SASKATCHEWAN RESEARCH COUNCIL

ASSESSING THE VULNERABILITY OF THE SANDILANDS PROVINCIAL FOREST TO CLIMATE CHANGE

Prepared for
Prairies Regional Adaptation Collaborative

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INTRODUCTION

The Forestry Branch of Manitoba Conservation and Water Stewardship is working on a pilot project to assess the vulnerability of one of the province's most highly utilized forests. The Sandilands Provincial Forest located in the south-eastern corner of Manitoba is a fully committed managed forest with annual harvest levels of approximately 250,000 m^3 of softwood and hardwood. The Sandilands contains boreal species but is dominated by pine growing on coarse sandy soils. As with most boreal forests it has been affected by frequent natural disturbances such as fires, wind events and losses from forest pests and diseases. This area is also highly susceptible to drought due to its sandy soils with low water holding capacity.

The Sandilands is part of the larger Pineland Forest Management Unit (FMU) 24 (see Figure 1) and is critical to Manitoba for its commercial, ecological and recreation opportunities. The objective of the vulnerability assessment is to identify sensitivity to predicted climate change and explore potential adaptation options for FMU 24. The Forestry Branch also expects this project to develop tools and processes for conducting future vulnerability assessments for other forested areas of Manitoba.

The assessment will follow the Guidebook for Assessing Vulnerability developed by the Climate Change Task Force of the Canadian Council of Forest Ministers (Edwards et al. 2012).

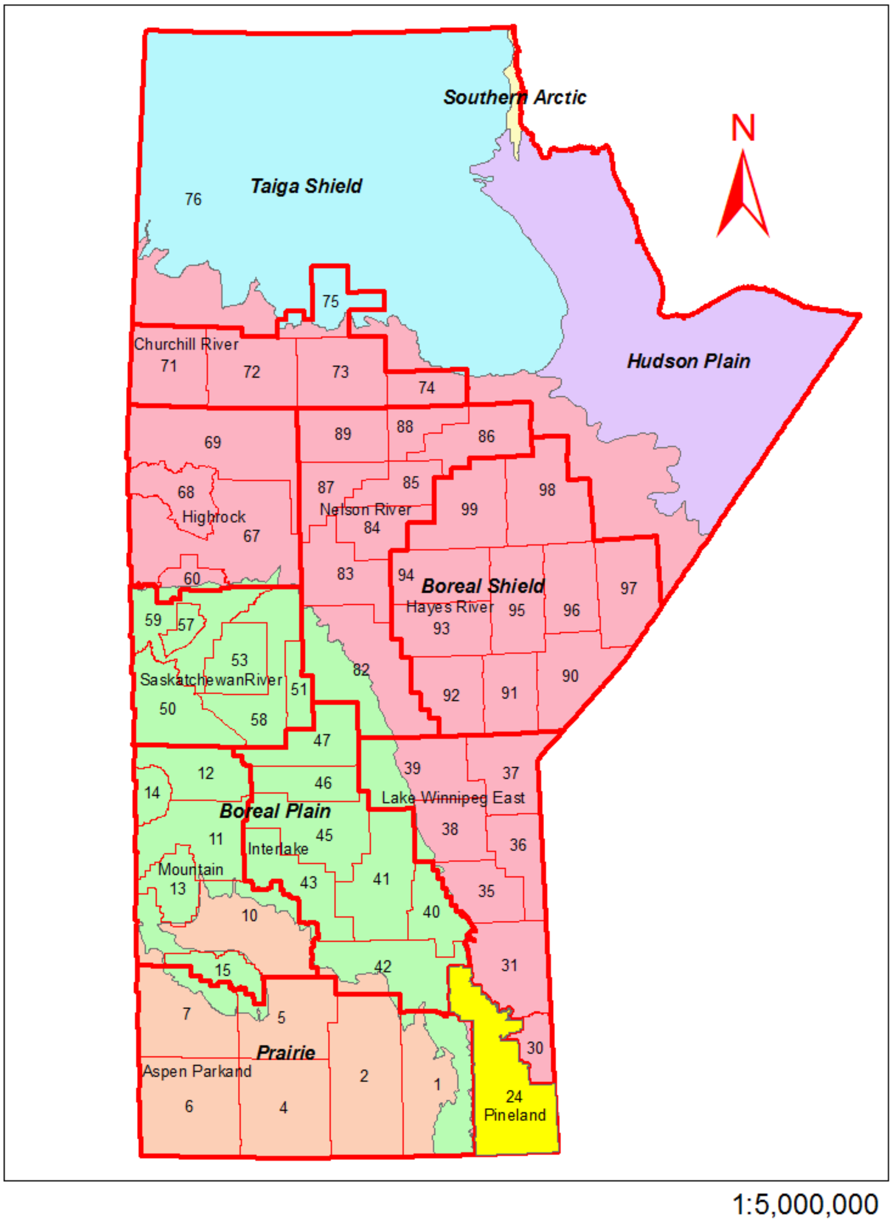

Figure 1. Location of FMU 24 (Pineland Forest Section) in SE Manitoba.

CLIMATE SCENARIOS

As part of the Terrestrial Ecosystems component of the Prairie RAC, the Forestry Branch of Manitoba Conservation requested a summary of climate scenario data for the Pineland Forest Management Unit (FMU 24) in SE Manitoba (Figure 1). The purpose was to provide localized projections of current and future climate within the study area over several time intervals (i.e., changes in temperature, precipitation, etc. over the next 20, 40.... years). This would provide Forestry Branch with information to validate assumptions used in their climate change assessment and to identify specific areas and forest types that may be vulnerable to climate change impacts and at risk for future disturbance.

The main source of future climate scenarios for vulnerability assessments is global climate models (GCM). These are computer simulation models of the earth's climate, representing transfers of energy and mass within the atmosphere vertically and horizontally, as well as between the atmosphere and the land surface, and the atmosphere and the oceans. GCMs produce estimates of temperature, precipitation and many other climate-related quantities on a grid of points covering the earth's surface. The grid spacing varies among models; for example the most recent Canadian GCM (version 4) produces data at a spacing of approximately 2.8 degrees latitude and longitude, or roughly 250 km. This is relatively high resolution at the global scale, but still too coarse for vulnerability assessments at the scale of the Pinelands FMU. Data from GCMs can be downscaled to a higher resolution product in two ways: statistical downscaling and dynamical downscaling. Statistical downscaling is a method for obtaining high-resolution climate or climate change information from relatively coarse-resolution GCMs. In this approach, statistical relationships are derived between observed small-scale (often station level) variables and larger GCM-scale variables using regression analysis. Future values of the large-scale variables obtained from GCM projections of future climate are then used to drive the statistical relationships and thereby estimate the smaller-scale details of future climate. The second method, dynamical downscaling, involves the development of a limited-area, high-resolution model (a regional climate model, or RCM) driven by boundary conditions (i.e. input data) from a GCM to derive smaller-scale information.

The Canadian RCM was developed by the Ouranos Consortium (Quebec) and Environment Canada, and data from the model are freely available at the Canadian Climate Scenarios Network website (http://www.cccsn.ec.gc.ca/). Since the CRCM data are of relatively high resolution, recent, and readily available, these data were chosen for this project. Data for the current version of the CRCM (v. 4.2.3) are based on the A2 greenhouse gas scenario, a relatively aggressive scenario that projects atmospheric CO_2 concentrations of 856 parts per million by 2100, or about triple that of today's level. Recent research has shown that actual emissions are exceeding these levels, so this is likely a conservative scenario (Peters et al. 2012). The CRCM produces data for all of North America at a grid spacing of approximately 45 km, or about 30 times higher resolution than that of the Canadian GCM (Music and Caya 2007). Data are available for the current time period, defined as 1971-2000; and for three 30-year future time periods: 2012-2039, 2040-2069 and 2070-2099. Data were generated for the following variables and time periods:

- Mean, maximum and minimum temperature annually and for each of the four seasons (spring, summer, autumn and winter), averaged over each of the 30-year time periods: 1971-2000, 2012-2039, 2040-2069 and 2070-2099
- Precipitation annually and for each of the four seasons, averaged over each of the 30-year time periods: 1971-2000, 2012-2039, 2040-2069 and 2070-2099
- The difference in mean, maximum and minimum temperature annually and for each of the four seasons between the current and future time periods (i.e., the difference between 1971-2000 and 2010-2039; 1971-2000 and 2040-2069; 1971-2000 and 2070-2099.
- The difference in precipitation annually and for each of the four seasons between the current and future time periods (i.e., the difference between 1971-2000 and 2010-2039; 1971-2000 and 2040-2069; 1971-2000 and 2070-2099.

These data were provided in an excel spreadsheet with drop-down pick-lists, allowing the user to select any combination of time period, season and climate variable. In addition, maps were generated showing the climate variables for various seasons and time periods and their differences, as listed above. The maps are for the entire province and are provided in GEOTIFF format. This file format allows georeferencing information to be embedded within a TIFF file. The additional information includes map projection, coordinate systems, ellipsoids, datums, and everything else necessary to establish the exact spatial reference for the file. See Appendix 1 for a full list of maps produced. Appendix 2 is the spreadsheet. Appendix 3 includes all of the GEOTIFF files and supporting data files.

The climate scenario data described above will provide a foundation on which to base a vulnerability assessment for the Pinelands FMU. Some preliminary analysis was done during the PRAC, and this will expand into a full forest vulnerability assessment in the 2012-2013 fiscal year. Other analyses will include the impacts of climate change and variability on tree growth, insect outbreaks and future fire risk. All of these processes are highly climate sensitive and the CRCM data will be useful in determining the effects of climate change on forests in SE Manitoba.

INITIAL RECOMMENDATIONS OR KEY FINDINGS TO DATE

The team has no specific findings or recommendations to date. In general we have found that:

- the CCFM Guidebook is easy to follow and provides good direction for the project
- The project does require significant resources in terms of staff time and data.

NEXT STEPS

Manitoba is planning to work collaboratively with the Province of Saskatchewan on the next phase of the assessment. This project will explore the vulnerability of Saskatchewan's Island Forests and Manitoba's Sandilands landscapes in terms of three climate change vulnerability factors: exposure, sensitivity and adaptive capacity.

Following this a workshop will be planned for the Forestry Branch (and possibly broader) to discuss findings, alternatives and future direction. The project is expected to produce a complete vulnerability assessment that Forestry Branch can utilize as a working example to conduct assessments for other forested areas within Manitoba.

REFERENCES

Edwards, J.E., Pearce, C. and Ogden, A. 2012. A Practitioner's Guide for Assessing Sustainable Forest Management Vulnerability and Mainstreaming Adaptation Into Decision Making. Canadian Council of Forest Ministers, Ottawa, ON.

Music, B. and Caya, D. 2007. Evaluation of the hydrological cycle over the Mississippi River Basin as simulated by the Canadian Regional Climate Model (CRCM). Journal of Hydrometeorology 8: 969-988.

Peters, G.P., Marland, G., Le Quéré, C., Boden, T., Canadell, J.G. and Raupach, M.R. 2012. Rapid growth in CO_2 emissions after the 2008-2009 global financial crisis. Nature Climate Change 2: 2-4.

APPENDIX 1:

LIST OF MAPS PRODUCED (ALL IN GEOTIFF FORMAT)

Appendix 1. List of maps produced (all in GEOTIFF format)

MEAN_MAX_TEMP_1971_2000_SUMMARY_ANNUAL
MEAN_MAX_TEMP_1971_2000_SUMMARY_AUTUMN
MEAN_MAX_TEMP_1971_2000_SUMMARY_SPRING
MEAN_MAX_TEMP_1971_2000_SUMMARY_SUMMER
MEAN_MAX_TEMP_1971_2000_SUMMARY_WINTER
MEAN_MAX_TEMP_2010_2039_SUMMARY_ANNUAL
MEAN_MAX_TEMP_2010_2039_SUMMARY_AUTUMN
MEAN_MAX_TEMP_2010_2039_SUMMARY_SPRING
MEAN_MAX_TEMP_2010_2039_SUMMARY_SUMMER
MEAN_MAX_TEMP_2010_2039_SUMMARY_WINTER
MEAN_MAX_TEMP_2040_2069_SUMMARY_ANNUAL
MEAN_MAX_TEMP_2040_2069_SUMMARY_AUTUMN
MEAN_MAX_TEMP_2040_2069_SUMMARY_SPRING
MEAN_MAX_TEMP_2040_2069_SUMMARY_SUMMER
MEAN_MAX_TEMP_2040_2069_SUMMARY_WINTER
MEAN_MAX_TEMP_2070_2099_SUMMARY_ANNUAL
MEAN_MAX_TEMP_2070_2099_SUMMARY_AUTUMN
MEAN_MAX_TEMP_2070_2099_SUMMARY_SPRING
MEAN_MAX_TEMP_2070_2099_SUMMARY_SUMMER
MEAN_MAX_TEMP_2070_2099_SUMMARY_WINTER
MEAN_MAX_TEMP_ANNUAL_DIFF_2010_2039_MINUS_1971_2000
MEAN_MAX_TEMP_ANNUAL_DIFF_2040_2069_MINUS_1971_2000
MEAN_MAX_TEMP_ANNUAL_DIFF_2070_2099_MINUS_1971_2000
MEAN_MAX_TEMP_AUTUMN_DIFF_2010_2039_MINUS_1971_2000
MEAN_MAX_TEMP_AUTUMN_DIFF_2040_2069_MINUS_1971_2000
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MEAN_MAX_TEMP_WINTER_DIFF_2010_2039_MINUS_1971_2000
MEAN_MAX_TEMP_WINTER_DIFF_2040_2039_MINUS_1971_2000
MEAN_MAX_TEMP_WINTER_DIFF_2070_2099_MINUS_1971_2000

MEAN_MIN_TEMP_1971_2000_SUMMARY_ANNUAL
MEAN_MIN_TEMP_1971_2000_SUMMARY_AUTUMN
MEAN_MIN_TEMP_1971_2000_SUMMARY_SPRING
MEAN_MIN_TEMP_1971_2000_SUMMARY_SUMMER
MEAN_MIN_TEMP_1971_2000_SUMMARY_WINTER
MEAN_MIN_TEMP_2010_2039_SUMMARY_ANNUAL
MEAN_MIN_TEMP_2010_2039_SUMMARY_AUTUMN
MEAN_MIN_TEMP_2010_2039_SUMMARY_SPRING
MEAN_MIN_TEMP_2010_2039_SUMMARY_SUMMER
MEAN_MIN_TEMP_2010_2039_SUMMARY_WINTER
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MEAN_TEMP_1971_2000_SUMMARY_AUTUMN
MEAN_TEMP_1971_2000_SUMMARY_SPRING

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MEAN_TEMP_2010_2039_SUMMARY_ANNUAL
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MEAN_TEMP_2010_2039_SUMMARY_WINTER
MEAN_TEMP_2040_2069_SUMMARY_ANNUAL
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PRECIP_TOTAL_1971_2000_SUMMARY_AUTUMN
PRECIP_TOTAL_1971_2000_SUMMARY_SPRING
PRECIP_TOTAL_1971_2000_SUMMARY_SUMMER
PRECIP_TOTAL_1971_2000_SUMMARY_WINTER
PRECIP_TOTAL_2010_2039_SUMMARY_ANNUAL

PRECIP_TOTAL_2010_2039_SUMMARY_AUTUMN
PRECIP_TOTAL_2010_2039_SUMMARY_SPRING
PRECIP_TOTAL_2010_2039_SUMMARY_SUMMER
PRECIP_TOTAL_2010_2039_SUMMARY_WINTER
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PRECIP_TOTAL_2070_2099_SUMMARY_AUTUMN
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PRECIP_TOTAL_WINTER_DIFF_2010_2039_MINUS_1971_2000
PRECIP_TOTAL_WINTER_DIFF_2040_2039_MINUS_1971_2000
PRECIP_TOTAL_WINTER_DIFF_2070_2099_MINUS_1971_2000

APPENDIX 2

EXCEL SPREADSHEET PROVIDING THE CHOICE OF CLIMATE DATA: SEASON, TIME PERIOD AND CLIMATE VARIABLE.

APPENDIX 3

GEOTIFF FILES AND SUPPORTING DATA FILES