Comparative LCA of
Rolland Enviro100 and Rolland Opaque50 made by Cascades with generic Virgin and Recycled North American papers

Produced by
Sandra Bourret & Mélanie Roy
Cascades Research and Development Centre

September 19th, 2011

EXECUTIVE SUMMARY

This LCA was designed to assess and compare the environmental footprint resulting from the production of uncoated free sheet Rolland Enviro100 and Rolland Opaque50 papers with that of uncoated free sheet, generic 100% recycled and virgin papers, considered representative of the 2009 North American market. As U.S.-based mills comprise 91% of the North American industry, American data was applied as considered most representative of the marketplace.

The results were obtained based on the distribution of one air-dry metric ton of fine paper made from recycled pulp and/or virgin bleached kraft pulp in North America in 2009.

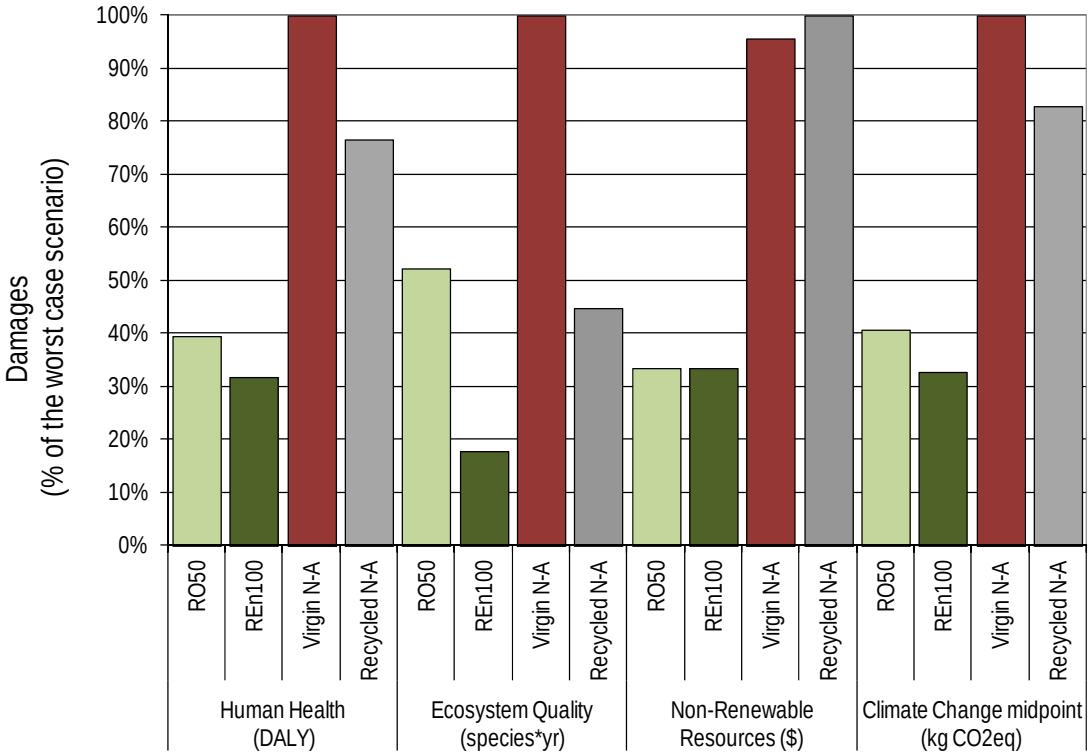
The papers sets under evaluation, generally used for similar commercial printing purposes, such as annual reports, brochures and mass mailings, are as follows:

- Rolland Enviro100 (REn100): Paper made from 100% recycled pulp in a non-integrated mill;
- North American Recycled paper (Recycled N-A): Generic paper made from 100% recycled pulp in an integrated mill;
- Rolland Opaque50 (RO50): Paper made from 50% recycled pulp/50% virgin pulp in a non-integrated mill; and
- North American Virgin paper (Virgin N-A): Generic paper made from virgin pulp in an integrated mill.

This cradle-to-grave study took into account various product [stages in a product's life cycle, including resource production (pulp, energy, chemicals, etc.), paper manufacturing and conversion, waste management, transportation, distribution and end-of-life treatment. However, it excludes the paper use phase as highly variable for fine papers and supporting data is unavailable for North American average use. Furthermore, as these papers were all utilized in the same market, this phase can be considered equal across the various scenarios[1].

The information included in the study is specific to Cascades Fine Papers Group, Rolland Division and to the two recycled pulp units: Breakey Fibres and Auburn Fibers. Data for the North American production of recycled and virgin paper was primarily sourced from the *Ecoinvent* database for the following categories: P*aper, recycling, with deinking, at plant* and *Paper, wood free, uncoated, at integrated mill.* These datasets were then adapted to the North American context by using Environmental Defense Fund (EDF) data for the production of *Recycled office paper* and *Virgin office paper*[2]. Effluent and fresh water supply, energy consumption and supply and waste data were the main sources requiring adaption for use in this analysis. As paper conversion data is unavailable in *Ecoinvent databanks*, the data needed for the generic paper sets specific to electricity, wrappings and wrappings transport was then sourced from Cascades Conversion Center. For the most part, data was sourced from *Ecoinvent*'s life cycle database. All of this information was then modeled by LCA SimaPro software[3] and evaluated on the basis of the life cycle impact assessment method ReCiPe 1.03[4]. The results were then compared to those obtained with Impact 2002+[5] method.

Wood products LCA is closely linked to data for carbon sequestration in soil and trees. The scientific community has yet to determine and establish a consensus on the proper calculation of biogenic carbon in wood products LCA. Cascades has established its position in this report but believes that the evolution of research will result in a more advanced understanding of the true impact of biogenic carbon emissions on climate change. Based on a report from UQAC[6] and on Cascades' informed opinion on carbon non-neutrality of short-lived wood products, the forest carbon balance is not considered to be neutral. This study considers that 20% of biogenic carbon emissions are derived from wood extraction. For every ton of wood harvested, 20% of its carbon content is released to the atmosphere, thereby affecting climate change. This percentage is only to be applied to comparative LCAs that require the use of generic scenarios based on the most representative data available to North America. For specific scenarios when forest inventory data is available, the carbon accounting should be based on actual forest carbon balance figures.



Potential environmental damages of Rolland Opaque50, Rolland Enviro100 and generic North American Recycled and Virgin papers
(ReCiPe 1.03, considering 20% of biogenic carbon from harvested wood)

The results of this study indicate that, of the four papers evaluated, Rolland Enviro100 has the smallest overall environmental footprint, with the exception of its impact on Non-Renewable Resources, which is similar to that of Rolland Opaque50.

When compared to North American Virgin and Recycled papers, Rolland Opaque50 has the smallest environmental impact, with the exception of its larger impact on Ecosystem Quality than the North American Recycled paper. This is mainly due to the use of virgin pulp.

Overall, the differences between the Cascades and the generic North American paper profiles assessed are primarily due to the following:

- ✓ **Higher energy consumption** for production of North American papers;
- ✓ **U.S.-based electricity** as fueled by coal, a source of high GHG emissions, and Cascades' Quebec-based paper production as 95% powered by hydroelectricity; and
- ✓ The use of **fossil fuels** to generate thermal energy for the production of the North American papers, while Cascades leverages biogas, a carbon neutral energy source.

The following table provides an overview of the key environmental impacts for Rolland Opaque50 and Rolland Enviro100, including the processes involved (bolded content) and the leading contributors within each of these processes. Only processes that contributed more than 10% the Damage or Impact category are included below.

Rolland Opaque50 and Rolland Enviro100 Environmental Profile: Leading Contributors
(ReCiPe 1.03, accounts for 20% of biogenic carbon from extraction of wood)

Damage category			Impact category
Human Health	*Ecosystem Quality*	*Non-Renewable Resources*	*Climate Change*
Rolland Enviro100			
Recycled pulp Hard coal supply (US grid mix) Natural gas combustion	**Recycled pulp** Hard coal supply (US grid mix) Natural gas combustion	**Recycled pulp** Hard coal supply (US grid mix)	**Recycled pulp** Hard coal supply (US grid mix)
Transport Waste paper, recycled pulp and paper distribution	**Transport** Waste paper and paper distribution	**Transport** Waste paper, recycled pulp and paper distribution (crude oil depletion)	**Transport** Waste paper and paper distribution
Chemicals Starch	**Chemicals** Starch and sizing agent		
		Energy Natural gas	
Paper landfill Methane emission	**Paper landfill** Methane emission		**Paper landfill** Methane emission
Rolland Opaque50			
Virgin pulp Wood extraction Process energy	**Virgin pulp** Forest occupation/ transformation	**Virgin pulp** Energy Hard coal and natural gas	**Virgin pulp** Wood extraction Process energy
Transport Paper distribution		**Transport** Waste paper, recycled pulp, virgin pulp and paper distribution (crude oil depletion)	**Transport** Waste paper, recycled pulp, virgin pulp and paper distribution
	Chemicals Starch and sizing agent		
		Energy Natural gas	
Paper landfill Methane emission			**Paper landfill** Methane emission

For both Rolland Enviro100 and Rolland Opaque50 the most environmentally impactful processes include are the manufacturing of **recycled and virgin pulp**, the **transport** of waste

paper, the distribution of pulp and paper, the use of chemicals, the sourcing of energy to power mills, and the relative use of paper landfills.

At midpoint in the analysis, the following two results were the only to differ from those observed at the endpoint.

- Rolland Enviro100 has a greater impact on human toxicity than the North American Recycled paper, mainly due to phosphate released in the soil coming from the sludge treatment (deinking and waste water) in mining site remediation.
    - For sludge management, during landfarming, phosphate is absorbed by surrounding plant life, while during the remediation site process, phosphate is released into the soil and thus potentially impacts the environment more than it would in landfarming. The contribution to human toxicity accounts for less than 10% of the overall Human Health indicator score.
- In addition, Rolland Enviro100 demonstrates a greater impact on terrestrial ecotoxicity than the other paper set studies, but, at the end point, the damage contribution is not significant (less than 3%).

The internationally-recognized midpoint indicators that are considered as the main contributors to their respective endpoints are climate change-human health, fossil depletion, agricultural land use, and natural land use.

Sensitivity analysis was employed to test the robustness of the results and respective conclusions. Any parameters that were determined as able to lower the potential impact resulting from Cascades' papers (potential of improvement) or were viewed as highly uncertain but significantly impactful were analyzed. The key takeaways from the sensitivity analysis are as follow:

- ✓ Energy Type (North American): The EDF[1] is the source of the only publicly available data for evaluation of the North American Virgin and Recycled fine papers. Although this data is reliable from a technological and a geographic standpoint, it is relatively outdated. As the virgin uncoated free sheet paper market is now dominated by large high-efficiency mills, a sensitivity analysis using FPAC's data[7] was conducted. This data differs in that it considers total energy as 20% less than EDF data, and fossil fuel consumption at 17% while EDF data is at 48%. As the FPAC data was not considered appropriate for recycled paper, yet another data source was required. The only data source deemed as acceptable to represent the North American Recycled paper's integrated mill, was that derived from the average energy consumption of four Cascades tissue mills, each operating an onsite deinking plant. The energy reported by Cascades tissue mills and applied for the North American Recycled paper sensitivity analysis was 27% lower than EDF-sourced data.
- ✓ Energy Type (Cascades): The replacement of biogas by natural gas in Cascades papers manufacturing processes and the replacement of Quebec's electricity mix by Canadian and US electricity mixes for paper and pulp manufacturing.
- ✓ Biogenic Carbon Accounting: To account for the different biogenic carbon accounting possibilities from wood supply, the results were assessed along the full sensitivity range of 0 to 100%.

- ✓ Transportation: Data on the distances between collection and sorting sites was not available. To estimate that distance and its impact on the results a known distance from sorting plant to the pulp mill was tripled and applied.
- ✓ Allocation procedure: For waste paper, the cut-off approach used in this study was compared to the allocation based on the number of use of virgin paper.
- ✓ Pulp supply: As Breakey Fibres has 40-50% less potential impact than Auburn Fiber, and as pulp manufacturing is a significant contributor to the environmental profile, the impact of choosing one or the other pulp supplier was also tested.
- ✓ Rosin content: Based on secondary research and Cascades' experience, the rosin content of the *Ecoinvent* data used for North American Recycled paper was decreased from 24.5 to 6 kg/MT. The effect of considering 24.5kg/MT was tested.
- ✓ Starch: For the North American papers, the potato starch was replaced by corn starch, which is more commonly used.

Sensitivity analyses demonstrate that the following assumptions, even if they slightly modify their specific environmental profiles, do not significantly affect the results derived from the comparative analysis of the North American and Cascades papers.

However, the use of Impact 2002+ does slightly modify slightly the conclusions obtained with the application of ReCiPe 1.03. Globally, both methods show the same trend, with the exception of an inverse conclusion for Ecosystem Quality caused by ecotoxicity results that take into consideration metal ions released in the soil. The metal ions result from the use of deinking and wastewater treatment sludge. In fact, the importance attributed to the valorized sludge is based on the assessment of a potential environmental impact, for which such impact is currently overestimated in Impact 2002+ for the ecotoxicity as well as for human toxicity as the metals are considered as 100% bioavailable[8].

Monte-Carlo uncertainty analysis also demonstrates that it is unlikely that the comparative analysis profile would be inverted. With the exception of Ecosystem Quality, where there is a small probability that the Rolland Opaque50 impact became lower than that of the North American Recycled paper.

All conclusions of this study should only be considered within their original context.

A third party reviewer critically evaluated this study. All issues raised by the review panel were properly addressed in the LCA report. The review panel assesses that overall the LCA study is in compliance and fulfills the requirements of ISO 14040 and 14044 for studies used to support comparative assertions intended to public disclosure.

Sandra Bourret
Chemical Engineering Technician
Project Manager

Mélanie Roy
Pulp and paper Technician

[1] Jolliet, O., Saadé, M., Crettaz, P., *Analyse du cycle de vie Comprendre et réaliser un écobilan*, ed. P.p.e.u. romandes2005, Lausanne.

[2] EDF, *Paper calculator, Chapter 3 update [Excel]: Tables A-1 to A-5* 2002

[3] SimaPro: www.pre.nl/simapro

[4] Goedkoop, M.J., Heijungs, R., Huijbregts, M., De Schryver, A., Struijs, J. et Van Zelm, R, *ReCiPe 2008, A life cycle impact assessment method which comprises harmonised category indicators at the midpoint and the endpoint level, First edition Report I:.* 2009: p. 126 p.

[5] Jolliet, O., Margni, M., Charles, R., Humbert, S., Payet, J., Rebitzer, G., Rosenbaum, R., *IMPACT 2002+: A New Life Cycle Impact Assessment Methodology.* International Journal of Life Cycle Assessment 8 (6). 2003. 8(6).

[6] Boucher, J.-F., Laurent, A.-B., Wells, J.-R., and Villeneuve, C., *An assessment of the biogenic carbon net emissions from the North American forest sector: Technical report.* , 2010.

[7] Canadians mills of paper made of chemical pulp or mechanical pulp

[8] TNO and CML, *Declaration of Apeldoorn on LCIA of Non-Ferro Metals.* , 2004, TNO and CML: Apeldoorn, Netherlands