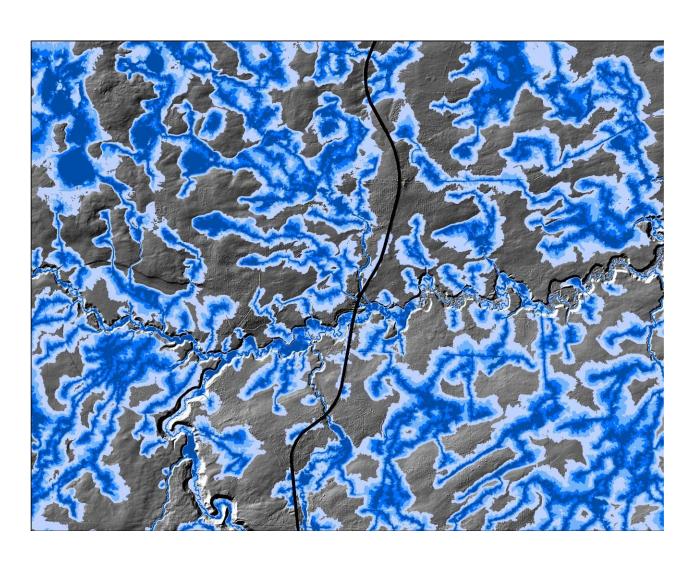
Wet Areas Mapping for Northern Alberta

Field Tour Slave Lake, Alberta September 28th 2012

Sponsored by:

Alberta Plywood
Alberta Environment and Sustainable Resource Development
Faculty of Forestry and Environmental Management, University of
New Brunswick

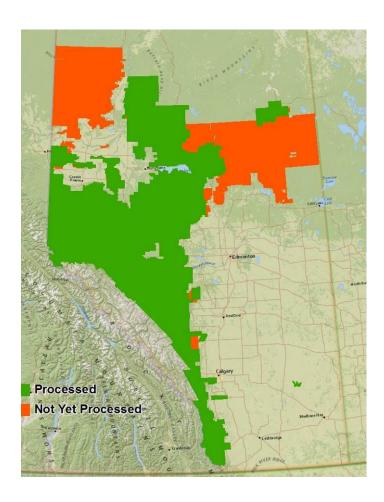


Objectives

Alberta's wet areas mapping initiative has four primary objectives:

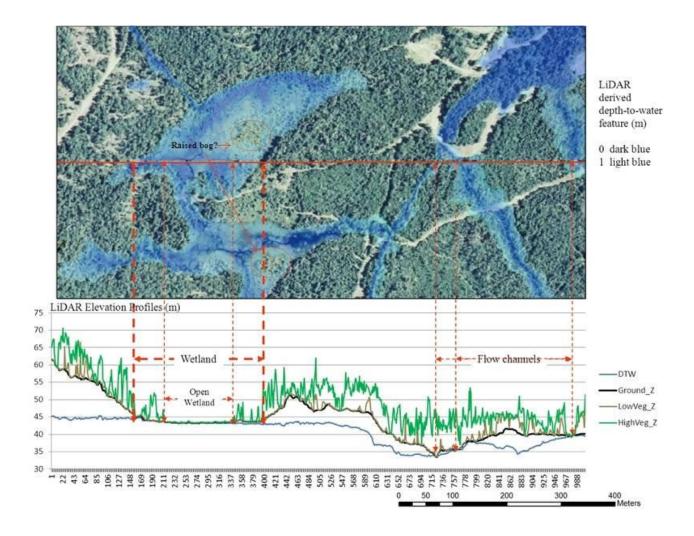
- (1) Provide Albertans with best available information regarding our soil and water resources and enable the wise stewardship of our natural landscapes;
- (2) Provide Alberta's industry sector who are working within Alberta's forested land base, and with specific emphasis to those combating the current mountain pine beetle epidemic, with a superior planning tool to facilitate best management practices around the land and water interface. It is hoped that these enhanced practices may lead to reductions in both planning and operational costs and increase industry competiveness;
- (3) Provide regulatory agencies across the Alberta Public Service with a superior planning tool to facilitate regulatory reviews and field inspections; and
- (4) Provide Alberta's innovation community with an innovative data layer that better predicts spatially the distribution of water within our forested landscapes.

Project Scope



Modelling Approach for Northern Alberta

The modelling approach utilized for northern Alberta differs significantly from that used in previous years for the Foothills Region. The model used for the latter region relied principally upon the 1 meter digital elevation model. This approach often failed to detect wetland complexes adequately. The model for northern Alberta is significantly more complex and incorporates the discreet, single-point-cloud data which was used to determine wetland boundaries (below).



Generated Data

- (1) depth-to-water Geotiff (released)
- (2) raster dataset of depth-to-water at 1m resolution (released)
- (3) raster dataset of follow-direction at 1m resolution (available upon request)
- (4) raster dataset of flow-accumulation at 1m resolution (available upon request)

Key considerations for successful implementation of WAM

Wet areas maps were developed for use by the Alberta forestry sector as a tool in the fight against mountain pine beetle. As such, the research emphasis was on producing a model that would accurately predict flow channels and wet, saturated soils sensitive to disturbance on what many refer to as the operable land base. That is to say, that portion of the land base that supports commercial forest operations. In such areas the modelled output was desired to enhance understating of hydrological risk on the landscape, and enhance access management with a goal of reducing the hydrological footprint of operations.

The current model was not designed to map regions of the non-operable land base per se which are typically comprised of a variety of wetland types. As a consequence, wet areas mapping should not be confused with wetland mapping, a purpose which the current model was not designed to accomplish.

The user is reminded that wet areas mapping products are, first and foremost, an indicator of hydrological risk. Output predicts soil conditions when soils are at, or near, field capacity. In other words, the mapping products predict field conditions during the wetter months when considerations of hydrological risk are more relevant.

Modelled output is static and not dynamic. Creating dynamic functionality to the model is not currently possible. Therefore, the user is reminded that soil wetness can vary by year and season and these factors must be considered when comparing predicted results to field observations. For example, during periods of prolonged drought, wet areas defined by depth-of-water of less than 10cm have been found to be dry in some locations. Though these areas may be dry during such drought periods they are expected to be wet or saturated at other times. Similarly, many small flow channels may also be dry during drought periods.

The stream layer is intended to identify both non-channelized and channelized flow on the landscape regardless of whether that flow is continuous, intermittent, or occurs only during periods of high rainfall. The user is cautioned that upper reaches of flow channels will almost always be in the form of ephemeral draws and will only convey water during or immediately after significant rainfall events. The user is also cautioned that small intermittent streams may be narrow in width and exceptionally difficult to locate in the field. Often such small channels are concealed by ground vegetation.

The current wet areas mapping process does not classify stream channels. Accordingly, the existing stream layer reflects the presence of all stream channel types including ephemerals which may be dry for much of the year.

Wet areas mapping products are intended to be but one source of information that land use planners consult to understand hydrological risks on the landscape. Mapped output should be used in conjunction with other sources of information.

Finally, the determination of depth-to-water can be used for determination of dry sites (i.e. where the water table is predicted to be at considerable depth) as well as wet sites (see image below where brighter colours reflect driest sites). Dry sites can be spatially determined using the depth-to-water raster files and suited for individual needs as required. This feature is one that is often overlooked.



Accuracy

Extensive field observations have been carried out each year since 2007 to assess accuracy of modelled predictions on the operable land base and to identify opportunities and needs for model improvements. Observations have included noting accuracy of predicted channel location and flow initiation point. Wet area boundaries were identified and compared to local vegetation characteristics, topographic position, soil features and observations of local soil moisture conditions.

Locations of predicted channelized flow (i.e. small intermittent streams but not including ephemeral draws) have been found to be within 5 meters of ground-validated sample points using sub-meter GPS receivers, approximately 70% of the time or better. Locations of wet areas above 50cm depth-to-water have also been found to be within 5 meters of ground-validated sample points, using sub-meter GPS receivers, approximately 70% of the time or better. Depth-to-water within the 50–100cm range is more diffuse and accuracy is more difficult to quantify but generally conform well to field observations. Accuracy of predicted depth-to-water beyond 1 meter in depth has not been quantified.

There has been no systematic assessment of the existence of false negatives (i.e. locations predicted to be dry but in fact are wet). Anecdotal evidence has suggested that such occurrences are low.

An independent audit of watercourse and wet areas accuracy was conducted in the fall 2010. The audit was conducted in the Lower and Upper Foothills Eco-regions in the Valleyview area.

- A total of 34 stream channels, comprised primarily of ephemeral and small intermittent channels, were accessed using a total of 236 assessment points.
 Predicted stream channels were found to be within 5m of field observations 75% of the time. Compliance increased to 87% when acceptable variance was increased to that of 10m.
- The model was found to over predict ephemeral streams channels by approximately 15%.
- Predicted locations of hydric soil conditions (i.e. depth-to-water of less than 10cm) where found to be within 5m of field observed wet areas at a rate equal to 94%.
- Predicted locations of sub-hydric (i.e. depth-to-water between 10-25cm) were found to be within 5m of observed locations 60% of the time. Compliance increased to 89% when acceptable variance was raised to 10m or less.
- Predicted locations of hygric (i.e. depth-to-water between 25-50cm), often more
 difficult to find in the field, were found to be within 5m of observed locations
 45% of the time. Compliance increased to 85% when acceptable variance was
 raised to 10m or less.
- Locations were identified for 21 confluences (i.e. locations where two stream channels converge) and compared to predicted locations. The model was found to be accurate to within 5m 52% of the time and 86% accurate to within 10m. Full compliance was found within 20m.

Known Sources of Error

Errors in predicted flow lines and wet areas have been documented and are to be expected. Sources of these errors have been identified though others may remain unknown at this time:

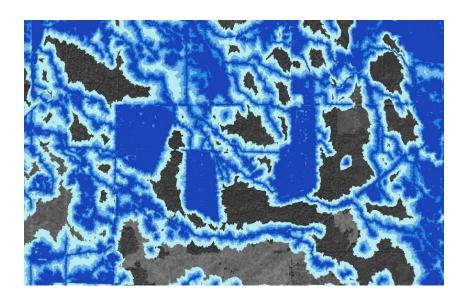
• The most common error are instances where the predicted commencement of an ephemeral water body is not correctly identified, but rather, occurs further downstream along the predicted flow channel. In these instances, associated wet areas may also be in error. The cause of these errors is owing to the fact that the model uses a generalized 4 hectare specific catchment area (SCA) threshold which is used to predict the point of stream channel initiation. The latter refers to the location on the landscape where sufficient hydrographic flow is assumed to be

present on the surface to form non-channelized flow (i.e. ephemeral draw). Local soil types, changes in sub-surface geology, and slope may each lead to local non-conformities. For most land use planning challenges, spatial accuracy of the point of flow initiation will likely be of lesser importance than spatial accuracy of the overall stream channel.

- Errors associated with flow channels may be the result of water movement that is strongly affected by sub-surface geological features that are unknown and are not accounted for in this modelling process.
- Errors related to under prediction of wet areas, i.e. falsely identified as dry, are often related to errors associated with the creation of a digital elevation models for areas dominated by a forest floor composed of thick moss. Thick layers of sphagnum typically associated with very wet areas and some wetlands often lead to the creation of a false digital elevation model. In these areas the bare earth identified by LiDAR may be falsely interpreted as being significantly higher than the surface of mineral soil. In such locations, wet areas are often falsely identified as dry. Consequently, wetland features such as raised peat bogs or poorly drained black spruce stands with thick sphagnum may only be partially identified as wet (Note: this source of error has been partially addressed in the 2012 version of the wet areas model for mapping in northern Alberta via the incorporation of the discreet-point-cloud data).
- Roads and other linear features may cause changes in overland flow that are difficult to model. Where available, mapped watercourse crossing information (culverts, bridges, etc.), supplied by various land users, assist in improving the accuracy of the wet areas mapping process. These mapped culverts allow flow to be properly routed "under" roads where no watercourse crossing may have been captured in the bare earth LiDAR image. The effectiveness of the integration of mapped culvert information is limited by both the completeness and the accuracy of the supplied watercourse crossing datasets. In some locations, inaccurate spatial information regarding precise culvert location can cause local errors at these locations. Alternatively, failure to account for a culvert that is physically present on the site may lead to flow routing along roadway ditches. In other locations, a missed culvert may lead to the upstream areas being falsely identified as dry if the upstream area did not have the required 4ha extent to form a flow channel.
- Seismic lines may result in subtle changes in overland flow patterns. These changes, or lack thereof, are difficult to discern. (Note: these sources of error have been partially addressed in the 2012 version of the wet areas model for use in northern Alberta via the development of an automated culvert locating tool).
- Isolated locations will exist within this dataset where predicted flow lines appear perfectly straight and do not obey topographic control. These straight lines exist because the overland flow routing algorithms were unable to resolve true flow

directions in these areas once the surface has been made hydrographically correct (ie. the surface has been filled/pits or depressions have been removed). When this layer is viewed in conjunction with the predicted wet areas map, the zones surrounding these straight flow lines will appear very wet. These discrepancies may appear on very flat areas where stream channels flow a heavily "meandered" pattern. The user should not rely on the map accuracy in these isolated locations.

- Accuracy may be affected by alterations to surface topography that have occurred since date of LiDAR acquisition. Newly created features that may affect overland flow include new roads with missing culverts, seismic lines, beaver dams and berms.
- The model version used to map the region north of Slave Lake incorporated algorithms designed to detect the presence of wetland features. These algorithms relied upon patterns in the discreet-point-cloud data to identify wetland boundaries. An error has been detected in this approach. Some older clearcuts, pre-1995, appear to have been captured in this analysis and falsely identified in the output as wetlands (below image). These areas may in fact be dry but are falsely assigned a depth-to-water value of zero. This error affects a small proportion of the land base but is nonetheless being addressed.



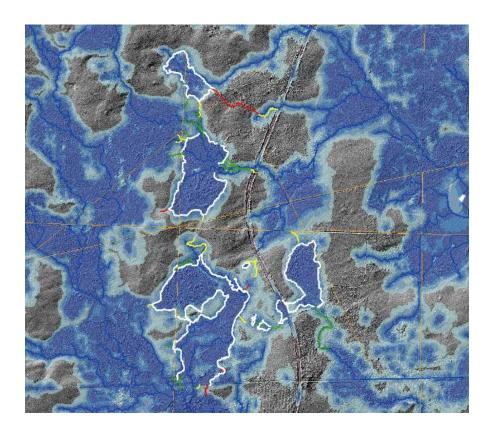
Disclaimer

The topographically derived flow-channel and wet-areas maps are computer derived. There will be locations were predicted output will not accurately reflect on site conditions. They are not intended to replace either on-site verification or professional due diligence. Computer predicted flow lines and depth-to-water are expected to be only one data layer considered by land use managers.

Wetland Connectivity

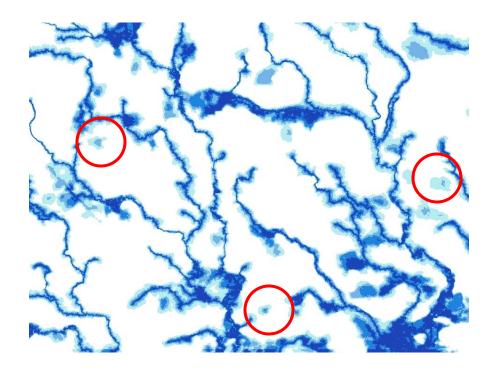
Connectivity between wetland complexes (below image) on vast landscapes has been typically unknown to resource planners and regulatory bodies. As previously mentioned, wetland connectivity and accurate determination of wetland borders has been a high research priority by the wet areas mapping team.

Results of peatland prediction and on the ground validation for the EMEND (Ecosystem Management Emulating Natural Disturbance) for a study area northwest of Peace River is shown below. Green lines represent correctly predicted connectivity in the form of small intermittent channels; yellow representing correctly predicted ephemeral draws. Red lines represent missed channels.



Vernal Pools

The wet areas modelling process is designed to spatially identity locations of what are thought to be vernal pools within individual stands (image below). Knowing the location of these features is of value to some as they may represent locations of higher biodiversity and candidates for in-block retention. They are also areas of colder, wet soils that may be more susceptible to soil rutting during wet periods.



Wet Areas Mapping as the New Innovation Platform: New Research

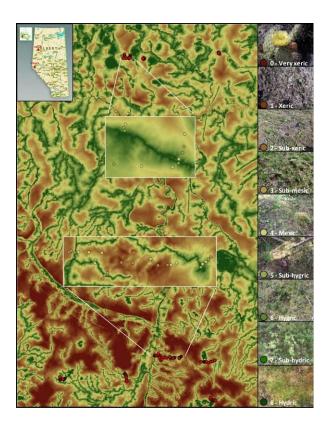


Image left displays landscape prediction of vegetation community types at high resolution for a region in northern Alberta (Doug Hiltz, graduate student, UNB). These results have significant implications for site classification and strategic investments in silviculture.

Wet areas mapping is the foundation for new silviculture and growth and yield research being conducted by Department of Renewable Resources, University of Alberta (Professors Lieffers, Nielsen, Comeau and Bokalo).



Additional information, publications and associated web links

http://www.youtube.com/watch?v=Vi7cgqMTovk

http://www.youtube.com/watch?v=LR4S2dZiTT0&feature=related

http://watershed.for.unb.ca/

http://watershed.for.unb.ca/publications

http://www.landusekn.ca/resource/lidar-workshop-building-sustainable-alberta-through-application-lidar-technologies

 $\frac{http://www.sfmn.ales.ualberta.ca/Events/NetworkWorkshops/AB-NewWetAreasMapInitiative.aspx}{NewWetAreasMapInitiative.aspx}$

Acknowledgements

The creators of the wet areas mapping process are Jae Ogilvie (Research Associate) and Dr. Paul Arp (Professor of Forest Soils) who are each located within the Faculty of Forestry and Environmental Management, University of New Brunswick. They have been working in partnership with Alberta Environment and Sustainable Resource Development and the Alberta forest industry since 2005. This long-term project has also benefited from the hard work of a number of graduate students associated with the University including David Campbell, Doug Hiltz, Kyle Chisholm, and Brian Gauthier.



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