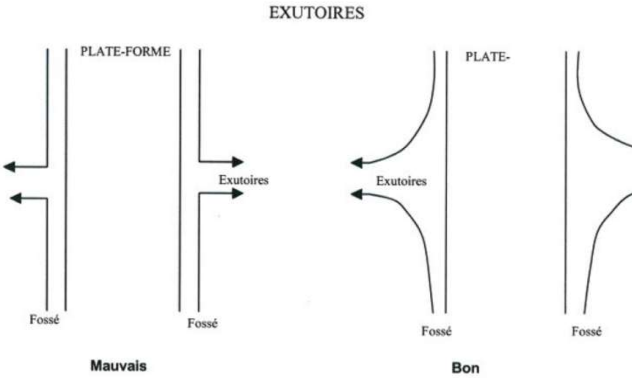


Illustration 10 – Good and bad connections from outlets to ditches (company in Gabon)

- **The basin / sedimentation pit**

This is a storm water collection hole that enables the "storing" of the sediment-laden water before it reaches a river or marsh. In doing so, the water discharges its sediments before flowing towards the river. It is used when it is impossible to create an outlet.

The sedimentation pit, by its function, **must be scraped regularly** in order to prevent it from completely filling up and no longer having any use.

- **The culvert or pipe**

This structure makes it possible, especially in side roads, to make the water cross to either side of the road under the traffic lane.

In general, companies use shovels equipped with a bucket, which are more manageable and precise and less impacting.

3.3 Works that cross over rivers and marshes

The construction of bridges and embankments can have highly significant visual impacts (which may even be difficult to reverse) on rivers (logjams, erosion, eutrophication, severe degradation of marsh forests, etc.). The building of crossing structures is therefore an activity which FSC-certified companies pay particular attention to.

FSC companies have developed precise procedures for the construction of such structures. In addition to the technical objective of producing a solid and well-built structure, the companies now add to this the careful consideration of the effects of vehicles that are approaching the river to be crossed in order to impact it as little as possible.

In addition, there are now procedures to monitor these structures, where the latter are noted using an evaluation grid to decide whether repairs are necessary, and - above all - in order to improve the techniques companies use to build such structures in the field, work after work.

3.3.1 Forest bridges

Generally speaking, **structures must allow for the proper flow of both water and fish** in order to not create an artificial reservoir upstream and not modify the river's regime downstream. Some companies, which have very strict constraints, observe standards that prevent the reduction of watercourse widths by over 20%.

3.3.1.1 General methodology and best practices

The best practices which limit impacts include:

- The levelling of **the site of the bridge without touching the banks.**
- Felling on the banks must be done using a chainsaw.
- Bull rakes remove the felled timber by cable.
- Do not leave timber in the river or the runoff.

Photo 1 – Photo of a forest bridge made in compliance with the standards of an FSC company in the Congo Basin

In the above picture, we can see that the banks have not been touched and that they still have vegetation, which makes it possible to limit as much as possible the phenomena of direct erosion into the riverbed.

3.3.2 Embankments

Embankments are built by companies that want to cross soft soils and large marshes. As such, dykes and embankments are constructed in flood-prone or permanently flooded areas.

Some companies carry out internal impact assessments prior to the construction of a new dam.

Moreover, we can cite the following best practices:

- Ballast will be taken from stable soil;
- Dykes and embankments are generally more sensitive due to the permanently wet soils of these areas. It is necessary to sufficiently open up the sunlight strips in order to keep the traffic lane completely dry;
- Regularly installed pipes to allow water to pass through, and to avoid upstream flooding;
- The embankments must be intersected by bridges or pipes that allow water to drain, and to prevent upstream flooding (especially in spots where the river is located);
- The number of bridges to be crossed must be sufficient, so as not to slow down the flow of water.

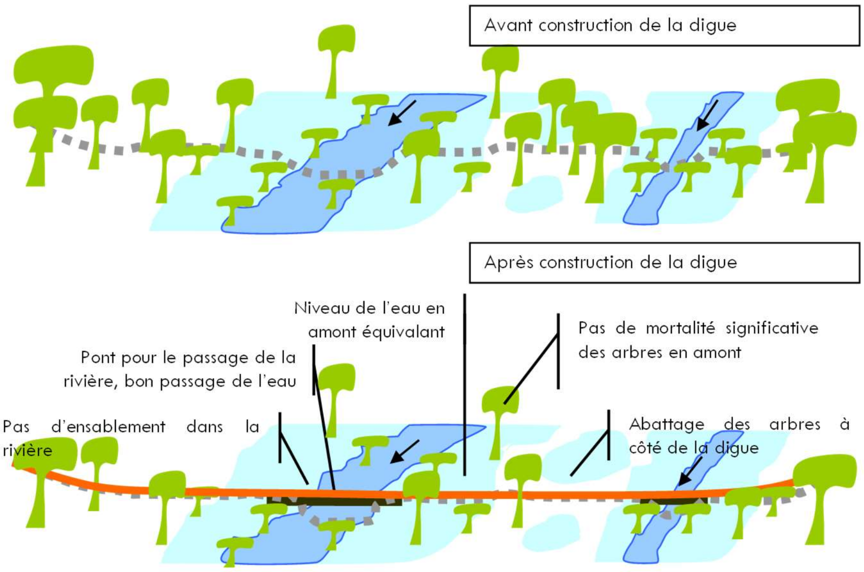


Illustration 11 – Diagram of the construction of an embankment (Congo-based company)

3.4 Log yards

N.B.: Some companies generally do not build log yards in forests; instead, they store blocks on the edge of forest roads (companies on flat terrain).

3.4.1 Planning and sizing of sites where log yards will be established

In general, rugged terrain leaves little room for companies in terms of choosing the location of forest log yards.

However, some best practices that aim to limit the impacts of log yard openings guide the planning of log yard locations. Thus, log yards must not be located within 50 metres of any river and must (as much as possible) be placed on flat ground. A slight slope of the log yard's platform is required to facilitate the flow of water.

The sizing of log yards must meet two fundamental aspects:

- the safety of workers in relation to the movement of machinery;
- sizing must not be disproportionately large compared to the volume to be removed.

Most companies aim to minimise the size of their log yards. Some companies define a maximum area (0.120 ha for example). Other companies also consider that the size of a log yard is linked to two main factors: the number of roots to be hauled away and the number of bull rakes operating.

3.4.2 Log yard opening methods

Beyond the purely technical aspects, companies are introducing practices that aim to limit the impacts of log yard openings, such as:

- Crop trees and species that are to be protected are marked;
- The bull rake clears the vegetation by advancing inwards (without removing soil);
- All vegetation (including large trees) **is felled towards the interior of the surface in order to avoid unnecessary damage to the surrounding environment;**
- Felled trees are cut into sections and lopped before being cleared;
- Land is to be levelled and runoff water is to be directed to the bottom of the log yard in the vegetation area, which must be within 30 m of a water body;
- Compact the log yard with a wheeled machine or a compactor.

3.4.3 Closure and restoration

These operations are extremely costly and some companies have not adopted them because the objective is to re-use the log yards during a second harvest, especially in rugged areas where the possibilities of setting up log yards are limited.

4. PRACTICES IN TERMS OF ROAD NETWORK PLANNING AT THE SCALE OF AN ANNUAL ALLOWABLE CUT ZONE

One of the most important principles of RIL is operational planning. This includes both long-term planning (on a rotation basis) and the production of management plans, as well as medium-term planning (five years) or short-term planning (annually).

The road network is generally planned for the medium to short term. The following examples are limited to the scale of an AAC zone, for which FSC companies have developed increasingly efficient practices, by incorporating the FSC principles.

The companies use items that are key for the planning of a road network:

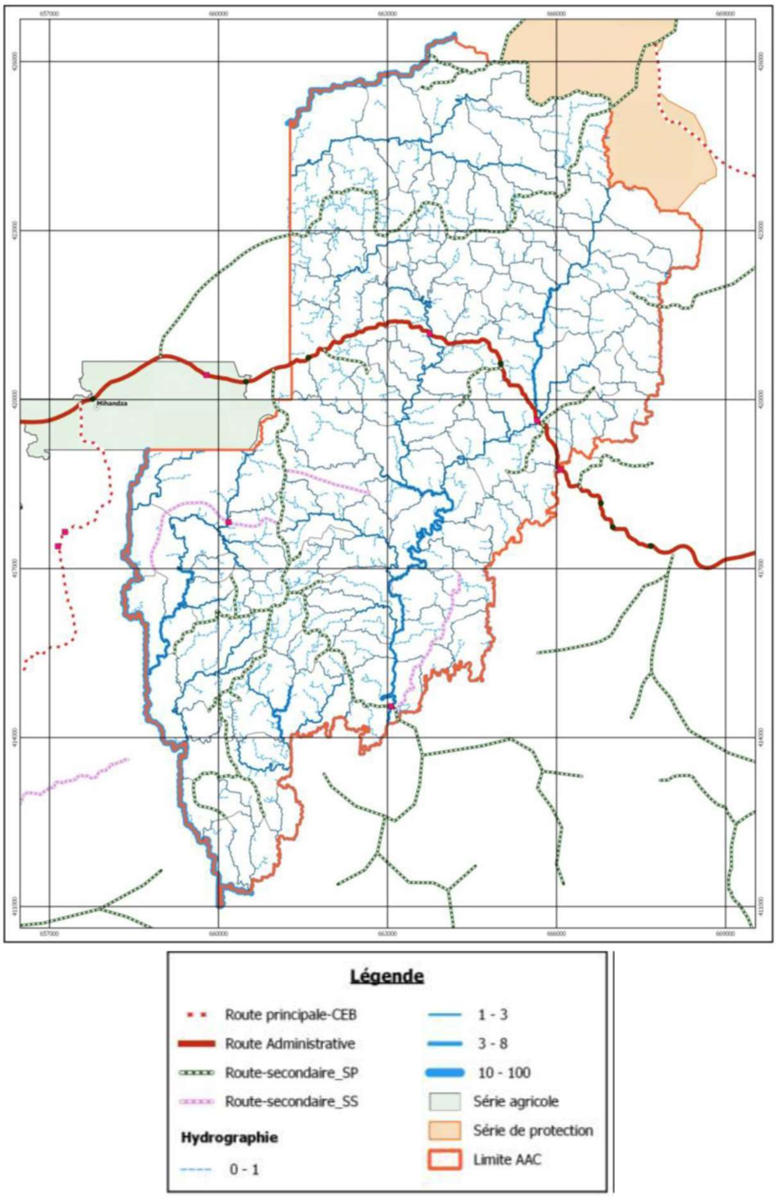
- The distribution of the resource (high or low density area) thanks to data from the logging operation's inventory;
- The topography (slopes to climb, ridges, passes and valley bottoms) such as the SRTM or IGN (National Institute of Geographic and Forest Information) maps;
- The hydrographic network (width of rivers, and places to build bridges and embankments)
- The nature of the terrain (sand / clay / rock / presence of laterite).
- The remoteness in terms of permanent timber removal axes.
- The elements to be protected, such as those in the HVC reports or in operational inventory data:
    - Protection of watercourses, marshes/rivers
    - Remarkable biodiversity elements (bais, etc.)
    - Social elements (agricultural fields, sacred sites, etc.).

FSC companies follow general principles regarding the planning of logging roads:

- **Planning and tracing of the road network as early as possible** on the logging site;
- **Minimise the length of roads** as much as possible;
- **Opt for the re-opening of previously existing roads** if the routing allows for it;
- **Whenever possible, orientation should be chosen in such a way as to maximise light,** which will cause the least possible amount of destruction;
- **Whenever possible, avoid biologically or ecologically sensitive environments;**
- **Minimise the number of watercourse crossings,** because they are technically challenging and have a highly significant environmental aspect;
- A maximum amount of planning should be focused on ridges in the less hilly areas;
- Planning must define the areas to be logged over the various seasons: **poor, remote and high-constraint areas are to be logged during the dry season, while areas that are rich, nearby and with few constraints will be logged during the rainy season.**
- **The optimal route (both economically and ecologically speaking) should be selected.**

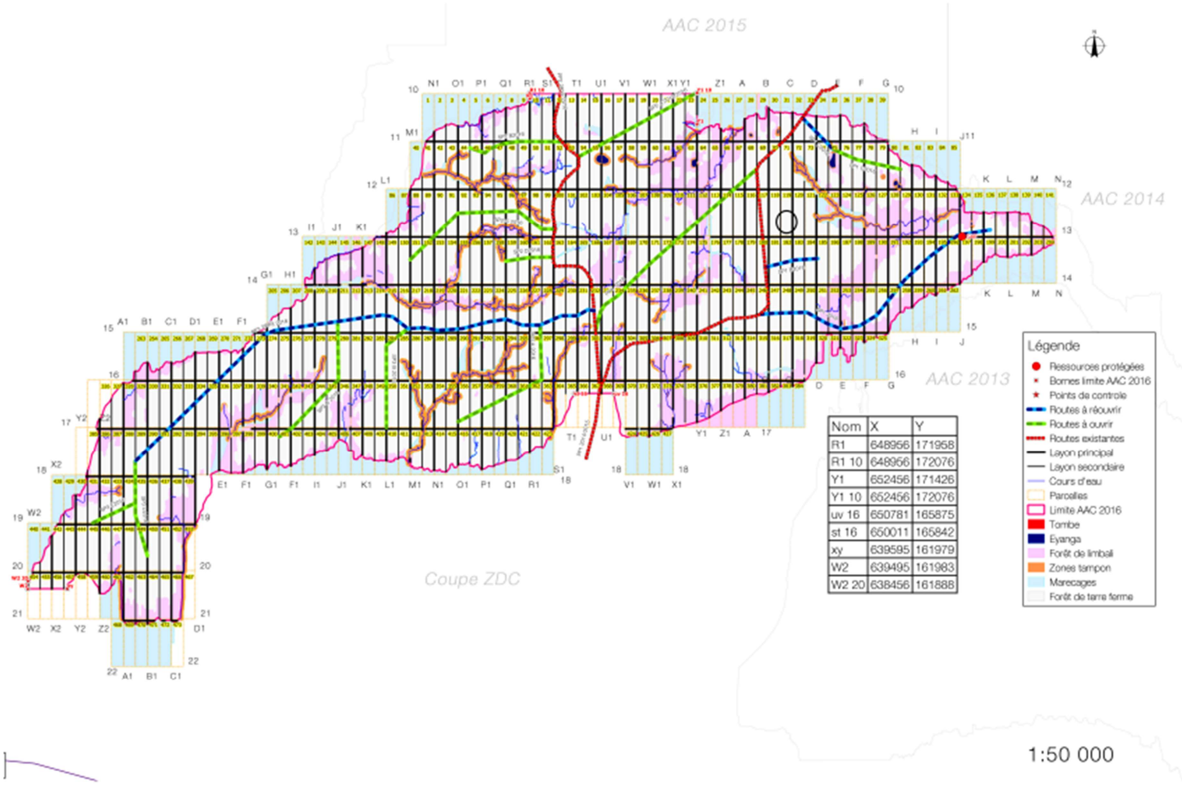
Two types of logic have been identified:

- **Rough terrain logic:**
  - Topographic and hydrographic data is used;
  - Theoretical layouts are sinuous and clearly established using topographical backgrounds;
  - Dry season and rainy season roads are planned well in advance;
  - Delimitation of logging operations in pockets (peaks).



Map 1 – Road infrastructure project in rough terrain (Gabon)

- **Flat terrain logic:**
  - Hydrographic data is used;
  - A representation of the counting plots guides the routes of roads in order to follow the 2 km spacing rule between secondary roads;
  - Theoretical routes tend to be rectilinear and centred on ridges;
  - Delimitation of logging operations in plots.



Map 2 – Road infrastructure project (Congo-based company)

5. POST-LOGGING OPERATIONS

Post-logging operations are a key point in RIL. **Often, this is one of the key features of certified companies,** as most Congo Basin companies that are not certified do not conduct any post-logging activities.

Post-logging activities aim to limit the direct impacts (erosion) and indirect impacts (facilitated access) of roads.

Once implemented, these requirements clearly demonstrate the willingness of FSC foresters to keep their massif under control.

5.1 The closure of roads

In addition to controlling traffic on the company's road network, sometimes in partnership with water and forestry brigades or nature conservation NGOs, all companies implement measures that aim to reduce the access to remote forest areas, either temporarily or permanently. Here are some of the techniques presented in the documents shared by companies.

- **Temporary closure:**

Companies use various temporary closure systems such as: concrete studs connected by cable, the placement of timber and holes in the traffic lane.

- **Permanent closure:**

Companies use various temporary closure systems such as: the placement of timber and holes in the traffic lane, the creation of a pit to form a mound of earth topped by timber, the placement of laterite blocks, etc.

The closure of a permanent main route should be done with specific care: bridges and pipes are disassembled in order to let the water circulate freely over time.

Illustration 12 – Definitive closure of a forest road (Gabon)

5.2 The dismantling of bridges and pipes

The dismantling of bridges and pipes is often considered to be the most effective way of limiting third party access to the forest. This requires ensuring that the area will not need to be accessed again. However, the dismantling of bridges and pipes is to be carried out with great care and the following measures ensure that this is done properly:

- Supervision/monitoring of the dismantling of the structures.
- Pipes are removed during the dry season to avoid water stagnation (and thus the creation of a marsh).
- Digging of the water collection pits for runoff water and outlets so that the water evacuates 60 m away from each side of the watercourse.
- Afterwards, a sedimentation pit is to be dug along the entire width of the road over 30 m away from the water and a pile of soil is to be created to block the road.
- Dismantling of the works, while ensuring that runoff water from the road is properly diverted towards the forest before the river, and by digging a trench perpendicular to the road 10 meters away from the riverbanks.
- Dismantling of the structures by removing the longitudinal ties/pipes and boards one by one
- Increase of the height of the sedimentation pit on the practicable side of the bridge using the dismantled pipes or longitudinal ties
- Restoration of the banks in the case of a forest bridge
- Ensure cleaning of the riverbed
- Verify restored works one year after restoration.

5.3 Methods to protect banks and watercourses

Some companies have sought to develop tools to combat the sedimentation of rivers by installing plywood strips held by stakes and supplemented by leaves. This can also be done with scrap planks (more durable) or stakes planted closely together or stakes cross-planted with horizontal stakes, all of which are supplemented with foliage.

NB: These practices have been developed in an experimental setting and are not generalised.

Photo 2 – Riverbank and watercourse stabilisation strips

This illustrates companies' willingness to perfect the RIL measures by looking for new and more effective practices, such as the above example in terms of erosion control.

6. LOGGING OPERATION MONITORING PRACTICES

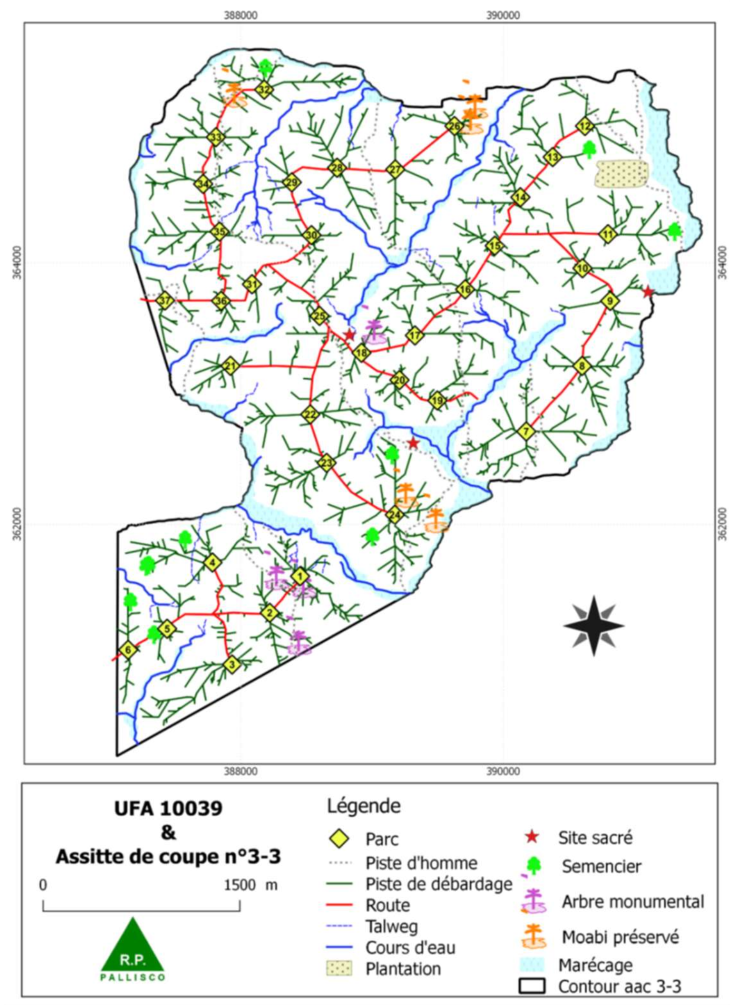
The monitoring of logging operations is a practice that is **almost exclusively specific to FSC companies**. In fact, FSC forest management standards incorporate the requirement that operations be monitored (Principle 8). More specifically, the following practices have been examined in depth:

- Mapping after completion of logging operations
- Monitoring indicators from the various reports (AAC closures, follow-up reports and assessments of the yearly operations, etc.).

6.1 Mapping of post-logging AACs

There are no specific standards for maps that illustrate what has been done such as: roads (possibly with the various types of roads), skidding, parks, harvesting months/periods, selected areas, unused areas, etc.

Map 3 – Location of forest interventions within the allowed cut allocation (Cameroon)



All forestry companies have data and tools that enable them to track their logging activities after completion, including the opening of the road network. The quality of AAC closure maps demonstrates that foresters are able to accurately monitor the evolution of their logging activities within an AAC context.

6.2 Monitoring indicators

An analysis of AAC closure reports, annual logging operation reviews, HCV monitoring reports, etc., enable several points to be highlighted:

- All companies monitor their production, their HCV level, etc. This is an FSC requirement (Principle 8).
- All companies have a fairly large number of indicators on items that range from production tracking to harvest quality indicators, park quality indicators, etc.
- Few indicators are comparable as the calculation methodologies are not necessarily identical.

6.2.1 Basic data

Companies collect a significant amount of basic data that enables one to analyse their performance. The below lists show the basic information used to calculate the indicators that follow thereafter.

Allowable cuts	Total surface area of the AAC zone AAC surface area logged Number of plots /pockets	Average plot / pocket surface area Number of usable crop trees Number of usable crop trees / plots, pockets
Production	Commercial production of the AAC zone (commercial volume in m^3) Total AAC harvest (number of crop trees harvested) Number of species harvested.	
Roads	Total length of planned roads Total length of roads Total length of permanent roads / main roads / secondary (rain) roads	Lengths of reopened / restored roads Average width of permanent / main / secondary roads
Skidding / removal	Lengths of skid trails Lengths of removal trails Average widths of skid trails	
Log yards / quarries	Number of yards planned Number of yards opened	Total surface area of yards Surface area of the various yards Same for quarries
Works (bridges/ pipes/ embankments)	Number of bridges / pipes / embankments built Number of watercourse crossings built	
Surface areas that are protected / sensitive / non-exploited	Wetland areas (swamps and river buffer zones) Non-exploited areas (topography / poverty) Other protected areas (steep slopes, etc.)	
Post-exploitation	Restored surface area (ha) Number of gaps enriched (reforestation effort) Mileage of closed roads after completion of operations Number of bridges / pipes / embankments dismantled after operations	

6.2.2 Monitoring indicators

Companies also control the quality of work such as the opening of roads, conformity with theoretical routes, the quality of water crossing structures, etc. However, FSC-certified companies also monitor their impacts thanks to various indicators.

N.B.: The values presented below are not average values - they are values taken from annual reports. These values may therefore vary depending on the year (market, density, etc.).

Harvest monitoring indicators	
Commercial volume (m^3) / surface (ha)	Between $2.78 m^3$/ ha and $19.1 m^3$/ha based on data provided <u>Maximum threshold</u> of $45 m^3$ / ha (Congo)
Number of stems harvested per hectare	Between 0.66 and 1.97 crop trees/ha based on data provided <u>Maximum threshold</u> of 2.5 crop trees / ha (Congo)
Road monitoring indicators	
Road or road density rate: Length of road (m or km) / surface (ha or 100 ha).	Depending on the company, between 0.64 km and 1.35 km/100 ha.
Valuation of the road: Commercial volume (m^3) / distance (km).	Depending on the company, between 250 m^3 and 2292 m^3/km of road.
River crossing monitoring indicators	
Some companies monitor instances of sedimentation, obstruction, and monitor the condition of crossing structures.	
Skidding-removal monitoring indicators	
Skidding length (m or km) / surface area (ha). **Skidding length (m) / commercial volume (m^3)**	**In Gabon:** 14.63 m/ha in an AAC zone in 2014. **In Gabon:** 1.54 m of commercial skidding/m^3 for an AAC zone in 2014.
Removal length (m or km) / surface area (ha).	**In Gabon:** 67.2 m/ha in an AAC zone in 2014.
Removal length (m) / crop tree harvested *N.B.: The significant difference between these results is due to fact that some differentiate skidding distances and removal distances, while for others these distances are expressed jointly.*	**In Gabon,** in 2014 this rate was 8.24 m of skidding / crop tree harvested. **In Congo,** this varied from 73 to 94 m of skidding / crop tree harvested.
Removal length (m) / commercial volume (m^3)	**In Gabon:** the rate was 7.04 m of skidding/commercial m^3 in an AAC zone in 2014.

Skidding length (m) / crop tree harvested	**In Gabon:** the rate was 37.77m of skidding / crop tree harvested.
Average length of removals	**In Cameroon:** between 3.62 and 3.93 m in 2015.
Impacted surface rate	
Rate of surface areas impacted by logging operations within the AAC zone. *N.B.: not all companies take into account the same items to calculate impacted surface areas.*	**In Congo:** roads, parks, quarries, skid trails, uprooted trees harvested: 8.7% with a maximum threshold of 7% for logging of 0.55 ft / ha. **In Congo:** road openings, felling gaps, skid trails: between 5.8 and 8.8% **In Cameroon:** logging operations: between 7.21 and 9.3% with a maximum threshold of 12% **In Cameroon:** roads, felling, skidding, parcs and quarries: 6.21% with a maximum threshold of 7% **In Gabon:** roads, skidding, park and **excl. felling gaps:** 1.92%
Rate of surface areas impacted by roads (percentage of the surface of an AAC zone) *N.B.: The names change from one company to another (rate of surfaces impacted by roads / clearing rate generated by roads / proportion of trails that are cleared out).* *Some companies provide details by road type and for new roads.*	**In Congo:** between 1.2 and 1.7% depending on the AAC zone with a maximum threshold of 3% **In Cameroon:** (cleared roads): 1.9% **In Cameroon:** between 1.56 and 1.88% **In Gabon:** between 0.5 and 1.1% **In Gabon:** between 0.56 and 1.12%
Proportion of the total surface area impacted by felling gaps	**In Cameroon:** between 1.04 and 4.77% **In Cameroon:** between 2.9 and 3.33%
Surface area disturbed per harvested crop tree (m²)	**In Cameroon:** for example for the sapelli, between 260 and 280m² on average per crop tree.
Proportion of the total surface area impacted by skidding	**In Cameroon:** between 1.31 and 3.6% in 2015 **In Cameroon:** between 3.1 and 3.7% in 2013 **In Gabon:** between 0.6 and 0.9%
Proportion of the total surface area impacted by skidding	**In Cameroon:** between 0.1 and 0.33% in 2015 **In Cameroon:** between 1.1 and 1.71% in 2013 **In Gabon:** between 0.3 and 0.5%
Proportion of the total surface area impacted by quarries	**In Cameroon:** between 0 and 0.05% in 2015
Monitoring indicators for sensitive, protected and preserved areas	

Proportion of the total surface areas of logging operations that are preserved/protected	**In Cameroon:** between 17.4 and 23.5% in 2013 **In Gabon:** 2.6% **In Gabon:** between 27 and 33% depending on the AAC zone
River conservation rate, Wetland damage rate, Buffer zone and marsh conservation rate (%) (excl. crossing), Number of trees felled in buffer zones, Number of sensitive areas damaged by logging operations, Protection of areas with steep slopes, etc.	
Protected tree monitoring indicator	
Crop tree damage rate	**In Gabon:** between 2 and 4% in 2015 with a maximum threshold of 7% **In Cameroon:** 4.8% in 2013
Pressure of logging operations on sensitive species (% exploited / inventoried)	**In Gabon:** for example, okoumé (60%) / Bilinga (68%)
Evolution of the seed preservation rate	**In Cameroon:** In 2013: 9 crop trees per 400 ha with a minimum threshold for certain species (example assamela 1 crop tree /400 ha).
Number of giant trees protected	**In Gabon:** 152 in 2014.
Post-logging operation monitoring indicators	
Proportion of roads closed after logging operations are completed	**In Gabon:** between 7 and 67% depending on the AAC zone in 2015 with a minimum threshold of 100%
Number of bridges and/or pipes dismantled	**In Gabon:** 0 in 2014
Surface area restored in 2015 (ha) **% restored zones / forecasts**	**In Cameroon:** 22777 ha in 2015 **In Cameroon:** 84.9% in 2015
Number of forest gaps enriched	**In Gabon:** 604 in 2014

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