User's Guide: Products Derived from LiDAR Data - 2nd edition

MINISTÈRE DES FORÊTS, DE LA FAUNE ET DES PARCS







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INTRODUCTION

It has often been shown that the information obtained from aerial LiDAR⁶ surveys generates significant economic benefits for the forest industry and for several other Québec government activity sectors (Lebœuf et al., 2015⁷). Nevertheless, the use of raw LiDAR data remains complex and requires extensive experience and advanced computing tools. To facilitate the use of this data and optimize the benefits of LiDAR data use, the ministère des Forêts, de la Faune et des Parcs (MFFP) has therefore generated and made available a range of user-friendly products derived from LiDAR data.

The purpose of this document is therefore to:

- i) present the basic products derived from LiDAR data that are available as open source data;
- ii) explain the basic tools that facilitate their use in **ArcGIS**;
- iii) explain the basic tools that facilitate their use in **QGIS**;
- iv) present the tools that can be used to develop new derived products (e.g. generate contour lines, convert rasters to polygons, fill lakes, delimit drainage basins (watersheds), reclassify rasters, generate a focal CHM, generate a topographic wetness index, etc.).

⁶ LiDAR: *Light Detection and Ranging*.

⁷ Available online: <u>https://mffp.gouv.qc.ca/documents/forets/inventaire/Analyse_retombees_LiDAR-</u> <u>Finale.pdf</u>

1 LIDAR DERIVED PRODUCTS

The four basic products derived from LiDAR data are the: 1) Digital Terrain Model (DTM), 2) Hillshade (Shaded Relief), 3) Canopy Height Model and 4) Slope Model. These products are in raster format and can easily be viewed in most basic GIS software packages, including ArcGIS and QGIS.

The following is a list of technical characteristics common to the four products presented in this document:

Geodetic reference datum	GRS 80 Ellipsoid
Geodetic reference system	NAD 83 SCRS
Projection	Modified Transverse Mercator (MTM)
Production method	Processed using Lastools, R, Gdal and ArcGIS
Data-viewing software	ArcGIS, QGIS, MapInfo, etc.

1.1 DIGITAL TERRAIN MODEL (DTM)

This raster file provides real numerical values representing altitudes in metres relative to the mean sea level. The raster file's pixel elevation values correspond to the linear interpolation of the network of irregular triangles created from the ground points. The spatial resolution of this raster is 1 metre.



The DTM is a basic product derived from LiDAR. It serves primarily to create the Hillshade and Slopes. It is also used for hydrological models, road construction, flood risk management, visual landscape analyses, and so on.

1.2 HILLSHADE (SHADED RELIEF)

This raster file simulates the three-dimensional appearance of a relief map. It therefore does not contain altitude values. Shadow and light are shades of grey associated with integers from 0 to 255 (from black to white). The spatial resolution of this raster is 2 metres.

A hillshade presents a very detailed image of the terrain and can be used for the identification and interpretation of surficial deposits, drainage, wetlands, etc.



1.3 CANOPY HEIGHT MODEL (CHM)

This raster file provides numerical values representing forest canopy heights or the heights of other raised elements (e.g. buildings). It corresponds to the difference between the digital surface model and the digital terrain model. The "MHC_nofeuillet.lyr" file represents a symbology (range of colours) for height in metres. The spatial resolution of this raster is 1 metre.



The CHM can be used to measure height, density and stand structure, and to construct statistical relationships in order to map volumes, basal areas, etc.

It should be noted that different elements must be taken into account before using the CHM to evaluate the height of trees or vegetation:

- 1. Tree heights are generally slightly underestimated by LiDAR. The disparity is greater in coniferous forests than in deciduous forests. It is also greater when the point density is lower. For example, a study done in the "reserve faunique des Laurentides" showed an underestimation of -0.98 metres based on 431 tree measurements and a LiDAR datum with a density of 7.1 points/m² (Sadeghi *et al.*, 2016). On the other hand, given that several factors have to be taken into account (forest type, point density, forest cover, etc.), it is strongly suggested that users carry out their own field measurement campaigns to determine if any adjustments to the data set are necessary.
- 2. The CHM can accurately determine the height of trees and vegetation. Based on the tops of fir and spruce trees, the CHM may initially make it appear that the crowns are much smaller in width than they actually are, because sometimes only one pixel, located on the highest point of the tree (e.g. 20 m), shows the actual height of the tree. The other surrounding pixels indicate lower values for the crowns (e.g. 15 m).
- 3. Finally, it should be noted that a certain expertise is required to integrate tree heights derived from a CHM to forest stand polygons. It is necessary to take the local maxima (maximum height of each crown) from the CHM and choose from a multitude of calculation methods to integrate the various heights (example: 95 th percentile, modal height, etc.).

1.4 SLOPE MODEL (SLOPES)

This raster file provides real numeric values representing slopes. The product is generated from the digital terrain model. The file "Pentes_*nofeuillet*.lyr" represents a symbology (range of colours) for slope classes: A [0 to 3 %], B]⁸3 to 8 %], C]8 to 15 %], D]15 to 30 %], E]30 to 40 %], F]40 to 50 %], X1]50 to 70 %], X2]70 % and +].



The slopes map can be used as a support tool for forest operations or roads construction.

⁸ The open bracket shows that the value is excluded from the class.

2 AVAILABILITY OF LIDAR DERIVED PRODUCTS

The first areas benefiting from LiDAR derived products in 2016 were the Saguenay – Lac-Saint-Jean region (UA 024-51), Mauricie region (UA 041-51) and the entire Outaouais region. In the following years, several other regions of Québec were also able to benefit from these products. LiDAR products are expected to be available for all of southern Québec by the end of 2022. For information on the areas for which products will be released in the future, please refer to the LiDAR product availability schedule at:

https://mffp.gouv.qc.ca/wp-content/uploads/Disponibilite_produits_derives_LiDAR.pdf

3 ACCESS TO LIDAR DERIVED PRODUCTS

LiDAR derived products are available free of charge and can be viewed or downloaded through three different ways.

A) Through the *Forêt ouverte* interactive map, users can **view** different basic LiDAR products and **download them free of charge**. To do this:

- 1. Access the interactive map: <u>https://www.foretouverte.gouv.qc.ca</u>;
- 2. In the menu, click on the "Cartes prédéfinies (Map themes)" tab.
- 3. Choose the "LiDAR" theme.
- 4. View the layers of your choice by clicking on the eye (it must be green).
- 5. If the eye next to a layer is grey, zoom in.
- 6. To download LiDAR derived products, display the layer "LiDAR Téléchargement (pleine qualité)" and click on the map sheet you wish to download.
- 7. If layers are superimposed, select the "LiDAR Téléchargement (pleine qualité)" layer in the new window that opens at the bottom of the screen.
- 8. Select a product by clicking on the "Accéder" button.

B) You can also view and download the data in a GIS (geographic information system) from the following Web map service (WMS):

https://geoegl.msp.gouv.qc.ca/ws/mffpecofor.fcgi?

C) It is also possible to download these products directly from the Données Québec website (the gouvernement du Québec collaborative, open data internet portal). To do this:

- Refer to the "<u>Données Québec</u>" LiDAR fact sheet. This fact sheet also contains other information pertaining to the use of these products, including metadata (year of acquisition, point density and presence of leaves).
- 2. Directly access the data directory, where data is categorized by map sheet: <u>https://diffusion.mffp.gouv.qc.ca/public/Diffusion/DonneeGratuite/Foret/IMAGERIE/Pr</u> <u>oduits_derives_LiDAR/</u>.

4 RASTER DATA IN ARCGIS

This section covers basic operations used to facilitate the use of LiDAR derived products with the commercial software package ArcGIS. While these techniques can all be used with other GIS software, the procedures will differ from one to another (operations for QGIS are described in <u>Chapter 5</u>). Also, take note that the proposed ".lyr" symbology will not work with other GIS applications.

4.1 BASIC FEATURES

4.1.1 View Raster Data

Once you have downloaded the LiDAR derived products (see <u>chapter 3</u>), you can open the files in ArcGIS by clicking on the "Add Data" button.



In the following window, select the ".tif" file of the map sheet you wish to view, or select the ".lyr" file to view the symbology proposed with the data (Note: MHC = CHM, MNT = DTM, MNT_Ombre = Hillshade and Pentes = Slopes).

Add Data			×
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The proposed symbology will appear if you selected a ".lyr" file.

4.1.2 Change the Symbology and Select Classes

To modify the proposed symbology, place the cursor over the layer name, right-click and select the layer's properties. The following window will appear. In the "Symbology" tab, click on "Classified" to change the number of classes. Then click on "Classify ..." to change the class break values.

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b	Sho	v dass b	oreaks usir	ng cell values		Display NoD	ata as	
About sy	nbology	Use	hillshade	e effect	Z:	1		



The following window will open where you can change the class break values.

To save the new symbology, place the cursor on the layer name, right-click and select "Save as layer file". You can then import this new ".lyr" symbology using the "Import" icon, as shown on the following image.

Layer Properties		×
General Source Key M	etadata Extent Display Symbology	
Show: Vector Field Unique Values	Draw raster grouping values into	classes 🔂 🔒
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	1 - 2	1 - 2 m
	2 - 3	2 - 3 m
1. The second	3 - 4	3-4m
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About symbology	Use hillshade effect	1
<u>noodcojmoology</u>		
		OK Annuler Appliquer

4.1.3 Create a Transparent Layer of a DTM Combined With a Hillshade

Combining a DTM and a Hillshade can be used to interpret certain terrain features. First, you must modify the DTM's symbology. To do so, position the cursor on the layer name and right-click to select the layer's properties.

Next, in the "Symbology" tab, select the "Stretched" category and choose a color ramp. You can also import the DTM's ".lyr" to apply the predefined symbology (see <u>section 4.1.1</u>).

Layer Properties	Ϋ́,				×
General Source Key Me	etadata Extent Display	Symbology			
Show: Vector Field Unique Values Classified	Stretch values along a	a color ramp		E	
Discrete Color	Color	Value 467,025 374,679	Label High : 467,025 Low : 374,679	Labeling	
	Color Ramp:	nd Value: ect Z: 1	0 L Disp	as 📃 🗸	
About symbology	Type: Percen min: 0,5	nt Clip] ma: bretch:	×: 0,5	Histograms	~
			ОК	Annuler	Appliquer

Next, go to the "Display" tab of the layer's properties window and apply a 50 % transparency.

Layer Properties			×
General Source Key Metadata Extent	Display	Symbology	
Show MapŢips Display raster resolution in table of conte Allow interactive display for Effects toolb	ents Þar		
Resample during display using:			
<u>C</u> ontrast: 0 % Brightness: 0 % Transparency: 50 % Display Quality Coarse Medium		Orthorectification Orthorectification using elevation Constant elevation: DEM Elevation adjustment Z factor: 2 factor: 2 offset: 0 Coord: Coord: Coord: Coord: Coord: Coord: Coor	
		OK Annuler Appliqu	er

When you overlap the DTM with the Hillshade, interpretation of the two combined layers provides information about both altitude and terrain.



4.1.4 Create a Hillshade from a DTM

The proposed Hillshade was designed with ArcGIS's default azimuth value of 315°. In some cases, depending on the direction of the glaciers, it may be appropriate to generate a hillshade at another azimuth for the relief of certain terrain structures to stand out, such as eskers.

To generate a new hillshade, you must add the DTM to ArcGIS. Next, open the image analysis window by clicking on "Windows" and then "Image analysis".

When the window appears, check the DTM to be edited. In the "Processing" section, select the desired colour gradient (black and white in the following example) and click on the "Hillshade"

icon:

Image Analysis		×
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The hillshade will appear in ArcGIS.

To change the azimuth of the hillshade, place the cursor on the name of the newly generated layer and right-click to select the layer's properties. Select the "Functions" tab, place the cursor on the hillshade function, right-click and then click on "Properties".

Layer Properties							
General Source Key Metadata	Extent Display Symbology Functions						
Function Chain							
MNT_3	Insert Function > Insert Python Raster Function Remove						
	Properties						

The following window, in which you can change the azimuth and Z factor in the "Hillshade" tab, will appear. We recommend that the Z factor be set to 2. It is preferable to set the azimuth to a value perpendicular to the land structures to be detected, as shown in the two examples below, where the angle of 320° makes it possible to identify a steep slope, something that cannot be done using an angle of 270°. A southern azimuth angle (e.g. 180°) should not be used because the topography will be reversed, as in the third example below.

Raster Function Properties		×	
General Hillshade Output Info	eneral Hillshade Output Info Key Metadata		
Input DEM: Azimuth:	MNT_32I12NE.tif	B	
Altitude:	45		
Scaling:	NONE		
Z Factor:	2 🖌		
Pixel Size Power:	0,664		
Pixel Size Factor:	0,024		
Remove edge effect			
	ОК	Annuler	



Example 1: Hillshade with a 270° azimuth and a Z factor of 2.



Example 2: Hillshade with a 320° azimuth and a Z factor of 2.



Example 3: Hillshade wtih a 180° azimuth (south) showing reversed topography.

4.1.5 Create a Slope Model

To create a slope model, a DTM must be added to the map's table of contents. Next, click on "Windows" in the toolbar and select "Image Analysis". When the window opens, select the DTM on which you wish to work and then click the "Add a function" button (in yellow in the image below) in the "Processing" section.

	Image Analysis 🛛 🗖	×
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A new window will open. Place the cursor on the DTM, then right-click and select "Insert Function". Select "Slope Function" from the list of functions.

Function Template Editor Function Chain Kabs2752_c058_4c82 Guidentity Function		f.s: f.s: f.s: f.s:	Curvature Function Elevation Void Fill Function Extract Band Function Geometric Function
MNT_32112M5	Insert Function Insert Python Raster Function Remove Properties	5x 5x 5x 5x 5x 5x 5x 5x 5x	Grayscale Function Hillshade Function Local Function Mask Function ML Classify Function NDVI Function
JX JX		fs: fs: fs: fs:	Resample Function Segment Mean Shift Function Shaded Relief Function Slope Function

A new window will open where you should select PERCENT_RISE as the output measure. Leave the Z factor at 1 and click on OK.

Raster Function Properties	×
General Slope	
Input <u>D</u> EM:	MNT_32I12NE.tif
Output Measurement:	PERCENT_RISE ~
<u>Z</u> Factor:	1
Pixel Size <u>P</u> ower:	0,664
Pixel Size <u>F</u> actor:	0,024
Remove edge effect	
	OK Annuler

Then click on OK in the "Function Template Editor" window, and you will obtain a black-and-white slope model. You can change the symbology (see <u>section 4.1.2</u>) or apply a ".lyr" file containing the desired symbology (see <u>section 4.1.1 or next page</u>). You can downlowd the proposed ".lyr" for slopes from the "Symbologie.zip" file at:

https://diffusion.mffp.gouv.qc.ca/public/Diffusion/DonneeGratuite/Foret/IMAGERIE/Produits_d erives_LiDAR/ To change the symbology, right-click on the layer you have created and select "Properties" to open its properties. In the "Symbology" tab, click on the "Import" button (in yellow in the image below), then select the ".lyr" file containing the symbology (e.g. "Pentes_32I12NE.lyr") and click on OK.

Layer Properties					×
General Source Key M	Metadata Extent Display	/ Symbology Functi	ions	\mathbf{X}	
Show: Vector Field Unique Values	Draw raster groupin	g values into classe	25	`	2
Classified Stretched Discrete Color	Fields Value <value></value>	Norm	alization	<none></none>	\sim
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About symbology	Symbol Range 0 0 - 3 3 - 8 3 - 8 8 - 15 15 - 30 30 - 40	sing cell values Z: 1	Label Nulle A (0 à 3%) B (4 à 8%) C (9 à 15%) D (16 à 30%) E (31 à 40%) D (16 à 50%) D (16 à 50%) D (16 à 50%) D (16 à 50%) D	isplay NoData as	~
			ОК	Annuler	Appliquer

This will give a slope layer with the desired symbology, similar to the image below. In the proposed symbology for slopes, the upper value of each class is included, e.g. the 0 to 3 % includes the value 3.000000 %, and the 3 to 8 % class starts at 3.000001 % and includes the value 8.000000 %.



4.1.6 Assemble Several Rasters

To assemble multiple raster images together, you can use the "Mosaic to New Raster" tool by clicking on "Data Management Tools > Raster > Raster Dataset > Mosaic To New Raster" in ArcToolbox. Assembly is best done using a limited number of map sheets. With more than 10 map sheets, the generated raster will probably be too large to use.



- 1. Input Rasters: Select the .tif images, not the .lyr files.
- 2. *Output Location*: Select the file in which the new raster will be saved.
- 3. *Raster Dataset Name with Extension*: Assign the name of the output raster with the .tif extension.
- 4. Spatial Reference for Raster (optional): Select the reference for one of the data layers.
- 5. *Pixel Type (optional)*: Select 8_BIT_UNSIGNED for a hillshade and 32_BIT_FLOAT for other products.
- 6. *Cell size*: Select the desired resolution (1 m is used in this example).
- 7. Number of Bands: Select 1.

- 8. *Mosaic Operator (optional)*: Select "Maximum", because the overlapping pixels are generally similar. However, other types of operators would have little impact on the result.
- 9. Mosaic Colormap Mode (optional): Select "First".

4.1.7 Clip Raster Data in a Given Area

To clip a raster, first select the raster to be clipped. Then select "Customize" > "Toolbars" and "Draw". Use the rectangle tool to create a rectangle for clipping.





Open the image analysis window by clicking on "Windows" > "Image Analysis". In the image analysis window, click on the "Clip" tool.

Win	dows Help			Image Analysis	□ ×
	Overview			°=	
	Magnifier			MNT_Ombre_32I12NE.tif	
	Viewer				
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			$\overline{\}$	Processing	-
				Use the data view extent or a selected polygon graphic or feature to chip out a portion of the selected layer(s), and create a temporary layer for each selection.	200

•

Lastly, right-click on the name of the clipped image and then on "Data > Export Data". This will enable you to save the new clipped raster.



C:\Users\majme1\Documents\ArcGIS\Default.gdb

Format:

(1-100):

Save

Compression Quality

File Geodatabase

75

Clip_MNT_Ombre_3

NONE

Location:

Compression Type:

About export raster data

Name:

÷.

Cancel

4.2 ADVANCED FEATURES

Other products can be created from basic LiDAR derived products using territorial analysis. Both applications previously mentioned (ArcGIS and QGIS) offer tools that can be used to obtain contour lines, convert rasters to polygons, fill lakes, delimit drainage basins (watersheds), reclassify rasters, generate a focal CHM, generate a topographic wetness index, etc.

4.2.1 Create Contour Lines

Requires the 3D Analyst licence (see the licence-free process with QGIS in <u>section 5.3.1</u>).

To create contour lines, you will need one or more DTMs for the region for which you want the contour lines. The DTMs should ideally be clipped (see <u>section 4.1.7</u>) or combined to obtain the desired area only, since this will increase processing speed. Once the area is ready, open ArcToolbox and select "3D Analyst Tools" > Raster-surface > Contour". The following window will open.

In the new window, select your "Input raster", select the output location ("Output polyline features" field) and enter the required distance between each line in the "Contour interval" field.

ArcToolbox	≺ Contour	
ArcToolbox ArcToolbox 3D Analyst Tools 3D Features CityEngine CityEngine Conversion Conversion Conversion Raster Management Raster Interpolation Raster Math Raster Reclass Raster Surface Raster Surface Raster Surface Contour Contour List Contour with Barrier Curvature Curvature Cut Fill Hillshade	Input raster Output polyline features Contour interval Base contour (optional) Z factor (optional) OK Cancel Environn	0 1
✓ Cut Fill ✓ Hillshade ✓ Slope		



This will give a result similar to the following image.

The colour of the lines can be changed by right-clicking on the layer and selecting the "Symbology" tab of the "Layer Properties" window. Labels can also be displayed using the "Labels" tab in the "Layer Properties" window. Check "Label features in this layer" and select the "Label Field" you wish to display.

Layer Prope	rties										
General S	Source	Selection	Display	Symbology	Fields	Definition	Query	Labels	Joins & Relates	Time	HTML Popup
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Method:		Label	all the fea	tures the sam	e way.			\sim			
All featu Text S	ires will b String —	be labeled u	ising the c	options specifi	ed.						
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Other	Options						Pre-defi	ned Labe	el Style		
	Placeme	ent Propertie	es	Scale	Range.			Lab	el Styles		
									OK An	nuler	Applique

4.2.2 Reclassify Rasters

It can be useful to reclassify rasters, among other things to convert a raster file into a vector layer. This operation requires the "Spatial Analyst" extension and is carried out using the Hillshade layer. First, the desired Hillshade must be added to the project's table of contents. Next, open ArcToolbox and select "Spatial Analyst Tools > Reclass > Reclassify". The following window will open.

Next, select the raster on which you wish to work and select "Value" in the "Reclass field". To reclassify the values, click on the "Classify" button in the reclassification section. The list of values will then appear in the field on the left-hand side, and a predefined classification will be offered. You can change it as you wish. Once the classification values have been chosen, select a location for your output raster and click on OK. Your new raster will be added to your map's table of contents.



4.2.3 Convert a Raster Image to Vector Format (Polygons)

Converting a raster image to vector format allows LiDAR data to be used on certain types of GPS devices that are unable to read raster files. Please note that the process is very time-consuming, so make sure you have clipped the area you want (see la <u>section 4.1.7</u>) before starting the process. In addition, we recommend reclassifying the raster (see <u>section 4.2.2</u>) to avoid producing a polygon for each pixel, which would make the layer too big to use.

To convert a raster, start by adding the raster you wish to convert to the project table of contents. Then, from Arc Toolbox, select "Conversion Tools > From Raster > Raster to Polygon". Next, select the desired input raster, select a location for the output polygon file, and click on OK.



4.2.4 Create a Focal CHM

A focal CHM can be created from a CHM. The focal CHM better indicates the maximum canopy height value for coniferous trees, making it easier to interpret stand height. However, the focal CHM artificially expands canopy diameter and thereby significantly overestimates cover density.

To create a focal CHM, start by adding the desired CHM to the project table of contents. Next, in Arc Toolbox, select "Spatial Analyst Tools > Neighborhood > Focal Statistics". The following window will open. In this new window, select the CHM you want as the input raster and select a location for your output raster. Next, select "Circle" in the "Neigborhood" drop-down menu and "MAXIMUM" in the "Statistics type (optional)" drop-down menu. For a CHM of a coniferous or mixed forest, you should test several radius values, but the value 3 generally gives good results and provides a better view of the maximum coniferous stem value.

ArcToolbox			
 Spatial Analyst Tools Conditional Density Distance Extraction Sequentization Sequentiza	Input raster Output raster Output raster Neighborhood (optional) Circle Neidhborhood Settinas Radius: 3 Units:		
 Block Statistics Filter Focal Flow Focal Statistics Line Statistics 	Statistics type (optional) MAXIMUM Ignore NoData in calculations (optional)	how Help >>	, J

After processing, you will obtain a raster similar to the following image.



Focal CHM



4.2.5 Topographic Wetness Index

The topographic wetness index (TWI) is used to assess the ground's capacity to retain moisture. It takes into account water accumulation and slopes at a specific location.

 Vome / Browse / Science & Engineering / Simulations / SAGA GIS

 Vome / Browse / Science & Engineering / Simulations / SAGA GIS

 SAGGA GIS

 Business Software

 Value

 Value

You must first download the SAGA file from: <u>https://sourceforge.net/projects/saga-gis/</u>.

Next, install the necessary SAGA toolboxes. To do this, right-click on "Arc Toolbox" and select "Add a toolbox". Then select the folder in which you saved your SAGA file (it must be unzipped first). In the SAGA file, select "ArcSAGA Toolboxes" and install the "Terrain Analysis - Preprocessing" and "Terrain Analysis - Hydrology" toolboxes.

Add Toolbox				×	
Look in: 🗧 /	ArcSAGA Toolboxes 🗸 🖌	۵ 🏠	🗟 🗰 🕶 🖻	<u>•</u> 🖆 🗊 🗳	
🛐 Shapes - Tra	insects.pyt		🜍 Terrain Ana	lysis - Lighting, V	
🗿 Spatial and	Geostatistics - Grids.pyt		🌍 Terrain Ana	alysis - Morphom	
🗿 Spatial and (Geostatistics - Kriging.pyt		🇊 Terrain Ana	alysis - Preproces	
🛐 Spatial and	Geostatistics - Points.pyt		🌍 Terrain Analysis - Profiles.py		
🛐 Spatial and	Geostatistics - Regression.pyt		🎯 Terrain Analysis - Slope Stab		
🛐 Terrain Anal	ysis - Channels.pyt		🌍 Tool Chains - Climate and V		
🛐 Terrain Anal	ysis - CliffMetrics.pyt	🌍 Tool Chains - Files.pyt			
🛐 Terrain Anal	ysis - Compound Analyses.pyt		Tool Chains	s - Grid Collectio	
🛐 Terrain Anal	ysis - Hydrology.pyt		🌍 Tool Chain	s - Grid Filters.py	
<				>	
Name:	Terrain Analysis - Hydrology.pyt; Te	rrain Ana	lysis - Preproc	Open	
Show of type:	Toolboxes		\sim	Cancel	

Once the toolboxes have been installed, the first process is to fill surface depressions. To do this, select "Preprocessing > Fill sink XXL". In the new window, select the DTM you want in the "DEM"

field, then select the location of the output file ("Filled DEM" field) and enter 0.01 as the "Minimum Slope [Degree] (optional)".

्रे Fill Sinks XXL (Wang & Liu)	- 🗆 X	(
	Fill Sinks XXL (Wang & Liu)	>
Filled DEM Filled DEM Degree] (optional) 0,01	This tool uses an algorithm proposed by Wang & Liu to identify and fill surface depressions in digital elevation models.	<
OK Cancel Environments << Hide Help	Tool Help	

Next, "Hydrology > SAGA open Wetness Index". The window on the right will be displayed. Select the DTM resulting from the first process (Filled DEM) in the "Elevation" field. Next, select a location for the output files, namely "Catchment Area", "Catchment Slope", "Modified Catchment Area" and "Topographic Wetness Index". Lastly, select "total catchment area" for "Type of Area" and "local slope" for "Type of Slope". The other settings should be default values.

This will give you the TWI in raster format. You can then change the symbology if you want (see <u>section 4.1.2</u>).

For more information about this method, see the following video on YouTube, produced by Sylvain Jutras and his team from Université Laval:

https://www.youtube.com/watch?v=V2hTDlhwo7s.

SAGA Wetness Index		x
Elevation		*
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	-	
Catchment Area		
Catchment Slope 🚩		
Modified Catchment Area 🚩		
	2	
Topographic Wetness Index		
	2	
Suction (facultatif)		
	10	
Type of Area (facultatif)	-	
Type of Slope (facultatif)	•	
local slope	•	
Minimum Slope (facultatif)		
	0	
Offset Slope (facultatif)	0.1	
Slope Weighting (facultatif)	0,1	
	1	
		Ŧ
OK Annuler Environnements	<< Masquer l'ai	de

5 RASTER DATA IN QGIS

This section covers basic operations for an easy use of LiDAR derived products in the open source software QGIS. These techniques work in other GIS applications, however the methods used differ from one to another. Also, take note that the suggested ".qml" symbologies will not work with other GIS applications.

5.1 DOWNLOAD AND INSTALL THE APPLICATION

QGIS is a free and open source geographic information system. It is user-friendly and designed for the general public. It can be downloaded from the QGIS website (<u>https://qgis.org/en/site/index.html</u>) and installed on multiple workstations free of charge. The application is created and constantly upgraded thanks to an extensive network of volunteers and user donations.



5.2 BASIC FEATURES

5.2.1 View Raster Data and Download Predefined Symbologies

Once you have installed QGIS and downloaded the LiDAR derived products (see <u>chapter 3</u>), you can open the files by clicking on the "Layer" tab, then "Add Layer" and "Add Raster Layer...".

Q Untitled Project -	QGIS	
Project Edit View	Layer Settings Plugins Vector Baster D	atabase <u>W</u> eb Pro <u>c</u> essing <u>H</u> elp
	Data Source Manager Ctrl+L Create Layer	
	Add Layer	Kan Add Vector Layer Ctrl+Shift+V
Layers & Re	Embed Layers and Groups	Add Raster Layer Ctrl+Shift+R
🥰 🕼 👒 »	Add from Layer Definition File	Add Delimited Text Layer
	R Copy Style	Reference Add PostGIS Layers Ctrl+Shift+D
	Paste Style	Radd SpatiaLite Layer Ctrl+Shift+L
		Madd MSSQL Spatial Layer Ctrl+Shift+M
	Copy Layer	Add DB2 Spatial Layer Ctrl+Shift+2
	Paste Layer/Group	Add Oracle Spatial Layer Ctrl+Shift+O
	Open <u>A</u> ttribute Table F6	Add/Edit Virtual Layer
	// Toggle Editing	Add WMS/WMTS Layer Ctrl+Shift+W
	B Save Layer Edits	Add Arc <u>G</u> IS MapServer Layer
	/// Current Edits	Add WCS Layer
	Save As Save As Laver Definition File	Mdd WFS Layer Image: Add ArcGIS FeatureServer Layer

Once the following window opens, click on the "..." to select the ".tif" file of the map sheet you wish to view, and click on "Add" (Note: MHC = CHM, MNT = DTM, MNT_Ombre = Hillshade and Pentes = Slopes).

Q Data Source Manager Raster		? <mark>x</mark>
📛 Browser	Source type	
V- Vector	File Protocol: HTTP(S), cloud, etc.	
Raster	Source	
▶ Delimited Text	Raster Dataset(s) D:\QGIS\MNT_32A10NO.tif	∞
🍄 GeoPackage		
🍂 SpatiaLite		
MSSQL		
DB2 DB2		
🙀 Virtual Layer		
C wms/wmts		
🚑 wcs		
WFS		
Recursion ArcGIS Map Server		
ArcGIS Feature Server		
CeoNode GeoNode	Close Add	Help



Once the file opens, a black-and-white layer will appear on the screen.

The predefined symbologies are not included in the ".tif" file. Separate ".qml" files must be downloaded (the ".lyr" format does not work in QGIS). These symbologies are in the Symbologie.zip file at:

https://diffusion.mffp.gouv.qc.ca/public/Diffusion/DonneeGratuite/Foret/IMAGERIE/Produits_d erives LiDAR/.

() () () () () () () () () ()	nffp.gouv.qc.ca/Pt 🔎 👻 🖒	🖉 Répertoire FTP /Public/Diffusi	<i> Répertoire FTP /Public/D</i>
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11/18/2019 10:53	Répertoire 226		
11/18/2019 10:53	Répertoire 22H		
05/16/2018 12:00	Répertoire 221		
05/16/2018 12:00	Répertoire 22J		
12/05/2017 12:00	Répertoire 22K		
10/18/2017 12:00	Répertoire 22L		
05/16/2018 12:00	Pépertoire 32D		
05/16/2018 12:00	Répertoire 32D		
05/16/2018 12:00	Répertoire 32E		
05/16/2018 12:00	Repertoire <u>32r</u>		
06/07/2019 12:00	Repertoire 32G		
06/07/2019 12:00	Repertoire 32H		
06/07/2019 12:00	Repertoire <u>321</u>		
03/10/2020 01:55	Répertoire <u>csv</u>		
01/14/2020 05:23	20,118,809 metadonn	lees.zip	
03/09/2020 02:02	995,265 <u>shp.zip</u>	<u> </u>	
01/14/2020 05:25	37,740 <u>Symbolo</u>	jie.zip	

To display the downloaded symbologies in QGIS, place the cursor over the layer name, right-click and select "Properties" to display the layer properties. The following window will appear.

To upload the desired ".qml" file, select the "Symbology" tab and then "Load Style" from the "Style" drop-down menu.

Q Layer Properties - MNT_3	32A10NO Symbology	
۹. 🗸	Band rendering	
🥡 Information 🛛 🖁	Render type Singleband gray	
Source C	Gray band Band 1 (Gray)	•
Symbology (Color gradient Black to white	•
	Min 271.848 Max	610.917
	Contrast enhancement Stretch to MinMax	•
🗠 Histogram		
Kendering		
Pyramids		
Metadata		
E Legend	Min / max values settings	
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~	Color rendering	
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В	arightness 0 🚔 Contrast	0
S	Saturation 0 🔄 Grayscale	● Off ·
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-	Recompling	
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	umbnail Legend	Palette
	Save as Default	
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	Rename Current	
\checkmark	default	
	Style	Cancel Apply Help

The proposed symbology will be applied to the chosen layer.

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Projet Editer, Vye Southe Ereferences Estensi	nen Venteur Beiter Beite dunnten hoternet Mellinge Innternert Aufe	
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5.2.2 Change the Symbology and Select Classes

The proposed symbology can be changed to suit your needs. To do this, select the layer's properties (right-click on the layer name and select "Properties").

Using the "Symbology" tab in this window, you can change the limit values and colours associated to each class interval by double-clicking on the colour box. You can also use the "Mode" dropdown menu to select different types of class intervals ("Continuous", "Equal Interval", and "Quantile"). Finally, you can change the number of classes by selecting the "+" and "-" buttons next to "Classify".

Q Layer Properties - MNT_32A10NO	D Symbology	? X
্ব ∎ Band ren	ndering	
information Render type	e Singleband pseudocolor	
🗞 Source 🛛 🗛	Band 1 (Gray)	-
Symbology	Min 225 Max 900	
Min / r	max values settings	
	on Linear	•
Histogram Color ramp	p	
Rendering Label unit suffix		
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225 Metadata 450	225 450	
675	675	
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QGIS Server		
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Classif	fy 🔄 😑 😂 🕒 👼	
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▼ Color ren	ndering	
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Brightness	0 🚖 🛛 Contrast 📃 🔹 0	
Saturation	0 🖨 Grayscale Off	
Hue	Colorize Strength	100% 🛓
▶ Resampli	ling	
	Thumbnail Legend Palette	
		~
Style 🔻	OK Cancel Apply	Help

5.2.3 Create a Transparent Layer of a DTM combined with a Hillshade

As mentioned in <u>section 4.1.3</u>, a combination of a DTM and a Hillshade can be used to interpret certain terrain features. First, start by adding the DTM and Hillshade to QGIS and then load the ".qml" symbology for the DTM, as described in <u>section 5.2.2</u>.

Next, in the DTM's "Layer Properties" window (right-click on the layer name, select "Properties"), select the "Transparency" tab and reduce "Global opacity" to 50 %.

Q Layer Properties - N	INT_32A10NO Transparency	• I = • P = •		? ×
٩	Global opacity			
🥡 Information			50.0 %	
🗞 Source	▼ No data value			
😽 Symbology	✓ No data value -3.4028234663852	2886e+38		
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1 Histogram	Transparency band None			•
🞸 Rendering	Transparent pixel list			
🖄 Pyramids	From	То	Percent Transparent	÷
Metadata				
•- · · ·				
Egend				
QGIS Server				
	Style 🔻	ОК	Cancel Apply	Help

Finally, overlap the DTM with the Hillshade. The combination of these two layers provides information on both altitude and terrain.



5.2.4 Create a Hillshade from a DTM

The proposed Hillshade was designed using ArcGIS's default azimuth of 315°. In some cases, depending on the direction of the glaciers, it may be appropriate to generate a hillshade at another azimuth for the relief of certain terrain structures to stand out, such as eskers.

To generate a hillshade in QGIS, you must add the DTM to your project. Next, click on "Processing" in the main toolbar and on "Toolbox".



The "Processing Toolbox" will then appear. Click on "Raster terrain analysis" and then on "Hillshade".

Q Hillshade	2 X
Parameters Log	
Elevation layer	
MNT_32A10NO [EPSG:2950]	•
Z factor	
2.000000	
Azimuth (horizontal angle)	
315.000000	∞ 🌲
Vertical angle	
40.000000 🗡	
Hillshade	
[Save to temporary file]	
Open output file after running algorithm	
0%	Cancel
Run as Batch Process Run in Background Close	Help

In the above "Hillshade" window, select your DTM as "Elevation layer" and identify the "Z factor" and desired "Azimuth" for the hillshade you want to create. The standard azimuth (horizontal angle) is 315° and the recommended Z factor is 2. We also recommend a vertical angle of 40°. Lastly, if you wish to save the final layer, select a file location and name in the "Hillshade" field. Otherwise, the layer created will be lost once you close the project. Click on "Run in Background".

As mentioned in <u>section 4.1.4</u>, it is preferable to set the azimuth at a value perpendicular to the land structures to be detected, and to avoid using a southern azimuth angle (e.g. 180°) which will reverse the topography.

This tool will produce a result similar to the following image. The small sign next to the layer name indicates that this is a temporary layer because no output location was given. To save the file permanently, right-click on the layer name, then on "Export" and "Save as". In the new window, click on "Scroll" to the right of the "File name" field and select a location and layer name. Before closing a project, it is a good idea to check if any layers you wish to save for further use have this symbol.



5.2.5 Create a Slope Model

To create a slope model using QGIS, you must start by adding a DTM to your project. Next, in "Processing Toolbox" ("Main toolbar" > "Processing" > "Toolbox"), click on "Raster terrain analysis" and then on "Slope".



The following window will be displayed. In this window, select your DTM as your elevation layer, leave the Z factor at 1 and select, if desired, an output location in the "Slope" field. If not, the created layer will be temporary, and will disappear once the project is closed. Lastly, click on "Run in Background".

R Slope			? ×
Parameters Log			
Elevation layer			
MNT_32A10NO [EPSG:2950]			-
Z factor			
1.000000			
Slope			
[Save to temporary file]			
☑ Open output file after running algorithm			
		0%	Cancel
Run as Batch Process	Run in Background	Close	Help

The new raster file will be in black-and-white.



To obtain the predefined symbology, you will need to load it by following the steps described in <u>section 5.2.2</u>. Select the "Pente.qml" file. This will result in an image similar to the one below.



5.2.6 Assemble Several Rasters

To assemble multiple raster images together, click on "Raster" in the main toolbar and then "Miscellaneous" and select "Merge".

Q *Untitled Project - QGIS		A R. A. Marken and A. M. M. M. M. M. M.
Project Edit View Layer Settings Plugins Vector	Baster Database Web	Processing Help
□ = = = : : : : : : : : : : : : : : : :	Raster Calculator Align Rasters Analysis	, [] [] 2
Layers & ×	Projections	
🛷 🕼 👁 🍸 🍇 🕶 🖬 🖬 🗔	Miscellaneous	Build Virtual Raster
A V P MNT 32A10NO	Extraction	Raster Information
225	Conversion	• 🖉 Merge
450 675 900		Build Overviews (Pyramids)

The following window will open. Assembly is best done using a limited number of sheets. Above 10 sheets, the generated raster will probably be too large to use.

In this window, select the rasters to be assembled as input layers and select the output location in the "Merged" field. Otherwise, the layer you create will be temporary, and will disappear once the project is closed. Next click on "Run in Background".

• Merge • Mergee • Merge • Merge • Mergee •
Parameters Log
Input layers
0 elements selected
Grab pseudocolor table from first layer
Place each input file into a separate band
Output data type
Float32
Advanced parameters
Merged
[Save to temporary file]
✓ Open output file after running algorithm
GDAL/OGR console call
gdal_merge.bat -ot Float32 -of GTiff -o C:/Users/thean3/AppData/Local/Temp/ processing_4c6362fd56b14f7eb4d1220c673c4bd3/3f9b67ba4eef4ddaae5022535b827cc1/OUTPUT.tifoptfile C:/ Users/thean3/AppData/Local/Temp/processing_4c6362fd56b14f7eb4d1220c673c4bd3\mergeInputFiles.txt
0% Cancel Run as Batch Process Run in Background Close

5.2.7 Clip Raster Data in a Given Sector

To clip a raster, first display the raster to be clipped. Then click on "Raster" in the main toolbar and select "Extraction" then "Clip Raster by Extent".

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Project Edit View Layer Settings Plu	ugins Vector Ras	ster Database Web	b Progessing Help
	n (⊂) (€ (⊂) († 1) († 1) († († († († († († († († († († († († (†	Raster Calculator Align Rasters	, [] [] 2 ≪ ≪ + ⊠ + □ + -2 □ 2 # 2 =
Layers	ē ×	Projections Miscellaneous	
4 V MNT 32A10NO		Extraction	Clip Raster by Extent
225 450 675		Conversion	Clip Raster by Mask Layer Contour

The following window will open. The input layer is the raster you wish to clip. For the size of the clip, click on the "…" next to the "Clipping extent" field. Next, select "Select extent on canvas" and use the cursor to select the area to be clipped on your raster. Lastly, select the location for the output file in the "Clipped (extent)" field. Otherwise, the created layer will be temporary and will be lost when the project is closed. Lastly, click on "Run in Background".

-		
Parameters Log		
Input layer		<u> </u>
MNT_32A10NO [EPSG:2950]	•	
Clipping extent (xmin, xmax, ymin, ymax)		
		Use layer/canvas extent
Assign a specified nodata value to output bands [optional]		Select extent on canvas
Not set	(w)	
Advanced parameters		=
Clipped (extent)		
[Save to temporary file]		
Open output file after running algorithm		
GDAL/OGR console call		
Invalid value for parameter 'Clipping extent'		
		-
	0% Cancel	
Rup to Ratch Brasses	round Close Hole	



5.3 ADVANCED FEATURES

Other products can be created from basic LiDAR derived products using territorial analysis. Both applications previously mentioned (ArcGIS and QGIS) offer tools that can be used to generate contour lines, convert rasters to polygons, fill lakes, delimit drainage basins (watersheds), reclassify rasters, generate a focal CHM, generate a topographic wetness index, etc.

5.3.1 Create Contour Lines

To create contour lines, you will need one or more DTMs of the region for which you want the contour lines. The DTMs should ideally be clipped or combined to obtain the desired area only, since this will increase processing speed. Once the area is ready, click on "Raster" in the main toolbar and select "Contour" in the "Extraction" tab.



The following window will open. In this window, select the raster of your choice as the input layer and select a location for your output file (the "Contours" field). Use the "Interval between contour lines" field to choose the desired interval between the contour lines, then click on "Run in Background". A file containing the contour lines will be added to your table of contents.

Q Contour	9 X
Parameters Log	
Input layer	•
MNT_32A10NO [EPSG:2950]	•
Band number	
Band 1 (Gray)	-
Interval between contour lines	
10.000000	€ =
Attribute name (if not set, no elevation attribute is attached) [optional]	
ELEV	
Offset from zero relative to which to interpret intervals [optional]	
0.000000	≪ 🚖
Advanced parameters	
Contours	
[Save to temporary file]	
Open output file after running algorithm	~
0%	Cancel
Run as Batch Process Run in Background Close	Help

Thereafter, in the "Layer Properties" window (right-click on the layer title > "Properties"), you can change the colour of the contour lines ("Symbology" tab in the side menu) and the altitude can be shown by displaying the labels. To do so, click on "Labels" in the side menu, then choose "Single labels", followed by "ELEV" in the drop-down menu "Label with". Next, click on "Placement" and select "Curved" to make the labels follow the lines.





5.3.2 Reclassify Rasters

To reclassify rasters in QGIS, you will need to use the GRASS GIS extension that is usually downloaded at the same time as the QGIS application. It is important to open the version of the application that includes this extension.

Programmes (8)	
Q QGIS Desktop 3.8.2	
Q OGIS Desktop 3.8.2 with GRASS 7.6.1	
😍 QGIS Browser 2.18.2	
QGIS Browser 2.18.2 with GRASS 7.0.5	
🚀 QGIS Desktop 2.18.2	
🚀 QGIS Desktop 2.18.2 with GRASS 7.0.5	
🚀 Qt Designer with QGIS 2.18.2 custom widgets	
Q Qt Designer with QGIS 3.8.2 custom widgets	

If you do not have the extension, you can download it here: <u>https://grass.osgeo.org/download/</u>.

Once the application has been downloaded and the correct QGIS version is open, you can access the GRASS toolbox in "Processing Toolbox" (main toolbar >"Processing" > "Toolbox"). Otherwise, click on "Options" in the "Processing Toolbox" taskbar.



In the new window, select the "Processing" tab, followed by "Providers" and "GRASS". Make sure the "Activate" field is checked.

0	Options — Processing		×
Q		Setting	Value
>	C	🕨 🌞 General	
	General	🕨 🔚 Menus	Reset to defaults
ŝ	System	🕨 🏇 Models	
A10.	686	👻 🌞 Providers	
	CRS	👻 🚋 GDAL	
	Data Sources	🚮 Activate	✓
		👻 🙊 GRASS	
Š	Rendering	🎡 Activate	V -
	Canvas & Legend	🎡 For raster layers, use r.external (faster) instead of r.i	in.gdal
	2	🛞 For vector layers, use v.external (faster) instead of v	v.in.ogr
	Map Tools	Location of GRASS docs	https://grass.osgeo.org/grass76/manuals/
	Colors	🎡 Log console output	
	colors	Log execution commands	
	Digitizing	▶ 🚯 OTB	
P	Lavouts	👻 🌀 SAGA	
-	Layouts	S Activate	✓
8	GDAL	S Enable SAGA Import/Export optimizations	\checkmark
0	v · · ·	🛞 Log console output	\checkmark
C	Variables	S Log execution commands	\checkmark
	Authentication	🕨 🥐 Scripts	
	Network		
	Locator		
	Advanced		
	Acceleration	/	
*	Processing		
			OK Cancel Help

In the GRASS toolbox, click on Raster (r.*) and then on "r.reclass". The following window will open.

In this window, select the input raster in the "Input raster layer" field. You must also indicate the reclassification rules, which can be applied either by importing a document containing the reclassification rules in the field "File containing reclass rules" or by entering them manually in the "Reclass rules text" section. Lastly, in the "Reclassified" field, select the location for your output file, so that it is saved and click on "Run".

Q r.reclass	2 X
Parameters Log Input raster layer MNT_32A10NO [EPSG:2950] File containing reclass rules [optional] Reclass rules text (if rule file not used) [optional] 1 thru 300 = 1 301 thru 400 = 2 401 thru 500 = 3 501 thru 600 = 4	• F.reclass Creates a new map layer whose category values are based upon a reclassification of the categories in an existing raster map layer.
Advanced parameters Reclassified [Save to temporary file] Open output file after running algorithm	
Run as Batch Process	0% Cancel Run Close Help

Your raster, with the new classification criteria, will be displayed on the screen. In the above example, the DTM values will be reclassified into four categories, based on altitude.



5.3.3 Convert a Raster Image to Vector Format (Polygons)

Converting a raster image to vector format allows LiDAR data to be used with certain types of GPS devices that are unable to read raster files. Firstly, make sure that the area of interest has been clipped as this is a very time-consuming procedure (see <u>section 5.2.7</u>). In addition, we recommend reclassifying the raster (see <u>section 5.3.2</u>) so as to avoid producing a polygon for each pixel, which would make the layer too big to use.

To convert a raster to polygons in QGIS, click on "Raster" in the main toolbar, then select "Conversion" and click on "Polygonize (Raster to Vector)".



The following window will open. The "Input layer" is the raster to be converted to polygons. In the "Vectorized" field, select a location to save the layer permanently. Click on "Run in Background". You will obtain a file similar to the image shown below.

Polygonize (Raster to Vector)		
Parameters Log		
Input layer		
Reclassified [EPSG:2950]		
Band number		
Band 1 (Palette)		
Name of the field to create		
DN		
Use 8-connectedness		
Vectorized		
[Save to temporary file]		
Open output file after running algorithm		
GDAL/OGR console call		
gdal_polygonize.bat C:/Users/thean3/AppData/Local/Temp/ processing_cf94fdaf20de4438a628f8fa0b97f55b/7c9a6c849a304394a388cd72d4e75dbf/output.tif C:/ Users/thean3/AppData/Local/Temp/processing_cf94fdaf20de4438a628f8fa0b97f55b/ 224ec00405854ab78544062f7179cc14/OUTPUT.shp -b 1 -f "ESRI Shapefile" None DN		
0% Cancel Run as Batch Process Run in Background Close		



To open the new layer's attribute table, right-click on the layer title and on "Open Attribute Table".



If you want the table to be included in your project window, click on "Settings" in the main toolbar, and then on "Options". In the new window, select "Data Sources" and check "Open attribute table in a dock window".



5.3.4 Create a Focal CHM

A focal CHM can be created from a CHM. The focal CHM better indicates the maximum canopy height value for coniferous trees, making it easier to interpret stand height. However, the focal CHM artificially expands canopy diameter and thereby significantly overestimates cover density.

To create a focal CHM, start by adding the desired CHM to the project's table of contents. Next, in "Processing Toolbox" (main toolbar > "Processing" > "Toolbox"), select the GRASS box (see section 5.3.2 to install the GRASS extension if necessary), then click on "Raster (r.*)" and on "r.neighbors".

The following window will appear. First, select the CHM you want to use as the input raster ("Input raster layer"). Next, select "maximum" in the "Neighborhood operation" field, enter "3" in "Neighborhood size" and check "Use circular neighborhood". Lastly, select a file location to save your output focal CHM (the "Neighbors" field) and click on "Run". The circular option may not be available in some versions of QGIS, meaning that you will obtain a focal CHM with square canopies.

Q r.neighbors	? ×
Parameters Log Input raster layer MHC_32A10NO [EPSG:2950] Raster layer to select the cells which should be processed [optional] Neighborhood operation [optional] maximum Neighborhood size [optional] 3 Sigma (in cells) for Gaussian filter [optional] Not set Quantile to calculate for method=quantile [optional] V Use circular neighborhood	r.neighbors Makes each cell category value a function of the category values assigned to the cells around it
Run as Batch Process	0% Cancel Run Close Help

After processing, you will obtain a raster similar to the following image.

Standard CHM

Focal CHM



5.3.5 Topographic Wetness Index

Another tool that can be created using LiDAR products and QGIS is the topographic wetness index (TWI), which is used to view areas having a potential for high moisture retention capacity. To do so, you must first have installed the "SAGA" extension.

The SAGA file can be downloaded here: <u>https://sourceforge.net/projects/saga-gis/.</u>



The SAGA toolbox can be found in "Processing Toolbox" (main toolbar > "Processing" > "Toolbox"). If not, click on "Options" in the "Processing Toolbox" taskbar.

The first step in creating a TWI is to fill depressions in the digital terrain model. To do this, select "Preprocessing > Fill sink XXL" (see section 4.2.5).

Next, in the "Processing Toolbox" taskbar (main toolbar > "Processing" > "Toolbox"), select "SAGA", then "Terrain Analysis-hydrology" and finally, "SAGA Wetness Index".

The following window will open. In this window, you must use the filled DTM raster completed in the previous step in the "Elevation" field. Next, select "absolute catchment area" in the "Type of area" field, and "local slope" in the "Type of slope" field. Lastly, you must select locations to save the four output files ("Catchment Area", "Catchment Slope", "Modified Catchment Area", and "Topographic Wetness Index"). This will generate a TWI similar to the following image, once the colours have been changed. Please note that this process is very long and modelling should be limited to the area of interest.

Saga Wetness Index		×
Parameters Log		
Elevation		
MNT_brut [EPSG:2949]		•
Suction		
10,000000		\$
Type of Area		
[0] absolute catchment area		-
Type of Slope		
[0] local slope		-
Suction		
0,000000		\$
Suction		
0,100000		\$
Suction		
1,000000		\$
Catchment area		
[Save to temporary file]		
✔ Open output file after running algorithm		
Catchment slope		
[Save to temporary file]		
✔ Open output file after running algorithm		
Modified catchment area		
[Save to temporary file]		
✔ Open output file after running algorithm		
Topographic Wetness Index		
[Save to temporary file]		
✔ Open output file after running algorithm		
0%		Cancel
U 70		Cancer
Run as Batch Process	Run	Close



6 CONCLUSION

This document is intended to help with the use of products derived from LiDAR data. For comments or to suggest improvements, please contact the Direction des inventaires forestiers:

inventaires.forestiers@mffp.gouv.qc.ca

7 **REFERENCES**

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 $a \checkmark b a \land b a \land$ A f a A fA P Q A PA P Q A P Q A P Q A P Q A P Q A P Q A P Q A P Q A P Q A P

