Banff International Research Station

for Mathematical Innovation and Discovery

Managing Fire on Populated Forest Landscapes
Sunday, October 20 through Friday, October 25, 2013

MEALS

*Breakfast (Buffet): 7:00 – 9:30 am, Sally Borden Building, Monday – Friday
*Lunch (Buffet): 11:30 am – 1:30 pm, Sally Borden Building, Monday – Friday
*Dinner (Buffet): 5:30 – 7:30 pm, Sally Borden Building, Sunday – Thursday
Coffee Breaks: As per daily schedule, in the foyer of the TransCanada Pipeline Pavilion (TCPL)
***Please remember to scan your meal card at the host/hostess station in the dining room for each meal.**

MEETING ROOMS

All lectures will be held in the lecture theater in the TransCanada Pipelines Pavilion (TCPL). An LCD projector, a laptop, a document camera, and blackboards are available for presentations.

SCHEDULE

Sunday 20 October 2013

16:00	Check-in begins (Front Desk – Professional Development Centre - open 24 hours)
17:30-19:30	Buffet Dinner
20:00	Informal gathering in 2nd floor lounge, Corbett Hall Beverages and small assortment of snacks are available on a cash honor system.

Monday 21 October 2013 (morning)

7:00-8:45	Breakfast	
8:45-9:00	Introduction and Welcome by BIRS Station Manager, TCPL	
9:00-9:15	Opening remarks by the Organizing Committee we're here to help fire managers: one way is to develop fire management decision support systems, which require incorporation of good statistics; why we wanted to hold the workshop (managers and statisticians and impact)	
9:15-10:30	Rob McAlpine:	Decision making in fire management – stepping back.
10:30-11:00	Coffee Break and Informal Discussions, TCPL	
11:00–12:00	David Martell:	Forest and Wildland Fire Management Analytics – some statistical challenges
12:00-13:00	Lunch	

Monday 21 October 2013 (afternoon)

13:00-14:00	Guided Tour of The Banff Centre; meet in the 2nd floor lounge, Corbett Hall	
14:00-14:15	Group Photo; meet in foyer of TCPL (photograph will be taken outdoors so a jacket might be required).	
14:15-14:45	Coffee Break and Informal Discussions, TCPL	
14:45-17:00	Neil McLoughlin:	Data slips trips and falls
	Kate Larson:	A game-theoretic model for resource sharing for wildfires.
	J. Park/J. Large:	Protecting People, Assets and Adjacent Lands: Landscape level fire and vegetation management in Banff National Park.
	Closing remarks.	
17:30-19:30	Dinner	

Tuesday 22 October 2013

7:00-9:00	Breakfast	
9:00-10:30	Discussion - Use of probability models to inform fire management decisions Led by: J. Hearne, J. Minas and P. Taylor	
	Mike Wotton:	Ignition processes and modelling / moisture estimation and rainfall interpolation.
10:30-11:00	Coffee Break and Informal Discussions, TCPL	
11:00-12:00	Valerie Isham:	Models for spatial-temporal rainfall
12:00-13:30	Lunch	
13:30-15:00	David Brillinger:	Spatial temperature data for a fire moving along a trough in the wind tunnel
	Haiganoush Preisler:	From Ignition to Spread: Wildland Fire Forecasting and Color Maps
	Rick Schoenberg:	Model evaluation for forecasts of wildfire activity and spread
15:00-15:30	Coffee Break and Informal Discussions, TCPL	
15:30-1700	Mary Grunstra:	Challenges and opportunities for research using historical forest fire data for Ontario, 1914-2012
	Steve Taylor:	Managing Human Activity in Fire Landscapes - Research Questions, Data, Approaches
	Roundtable discussion#1:	Future directions for rainfall interpolation.
17:30-19:30	Dinner	

Wednesday 23 October 2013

7:00-9:00	Breakfast	
9:00-10:30	Dan Thompson:	Boreal peatland vulnerability to wildfire: synthesizing datasets and models.
	Steve Cumming:	Wildland fire in ecological modelling and conservation planning: simulating boreal fire regimes.
10:30-10:45	Coffee Break and Informal Discussions, TCPL	
10:45-12:15	Meg Krawchuk:	Pyrogeographer on the loose: so much data, so little time
	Max Moritz:	Thoughts on modelling environmental constraints on fire activity at broad scales.
12:15-13:30	Lunch	
13:30-17:00	Free afternoon	
17:30-19:30	Dinner	

Thursday 24 October 2013

7:00-9:00	Breakfast	
9:00-10:30	A. Albert-Green:	Visualization tools for assessing the Markov property: sojourn times in the Fire Weather Index.
	Neal McLoughlin:	Fire danger at the top of the yardstick.
	W. John Braun:	A spatial control chart.
10:30-11:00	Coffee Break and Informal Discussions, TCPL	
11:00-12:00	Francis Zwiers:	Observed, simulated and projected changes in indicators of climate extremes.
12:00-12:10	Planning discussion for afternoon session.	
12:10-13:30	Lunch	
13:30-15:00	Open for roundtables, or team discussions and breakout sessions	
15:00-15:30	Coffee Break and Informal Discussions, TCPL	
15:30-1700	Roundtable discussion #2:	Wrap-up and planning for ongoing projects.
17:30-19:30	Dinner	

Friday 25 October 2013

7:00-9:00	Breakfast
9:00	Final wrap-up and planning for ongoing projects / individual team meetings
10:30-11:00	Coffee Break and Informal Discussions, TCPL (available from 10:00 am onwards but must finish by 11:00 am)
11:30-13:30	Lunch

Checkout by 12 noon.

** 5-day workshop participants are welcome to use BIRS facilities (BIRS Coffee Lounge, TCPL and Reading Room) until 3 pm on Friday, although participants are still required to checkout of the guest rooms by 12 noon. **

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ABSTRACTS (in alphabetic order by speaker surname)

Speaker: **Alisha Albert-Green** (U. Western Ontario), **John Braun** (U. Western Ontario), **David Martell** (U. Toronto) and **Douglas Woolford** (Wilfrid Laurier U.)

Title: Visualization Tools for Assessing the Markov Property: Sojourn Times in the Forest Fire Weather Index

Abstract: In Canada, the Fire Weather Index (FWI) provides forest fire managers with an overall measure of fire danger. Specifically, the FWI is a numerical rating of the potential intensity of a forest fire based on its potential spread rate and the amount of vegetation available for combustion. In our analyses, we consider daily FWI time series, recorded over 42 fire seasons from a sample of fire-weather stations in Ontario, Canada. Graphical exploratory analyses of the data, including stalagmite plots (a new interactive, three-dimensional visualization tool), show that the FWI switches between epochs of nil and non-nil behaviour. This work develops a framework for assessing sojourn times in these two phases. At some sites, the FWI process appears to begin each year as an approximate Markov process before gradually losing its Markovian character. However, a time-homogeneous discrete time Markov chain model is insufficient overall, since those sojourn times are not found to be geometrically distributed. Instead, the duration of epochs in each of these phases can be more accurately modelled using beta-geometric random variables which incorporate seasonality of phase-specific run length behaviour using local likelihood methods.

Speaker: **David Brillinger** (U. California Berkeley)

Title: Spatial temperature data for a fire moving along a trough in a wind tunnel

Abstract: TBA

Speaker: **W. John Braun** (U. Western Ontario)

Title: A spatial control chart

Abstract: Control charts have been traditionally used to monitor production processes (i.e., quality control). Measurements are taken at regular intervals and they are plotted as a time series. Observations that exceed certain thresholds may indicate that a processes mean or variance is changing. In this work we propose a spatial version of a control chart in order to monitor time-series of observations measured at different locations in space. Measurement sites are plotted on a map, colour-coded to indicate how far they are currently deviating from the long-term average at that site for that time of year. This is applied to time-series of Fire Weather Index (FWI) from a set of fire-weather stations in Ontario, Canada. It can be used to identify regions which are anomalously high. How to handle missing observations is also discussed.

Speaker: **SG Cumming** (Université Laval) and **FKA Schmiegelow** (University of Alberta)

Title: Wildland fire in ecological modelling and conservation planning: Simulating boreal fire regimes

Abstract: In boreal forests, fire, vegetation and climate interact to create the dynamic mosaic of forest age and structure that we map as an economic resource and as wildlife habitat. The patterns (partially) created by fire are increasingly being used as templates or criteria for forest management and conservation; this demands the ability to describe, explain and forecast ever-more complex attributes of fire regime, up to and including spatial variation in fire severity. Detailed observational data that would allow us to model these patterns have only been collected in quite recent times, when our ability to discern the underlying relationships has been confounded, to an unknown degree, by the effects of fire management. We will illustrate the applications of simple empirical models of fire regime parameters, using as case studies two national projects related to woodland caribou conservation and to protected areas design. We will show how such models that neglect confounding factors (e.g. fire suppression) or previously neglected process details (e.g. fire severity) are no longer satisfactory and increasingly challenged by partner agencies. Finally, we will suggest some opportunities for the statistical sciences community to work with ecologists and forest managers in developing the next generation of models more suited to real applications.

Speaker: **John Hearne** (RMIT: Royal Melbourne Institute of Technology), **James Minas** (RMIT) and **Peter Taylor** (U. Melbourne)

Title: Discussion - Use of probability models to inform fire management decisions

Abstract: Following the devastating 2009 Black Saturday bushfires the Victorian State Government has invested in research to establish models to predict fire ignition and escalation based on a range of environmental, social and economic factors. This research is intended to support the Government's policy objective of establishing an explicit risk management system to guide fire management investment and decision making. An important first step in this research is the development of a conceptual model that considers how probability of ignition and escalation can be incorporated into decision support systems. This needs to occur at both the strategic level (e.g. investment decisions, application of fire regimes and upgrading power lines) and the tactical level (e.g. planning patrols and pre-deployment of aircraft, initial attack crews and incident management teams). This research is in its early stages and as such we will not be presenting results. Rather, this session will be run as a facilitated discussion forum with a view to promoting exchange of ideas and new collaborations.

Speaker: **Mary Grunstra** (U. Toronto)

Title: Challenges and opportunities for research using historical forest fire data for Ontario, 1914-2012

Abstract: The Fire Management Systems Lab is currently undertaking research that investigates the performance of Ontario's detection and initial attack systems from 1930 to 2012, and trends in railway fires from 1914 to 2011. The data used for these projects has been obtained from multiple sources, including the OMNR's digital fire archive (1960-2012), by manually coding original fire reports (1930-1959), and from historical statistics and government documents (1914-2012). While the available data enables both spatial and temporal analyses of trends in forest fire activity since the early twentieth century, it also poses multiple challenges. This presentation will focus primarily on sources of data errors and the challenges that they pose to research.

Speaker: **Valerie Isham** (University College London)

Title: Models for spatial-temporal rainfall

Abstract: The question posed in the invitation to speak at the workshop was as follows:
How can data from a sparse network of weather stations be used to improve the interpolation and/or modelling of rainfall?

In partial answer to this I will review some rainfall modelling to which I have contributed and try to outline the advantages and disadvantages of the various approaches. I will start with continuous time stochastic models for rainfall at a single location. Such models are very well-developed, and provide a useful starting point to the spatial-temporal models. I will then discuss a) high-resolution continuous time, continuous space stochastic models and b) discrete time, discrete space (multisite) statistical models. The latter have been applied very successfully at a daily time scale, but are not suitable as they stand at much finer temporal resolutions. Finally, I will briefly discuss some models of soil moisture that combine stochastic rainfall with deterministic soil drainage and evapotranspiration.

Speaker: **Meg Krawchuk** (Simon Fraser University)

Title: Pyrogeographer on the loose: so much data so little time

Abstract: There are a wealth of fire-related data available for asking burning questions, but a difficult key is finding the right data and the right scale for the right question. I'll aim to discuss a variety of project areas in which my lab is working using different spatial and temporal scales of fire/burn data from state and provincial fire management records, Landsat, MODIS, and field-based observations. I'm a geographer and spatial ecologist not a statistician so the majority of analysis I do focuses on the use of relatively traditional statistical models, and I'll touch on my perspectives of simplicity and give some examples of frameworks we've used, the most frequent these days being the zero-inflated Poisson.

Speaker: **Kate Larson** (U. Waterloo)

Title: A Game-Theoretic Model for Resource Sharing for Wildfires

Abstract: The Canadian Interagency Forest Fire Center (CIFFC) was created in 1982 with the primary mandate to facilitate the exchange of wildland fire fighting resources including personnel, equipment and aircraft between member agencies. Since its establishment, resource sharing across agencies has increased dramatically. However, there has been a growing recognition by the CIFFC Council of Directors and the Wildland Fire Management Working Group that the current levels of resource sharing will not be adequate for future activity. There have been several incidents in the recent past where there were insufficient resources to meet the national demand, and trends in changing climates, fire occurrence and the expansion of the wildland-urban interface coupled with government fiscal trends of cost containment and reduction all point to increased resource shortages. There is, thus, interest in investigating new solutions to the problem.

Although in Canada we have been sharing resources between agencies for more than twenty-five years, to the best of our knowledge, little is known about the strategic process that goes into the borrow/lend decision. When does an agency request resources is, perhaps, an easy question, but the more difficult, and perhaps more interesting, is "When and how do we lend?". Understanding the parameters that guide this decision among the lending agencies could provide a profound understanding of the nature of lending in the country and provide some guidance to mitigating barriers to resource sharing. To this end, we have commenced a study of the factors which influence decision-making with respect to resource sharing across Canada. By conducting interviews with agencies across the country as well as CIFFC, and by building a game-theoretic model to capture strategic aspects of resource-sharing, we aim to provide insights into resource-sharing across the country.

Speaker: **David Martell** (U. Toronto)

Title: Forest and Wildland Fire Management Analytics – some statistical challenges

Abstract: Analytics has been described as the scientific process of transforming data into insight for making better decisions. Statisticians have made many important contributions to forest and wildland fire management but many important challenges remain. I will begin by identifying some of what I consider to be recent fire management contributions by statisticians. I will then describe how fire managers use airtankers, some of the many decision-making problems airtanker managers must resolve, how analytics have been used to help resolve airtanker management problems and important open problems that I believe call for more statistical science.

Speaker: **Rob McAlpine** (Ontario MNR)

Title: Decision Making in Fire Management – Stepping back.

Abstract: To the external cursory observer, wildland fire fighting activities appear to have an immediacy about them. Fires happen and we respond. This immediacy and focus on the event can lead to a simplified view of the range of decisions required to deliver fire management on the landscape. All Canadian fire management agencies manage fire across broad landscapes, and decisions made range from the small scale instantaneous front line decision of the fire fighter, to the broad, province-wide decisions made at the political level.

This talk will begin to explore the range decisions made in fire management organizations, the challenge of data variability driving those decisions, and some current trials facing the fire management community.

Speaker: **Neil McLoughlin** (Alberta ESRD)

Title: Data Slips, Trips and Falls

Abstract: Statisticians and physical modellers working on wildfire-related questions often utilize historical fire and weather archives and/or geospatial datasets maintained by fire management agencies. While these datasets are rich sources of information, they are also a reflection of policy changes, evolving collection methods and variable quality control measures. It is conceivable that analysis results could lead to erroneous conclusions if the subtleties associated with fire management data are overlooked. This presentation provides Alberta examples of how the unwary researcher may slip, trip or fall when using fuel, weather, and/or fire history data. Data sharing agreements will also be discussed.

Speaker: **Neil McLoughlin** (Alberta ESRD)

Title: Fire Danger at the Top of the Yardstick

Abstract: The Canadian Forest Fire Weather Index (FWI) System provides a weather-based approach for tracking fuel moisture and several relative indices of fire behaviour in a standard forest type (Van Wagner 1987). Alberta's Wildfire Management Branch forecasts regional FWI System values each day during the fire season, and subsequently archives observations from an extensive weather station network. Forecast values support operational decisions concerning how many fire fighting resources to pre-position each day for optimal response times and suppression capability over large geographic areas. Historical values are of interest to wildfire management planners who attempt to model potential fire behaviour in high risk areas. Extreme fire behaviour is often associated with extreme fire weather. Fire managers in Alberta have typically used 90th percentile values as their benchmark. Recent wildfire events have caused fire managers to focus their attention on 95th and 99th percentile conditions and other approaches for worst case probability modelling (Flat Top Complex Wildfire Review Committee 2012). This presentation outlines the strengths and limitations of the current approach for benchmarking fire danger in Alberta and emphasizes the need for alternative techniques.

Speaker: **Max Moritz**

Title: Thoughts on Modeling Environmental Constraints on Fire Activity at Broad Scales

Abstract: Due to advances in statistical techniques, plus the availability of extensive mapped fire datasets, there has been a flurry of recent studies on modeling spatial relationships between fire and environmental variables that control its occurrence. My presentation will cover some of the challenges inherent in fire modeling, particularly at broad (including global) scales, where the span and/or completeness of data may be a limitation. For example, whether a given snapshot of fire observations can allow for a representative and relatively general set of causal relationships can depend on the techniques used. This issue may be even more important when multiple fire regime parameters are being quantified. I will also present some of the techniques we (royal) have used for identifying where fire activity is influenced by a particular variable, the success of which may also be limited by the availability of data and the transferability of such relationships across space and time.

Speaker: **Jane Park** (Parks Canada) and **Jonathan Large** (Parks Canada)

Title: Protecting People, Assets and Adjacent Lands: Landscape level fire and vegetation management in Banff National Park.

Abstract: We will talk about Ecosystem based fire management in Banff as well as a number of decision support tools that we use for research/monitoring (fire weather data, burn severity mapping, smoke mapping) and prescribed fire prescription development.

Speaker: **Haiganoush Preisler**

Title: From Ignition to Spread: Wildland Fire Forecasting and Color Maps

Abstract: In this talk I will discuss the landscape level wildfire risk maps we are producing based on probability models. What (if any) is the utility of these maps to managers? How are they being used, or are they being used at all? How should one interpret these maps? How can we incorporate variability?

Speaker: **Rick Paik Schoenberg** (U. California at Los Angeles)

Title: Model evaluation for forecasts of wildfire activity and spread

Abstract: Some methods for evaluating point process models, coverage process models, and other models for wildfire occurrence and spread will be discussed. Particular focus will be placed on deviance residuals, super-thinned residuals, and Voronoi residuals. Advantages and disadvantages of the different methods will be reviewed, and some related open problems and ways in which wildfire forecasters and statisticians might help one another will be reviewed.

Speaker: **Steve Taylor** (Canadian Forest Service)

Title: Managing Human Activity in Fire Landscapes - Research Questions, Data, Approaches

Abstract: In landscapes prone to fire, managing human activity and development may be as important as managing fire response. This talk will provide a brief historical perspective on fire in the wildland urban interface in Canada, and review some research questions, data sources, and approaches that may inform management in fire prone landscapes.

Speaker: **Dan Thompson** (Canadian Forest Service)

Title: Boreal peatland vulnerability to wildfire: synthesizing datasets and models

Abstract: Peatlands cover approximately a quarter of the boreal forest, and form an equal contribution to the annual burned area in Canada. Boreal peatlands exist in a gap where neither silvicultural inventories nor fire science research has historically captured peatland abundance and dynamics. As a result, there is often only sparse data available on peatland extent, fuels and fuel moisture, and fire behaviour. Even more poorly understood is the potential response of these forested peatlands to the multiple stressors of climate change as well as direct and indirect anthropogenic disturbances. A key factor behind this uncertainty is that existing wildfire fuel moisture and behaviour models do not take into account the deep organic soils in peatlands; the temporal scale of drought and mositure deficits goes well beyond those in more finely-modelled upland forests. Here we discuss the unique challenges posed by attempting to model wildfire vulnerability in forested boreal peatlands, as well as highlighting some of our recent successes and continued areas of research effort.

Speaker: **B. Mike Wotton** (Canadian Forest Service / U. Toronto)

Title: Ignition processes and modelling / moisture estimation and rainfall interpolation

Abstract: An overview of wildland fire ignition processes will be given, with a focus on lightning-caused forest fire ignitions. Then, how moisture content is currently estimated operationally will be discussed, along with comments about the potential areas for improvement, including a discussion of the open question on how observed lightning-flash densities could be used to aid rainfall interpolation.

Speaker: **Francis Zwiers** (Pacific Climate Impacts Consortium, University of Victoria)

Title: Observed, simulated and projected changes in indicators of climate extremes

Abstract: There is an accumulating body of evidence suggesting that on global scales, temperature and precipitation extremes have both changed in response to human influences on the climate over the past half-century or so. The research on temperature extremes, in particular, is now quite well established, although work to understand the feedback mechanisms involved in individual extreme temperature events is ongoing. The evidence on precipitation extremes is less well established, although there is increasingly strong evidence that human influence is detectable in observations at the largest scales that are resolvable in available international compilations of daily precipitation records. In contrast, the picture concerning more complex indicators of dryness (e.g., various drought indices) seems to be somewhat less clear. Increasingly, climatologists are using statistical extreme value theory in their analyses, although most studies to date have not explicitly modelled the spatial dependence of extremes. This talk will review some of the recent research on historical changes in extremes and projections for the future. It will also point out some statistical challenges that arise from this work.