M-Prime Centre for Disease Modelling
York University, Toronto

August 29th-31st, 2011

Symposium on Modelling and Informatics of Disease and Environment (SMIDE)

Symposium Manual

Sponsored by: M-Prime, CDM, and Fields Institute

Location: 280N York Lanes (See #24 on map)
Keele Campus, York University
4700 Keele St., Toronto, ON, M3J 1P3

Audio Video: PC and data projector available

Accommodation: Executive Learning Centre at the
Schulich School of Business,
York University, Keele Campus
56 Fine Arts Road, Toronto, ON M3J 1P3
(http://elc.schulich.yorku.ca)
(**See #42 on Map of Campus**)

Welcome to the Symposium on Modelling and Informatics of Disease and Environment (SMIDE), a series of invited talks, group discussions and informal collaborations.

Organizing Committee:

Prasanth Goswami	CSIR Centre for Mathematical Modelling and Computer Simulation (C-MMACS), India
Jianhong Wu (contact)	Mprime Centre for Disease Modelling at York University
Jörg Grigull	Department of Mathematics and Statistics, York University

Local Arrangements & Contacts: Tara Fernandez
Centre for Disease Modelling, York University
Suite 5021 TEL Building
4700 Keele St.,Toronto, ON, M3J 1P3
Tel: 416-736-2100 ext.20710
Email: taraf@yorku.ca

Symposium Goals

This symposium introduces the national capacity of both India and Canada in the areas of critical importance to environment and vector-borne disease modeling: national priorities, disease surveillance, data sharing and bioinformatics, statistical analysis and mathematical modeling. The symposium will be organized in a relatively unstructured fashion, so each plenary and invited lecture will be followed by a mediated group discussion. There will be less formal lectures than usual workshops to allow participants to form groups to discuss potential collaborations.

Monday August 29th, 2011

Surveillance and modeling environmental impact on health

Morning

9-9:15 am	Welcome and introduction
9:15-10:15 am	**Dr. Nicholas Ogden**, Centre for Food-borne, Environmental and Zoonotic Infectious Diseases (via teleconference) ***"Wildlife disease: challenges, public health needs and modelling methods"***
10:15-10:45 am	**Dr. Hermann Eberl**, University of Guelph ***"On honeybees, varroa destructor and deadly diseases: a mathematical approach"***
10:45-11:15 am	**COFFEE BREAK**
11:15-11:45 am	**Dr. Julien Arino**, University of Manitoba "***A metapopulation model for the spread of malaria"***
11:45-12:15 pm	**Dr. Jane Heffernan**, York University ***"Modelling the Effects of Immunity"***
12:15-1:30 pm	**LUNCH**
Afternoon	***Lyme Disease Track***
1:30-2:00 pm	**Dr. Amy Greer,** PHAC and Dalla Lana School of Public Health, U of T ***"It's Getting Hot Out There: Climate, Environment and Infectious Disease Risk"***
2:00-2:30 pm	**Dr. Yijun Lou and Dr. Xiaotian Wu,** York University **"*The Impact of Climate Warming on the Establishment of Lyme Disease tick vector Ixodes scapularis"***
2:30-3:00 pm	**Dr. Patrick Leighton**, University of Montreal ***"Range expansion of the Lyme Disease vector Ixodes scapularis in Canada"***
3:00-3:30pm	*Group Discussion led by Dr. Amy Greer*
3:30-3:45 pm	**TEA BREAK**
3:45-4:30 pm	**Dr. K.V. Ramesh,** CSIR Centre for Mathematical Modelling and Computer Simulation, Bangalore, India ***"Observed climate change and future climate projections over India"***
6:30-9:30 pm	**SMIDE Banquet Dinner at Black Creek Pioneer Village, semi-formal attire**

Tuesday August 30th, 2011

Modeling capacity for disease control and emergency response

Morning

9-9:15 am	Welcome and Introduction
9:15-10:15 am	**Dr. USN Murty**, Indian Institute of Chemical Technology (CSIR), Hyderabad, India ***"Assessment of Malaria incidence with reference to Climate Change: An Indian Scenario"***
10:15-10:30 am	**COFFEE BREAK**
10:30-11:30 am	**Dr. P. Goswami,** CSIR Centre for Mathematical Modelling and Computer Simulation, Bangalore, India ***"Quantitative Relation between Weather Variables and Malaria: A Case Study over North East India"***
11:30-12:00 pm	**Dr. Dongmei Chen,** Queen's University ***"Risk signals of an influenza pandemic caused by highly pathogenic avian influenza subtype H5N1: Spatio-temporal perspectives"***
12:00-1:00 pm	**LUNCH**
Afternoon	***Mosquito and West Nile Virus Track***
1:00-1:30 pm	**Dr. Curtis Russell,** Public Health Ontario ***"West Nile virus in Ontario"***
1:30-2:00 pm	**Dr. Guihong Fan**, York University ***"Modeling and models for the dynamics of West Nile virus"***
2:00-2:30 pm	**Dr. Huaiping Zhu**, York University ***"Will Peel region have more culex pipiens/restuans next week?"***
2:30-3:00pm	*Group Discussion led by Dr. Huaiping Zhu*
3:00-3:30 pm	**TEA BREAK**
3:30-4:00 pm	**Dr. Srinivas Rao Mutheneni,** Indian Institute of Chemical Technology Hyderabad, India ***"Impact of weather variables on infected vector mosquitoes of Japanese encephalitis virus in Andhra Pradesh, India.***
4:00-4:30 pm	**Dr. Seyed Moghadas**, York University ***"How did the 2009 pandemic affect different age groups of Canadian First Nations?"***

Wednesday August 31st, 2011

Bioinformatics and in-hosting dynamics

All Day

9-4:30pm Day for Collaborations

Meeting rooms/Offices available:

5021A Tel Building (YIHR)

5021C Tel Building (YIHR)

5021M Tel Building (YIHR)

"Wildlife disease: challenges, public health needs and modelling methods"

Dr. Nicholas Ogden
Centre for Food-borne Environmental and Zoonotic Infectious Diseases, PHAC Ottawa

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On honeybees, varroa destructor and deadly diseases: a mathematical approach

Dr. Hermann Eberl
Professor, University of Guelph

The western honeybee is in trouble. In recent years beekeepers all over Europe and North America reported drastic, unprecedented losses of colonies. Among the many stressors that were proposed, parasitic varroa mites have been identified as one of the main culprits. These mites, in addition to being harmful to the bees themselves can carry man different viruses. We present a simple model of the honeybee-varroa mite-acute bee paralysis virus complex, which we study both with analytical and numerical methods.

A metapopulation model for the spread of malaria

Julien Arino
Professor, University of Manitoba

I will present a model for the spatio-temporal spread of malaria using a metapopulation framework. The model incorporates transmission-blocking partial immunity in the human hosts, with recovered hosts still able to transmit the parasites to vectors, albeit with lower probability. The model is shown to exhibit a backward bifurcation. Using type reproduction numbers, the patches reservoir of infection are identified, allowing to pinpoint regions where interventions will be most efficacious.
This is joint work with Arnaud Ducrot (Bordeaux) and Pascal Zongo (Ouagadougou).

"Modelling the Effects of Immunity"

Dr. Jane Heffernan
Professor, York University

Immunity, gained from infection or vaccination, affects the spread of disease and the success of some vaccination programs. In this talk we will discuss the effects of prior immunity on pandemic influenza, measles outbreaks and herpes vaccination.

IT'S GETTING HOT OUT THERE: CLIMATE, ENVIRONMENT AND INFECTIOUS DISEASE RISK

Dr. Amy Greer
PHAC and Dalla Lana School of Public Health, University of Toronto

Global climate change is inevitable — the combustion of fossil fuels has resulted in a build-up of greenhouse gases within the atmosphere, causing unprecedented changes to the earth's climate. The Fourth Assessment Report of the Intergovernmental

Panel on Climate Change (IPCC) suggests that North America will experience marked changes in weather patterns in coming decades, including warmer temperatures and increased rainfall, summertime droughts and extreme weather events. These events are likely to cause important changes in the incidence and distribution of infectious diseases, including vectorborne and zoonotic diseases, water- and food-borne diseases and diseases with environmental reservoirs. In this presentation, I will describe a case-crossover methodology to identify acute associations between environmental exposures and infectious disease case occurrence and highlight how climate change predictions may influence historical disease patterns in North America. I will also highlight opportunities and challenges for incorporating these environmental risk data into mathematical models using a "One Health" framework. The significant global weather pattern changes expected in the coming years require that the scientific community leverage existing tools, strengthen interdisciplinary collaborations, and develop new methodologies to identify the range of possible disease outcomes that could be expected under different climate scenarios. This understanding will allow us to optimize public health responses and mitigate infectious disease risk especially in vulnerable populations.

The Impact of Climate Warming on the Establishment of Lyme Disease tick vector *Ixodes scapularis*

Dr. Yijun Lou and Dr. Xiaotian Wu
Postdocs, Centre for Disease Modelling, York University

A stage-structured periodic deterministic model is formulated to assess the climate warming impact on the tick ({\it Ixodes scapularis}) population at Long Point, Ontario, Canada. The model is parametrized, and the tick development and questing activity data are compiled from the laboratory and field experiments conducted in Canada. Mean monthly temperatures of the study region are estimated for the two periods between 1961-1990 and 2000-2009, and some Fourier series analysis is conducted to derive the season-based model coefficients by fitting the temperature and tick data. These validated estimations provide the basis for our study using the deterministic model with periodic coefficients to describe the influence of climate warming on the Lyme disease establishment in the considered region. The stage-structured periodic deterministic model is then analyzed both analytically and numerically. The basic reproduction number for the tick population, the number of new female adult ticks produced by an index female adult tick when there are no density dependent constraints acting anywhere in the life cycle of the tick population, is derived. This number serves as a threshold parameter for tick invasion: the tick is doomed to extinction when this number is less than unity; and the tick can successfully invade into the study region and may stabilize at a positive seasonal equilibrium state when this number is greater than one. Both temperatures and host densities influence the value of the basic reproduction number, thereby influencing the risk of tick establishment in a habitat, specifically, climate warming promotes tick survival in favorable habitats and affiliates tick invasion to previously non-endemic areas. Using the temperatures simulated by the third generation coupled Canadian Global Climate Model (CGCM3) with emissions scenario `A2', the increase and pattern shift of the tick population for three future periods 2011-2040, 2041-2070 and 2071-2100, and thus the resultant Lyme risk are predicted. This is joint work with Venkata R. Duvvuri, Nicholas H. Ogden and Jianhong Wu.

Range expansion of the Lyme Disease vector *Ixodes scapularis* in Canada

Patrick Leighton
Postdoc, University of Montreal

Over the past two decades *Ixodes scapularis*, the primary tick vector of Lyme disease in eastern North America, has expanded its range northward from the USA to colonize new regions in southern Canada. Since 1990, ticks have been collected across Canada and submitted to national authorities by veterinarians, medical practitioners, and the general public, providing a unique picture of the northward spread of *I. scapularis* populations. We used this 19-year time series to model the spread of *I. scapularis* in Canada in order to identify factors influencing the speed and direction of spread. Our results point to both long-distance dispersal of ticks by migratory birds and local dispersal by resident hosts as important mechanisms underlying patterns of range expansion for *I. scapularis*. Annual temperature (degree days) was the most important determinant of environmental suitability for tick establishment, suggesting that tick range expansion may be facilitated by climate warming. Model projections suggest that *I. scapularis* range will expand substantially in the coming decade, resulting in a substantial increase in the human risk of Lyme disease with the proportion of the human population of eastern Canada inhabiting areas with established tick populations increasing from approximately 20% in 2010 to over 80% by 2020. This first empirical model of *I. scapularis* range expansion provides an important estimate of the relative influence of host dispersal mechanisms and habitat suitability on the process of tick invasion at the continental scale, and a new tool to guide surveillance and focus interventions on the most critical areas.

Observed climate change and future climate projections over India

Dr. K.V. Ramesh
CSIR Centre for Mathematical Modelling and Computer Simulation, Hyderabad, India

Changes in precipitation, temperature, and other environmental variables have both direct effects (through drought, flood, and extreme weather events) and indirect effects (through changes in transmission and outbreaks, particularly diseases transmitted by mosquitoes, rodents, or water) on human health. Quantification of observed changes and estimates of future changes in climate variables like wind, rainfall, temperature, humidity and etc., will be of helpful in identifying the regions which are vulnerable for transmission and outbreak of infectious diseases. Here we present the past observed changes for the period 1981-2010 and possible future changes for the next 100years. Initial study on past climate reveals that overall the number of rainy days and its spatial extent is decreasing. The surface temperature shows both increasing and cooling trends over India. The preliminary finding of future climate projections over India is also discussed.

Assessment of Malaria incidence with reference to Climate Change: An Indian Scenario.

Prof USN Murty
Director Grade Scientist, Head Biology Division
CSIR-Indian Institute of Chemical Technology

According to WHO report (2010), 11 countries in the South-East Asia region 10 are endemic for malaria. Approximately 60% of the total population in the region is at some risk of malaria, with 20% at high risk. India contributes around 76% of total malaria cases from this region. Malaria is major public health concerns in the North Eastern states of India, in which Arunachal Pradesh (AP) is considered as highly endemic for malaria caused by both *Plasmodium falciparum* and *P. vivax*. Studies on malaria in AP have been confined in this work chiefly for its vulnerability to Climate change. Correlation between epidemiological and meteorological parameters in the region has been fortified through penetrative analysis of the germane factors in the study zone. To design a forecasting model concentric to the endemicity of that particular state, morbidity (malarial cases for the last six years) and Annual Parasite Index (API) have been deliberated to represent the disease transmission trends. The commitment of temperature on parasite development and vector density/population showing varied insecticide resistance has been entrenched. Another important climatic variable rainfall is studied for its impact on API in India. Similarly wind strength versus malaria cases has been debated for the past five decades in the country. Unifying all such analyses from various ends, a dynamic model is developed to predict the epidemiological cases in 12 districts of Arunachal Pradesh of North East India which is one of the high endemic zones for malaria in India. Although all the three weather variables: temperature, rainfall and humidity are known to play important roles in vector genesis, simulation of epidemiology examined through this model with these weather variables showed large differences from actual observations for certain districts. An analysis of simulation with humidity and rainfall showed large errors and the best results were obtained with temperature only. The conception of this model is being pursued further to enhance the precision of the simulations. The current model of malaria epidemiology of vector population driven by weather variables can be used at short scales for outbreak forecast by using high resolution weather monitoring and forecasts.

Quantitative Relation between Weather Variables and Malaria: A Case Study over North East India

Dr. Prasant Goswami
CSIR Centre for Mathematical Modelling and Computer Simulation, Bangalore, India

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Risk signals of an influenza pandemic caused by highly pathogenic avian influenza subtype H5N1: Spatio-temporal perspectives

Dr. Dongmei Chen
Queen's University, Kingston, Ontario

Highly pathogenic avian influenza (HPAI) subtype H5N1 is a trans-boundary animal disease that has crossed the animal-human species barrier and caused a broad-scale impact on the poultry industry, wild bird population and human health in the past decade. Understanding the spatiotemporal patterns of H5N1 outbreaks can provide visual clues to the dynamics of disease spread and risk areas, thereby helping to improve the cost-effectiveness of planning and implementing the control and prevention strategies. Previous studies only covered outbreaks in relatively short periods. This study described the epidemic characteristics and investigated the temporal, spatial and space-time dynamic patterns of H5N1 outbreaks in domestic poultry using a global database from December 2003 to December 2009. The analysis revealed two major findings. First, the beginning date of epidemic wave was postponed, the epidemic duration was prolonged and the magnitude of epidemic was
reduced over time, but the disease transmission cycle had not been efficiently interrupted. Second, two "hot spot" regions of H5N1 outbreaks were identified: historically a well-known one in East and Southeast Asia and a newly emerged one in the boundaries of Europe and Africa, where enhanced surveillance should be conducted, especially the newer "hot spot" region. The risk of influenza pandemic from HPAI H5N1 remains high.

West Nile virus in Ontario

Dr. Curtis Russell
Program Consultant, Enteric, Zoonotic and Vector-Borne Diseases, Public Health Ontario

This presentation will cover a general introduction to West Nile Virus and its history in Ontario. We will discuss Ontario's WNV mosquito surveillance program and how it relates to control activities conducted around the province.

Modeling and models for the dynamics of West Nile virus

Dr. Guihong Fan
Postdoc, York University

There have been extensive modeling studies of the dynamics of West Nile virus since its first arrival in North America. In this talk, I will present a summary of some modeling work on mosquito-borne diseases of the LAMPS working group. I will focus on the following topics
1. Backward bifurcations, outbreak and initial ratio of the sizes of vector-mosquito and avian host;
2. Impact of temperature and Hopf bifurcations, the driven mechanisms of oscillations and multiple peaks of the infection;
3. Impact of avians species diversity and transmission;
4. Weather and environmental factors and their impact on mosquito abundance.

Will Peel region have more culex pipiens/restuans next week?

Dr. Huaiping Zhu
Professor, York University

Forecasting the vector mosquito abundance in a region is important and essential for the risk assessment, control and prevention of mosquito-borne diseases. By using the data of the mosquito surveillance program of administrated by Vector-borne Disease Unit, Infectious Diseases Branch of Ministry of Health and Long Term Care, Ontario, and the historical weather data, we develop a preliminary version of the weather driven model for the West Nile virus transmitting mosquitoes: culex pipiens/restuans. We carry out a case study of the mosquito abundance for the region of Peel. With the weather driven model and the weather forecasting data for the following week, we can simulate and forecast the mosquito abundance for the following week for the region. This is a joint work with Jiafeng Wang, Nicholas Ogden, Curtis Russell, Paul Proctor and Kaz Higuchi.

POSTER PRESENTATION:

Impact of weather variables on infected vector mosquitoes of Japanese encephalitis virus in Andhra Pradesh, India

Dr. M. Srinivas Rao
Indian Institute of Chemical Technology (IICT), Hyderabad, India

Japanese encephalitis (JE) is endemic in Kurnool district of Andhra Pradesh, India, where *Culex tritaeniorhynchus* and *Culex gelidus* are reported as primary vectors for transmission of JE virus. A longitudinal study was carried out to assess the seasonal pattern of Japanese encephalitis (JE) vector density and virus infection rates in different seasons. Climatic attributes are more associated with relative mosquito abundance and transmission of mosquito borne infections in many parts of the world, especially in warm and tropical climatic regions. In each geographic area, temperature and precipitation are the two important variables for mosquito density, in conjunction with other seasonal factors for JE epidemics. Various mosquito species like *Culex gelidus* and *C. tritaeniorhynchus* have been collected from study area. High prevalence of *Cx. gelidus* (68.05%) was recorded in urban area whereas, *Cx. tritaeniorhynchus* (57.51%) was found to be more in rural belts than urban sector. Climatic factors such as rainfall and temperature were found to be correlated with the Per Man Hour (PMH) density, whereas the humidity was inversely correlated with mosquito density.

The field collected vectors were subjected for JE virus after dessication using ELISA method. Vector susceptibility showed higher infection rate of 1.50 during the rainy and winter seasons, a lower minimum infection rate (MIR) of 0.636 during summer for *Culex tritaeniorhynchus*. Similarly MIR in *Culex gelidus* was observed in rainy season with an arithmetic mean of 2.488, 89.19 in winter and 0.65 during summer. From this study it is noticed that MIR of *Cx. gelidus* and *Cx. tritaeniorhynchus* were modulated by various meteorological parameters. A systematic databse was developed to get more usefriedly reports for control operations and modeling studies. Details are discussed.

How did the 2009 pandemic affect different age groups of Canadian First Nations?

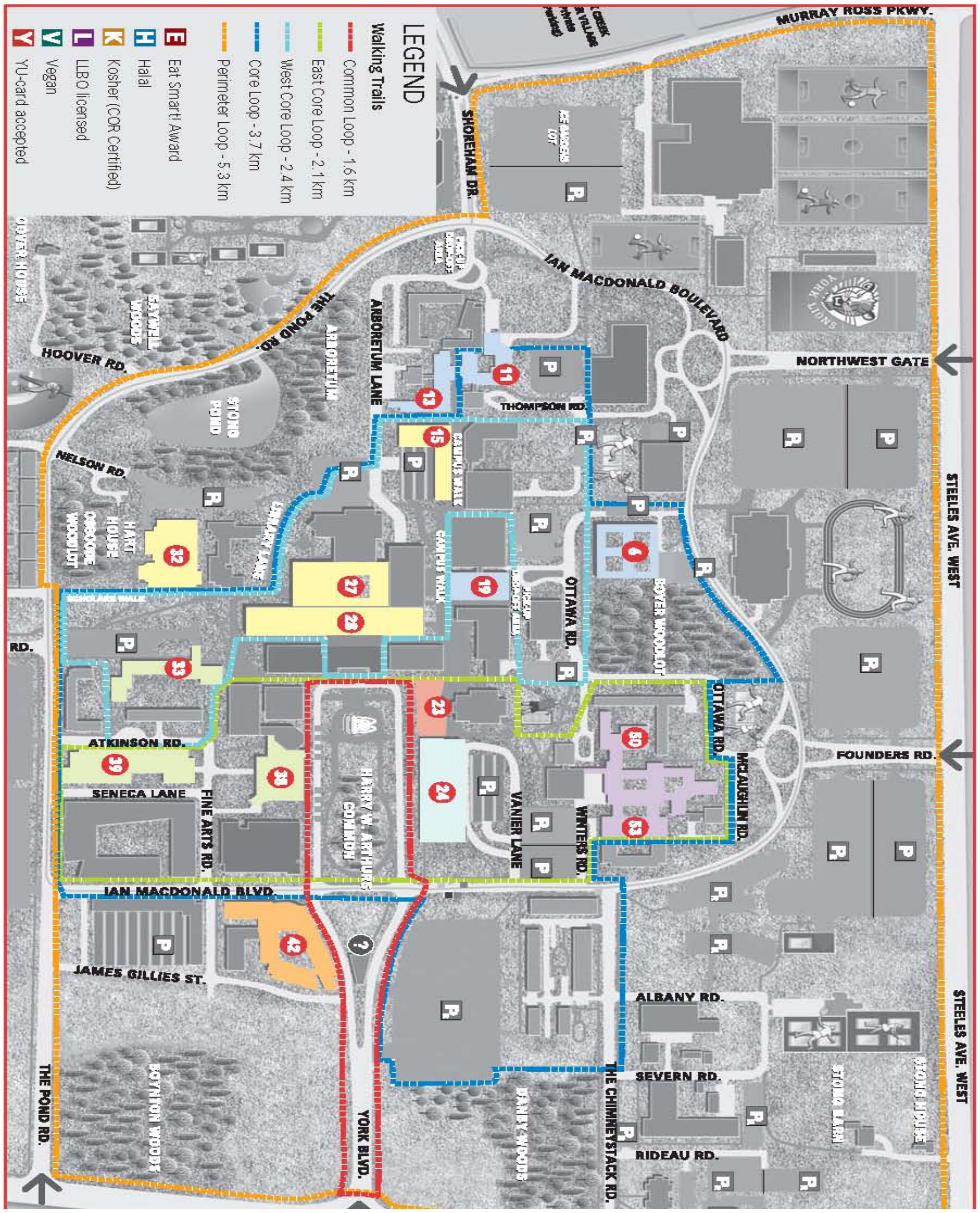
Dr. Seyed Moghadas
M-Prime Centre for Disease Modelling, York University

One striking aspect of the 2009 H1N1 influenza pandemic in Canada was its disproportionate impact on indigenous populations. We show this impact through a comparative analysis of age-standardized ratios of infection and hospitalization between First Nation and non-First Nation populations in the province of Manitoba, Canada. We highlight the importance of demographic variables and health disparities in the variability of disease incidence in different geographic locations.

Workshop Participants

	First Name	Last Name	Institution	Email
1	Tahmina	Akhter	Ryerson University	takhter@ryerson.ca
2	Julien	Arino	University of Manitoba	arinoj@cc.manitoba.ca
3	Dongmei	Chen	Queen's University	chendm@queensu.ca
4	Michael	Chen	York University	chensy@mathstat.yorku.ca
5	Yuming	Chen	Wilfred Laurier University	ychen@wlu.ca
6	Hana	Dobrovolny	Ryerson University	hdobrovo@ryerson.ca
7	Yimin	Du	York University	yimindu@hotmail.com
8	Venkata	Duuvuri	PHO-Public Health Laboratory Toronto	venkata.r.duvvuri@gmail.com
9	Hermann	Eberl	University of Guelph	heberl@uoguelph.ca
10	Guihong	Fan	York University	gfan@mathstat.yorku.ca
11	Paul	Gordon	University of Guelph	pgordon@uoguelph.ca
12	Prasant	Goswami	CSIR Centre for Mathematical Modelling and Computer Simulation	goswami@cmmacs.ernet.in
13	Amy	Greer	Hospital for Sick Kids	amylgreer@yahoo.com
14	Lina	Hao	York University	haoln@yorku.ca
15	Jane	Heffernan	York University	jmheffer@mathstat.yorku.ca
16	Amy	Hurford	Fields Institute, York University, University of Toronto	hurford@yorku.ca
17	Majid	Jaberi	York University	mjdjaberi@gmail.com
18	Manisha	Kulkarni	Public Health Agency of Canada	manisha.kulkarni@phac–aspc.gc.ca
19	Patrick	Leighton	University of Montreal	patrick.a.leighton@umontreal.ca
20	Yijun	Lou	York University	Ylou@yorku.ca
21	Neal	Madras	York University	madras@mathstat.yorku.ca
22	Sharmistha	Mishra	St. Michael's Hospital	sharmisthak@gmail.com
23	Seyed	Moghadas	York University	Seyed.moghadas@gmail.com
24	USN	Murty	Biology Division IICT	Murty_usn@yahoo.com
25	Srinivasa Rao	Mutheneni	Indian Institute of Chemical Technology	msc_srinivas@yahoo.com
26	Nicholas	Ogden	Public Health Agency of Canada	Nicholas.Ogden@phac-aspc.gc.ca
27	Kazi	Rahman	University of Guelph	krahman@uoguelph.ca

28	K.V.	Ramesh	Indian Institute of Chemical Technology	Ramesh@cmmacs.ernet.in
29	Vardayani	Ratti	University of Guelph	vratti@uoguelph.ca
30	Curtis	Russell	Public Health Agency of Ontario	Curtis.Russell@oahpp.ca
31	Chunhua	Shan	York University	chunhuashan@gmail.com
32	Xiangsheng	Wang	York University	xswang4@mail.ustc.edu.cn
33	Jianhong	Wu	York University	wujh@yorku.ca
34	Xiaotian	Wu	York University	wxt1109@yorku.ca
35	Yanyu	Xiao	University of Western Ontario	Yxiao26@uwo.ca
36	Ping	Yan	Public Health Agency of Canada	Ping.Yan@phac-aspc.gc.ca
37	Yong	Yang	York University	yangyong@yorku.ca
38	Huaiping	Zhu	York University	huaiping@mathstat.yorku.ca
39	Hossein	Zivari-Piran	York University	hzp@mathstat.yorku.ca



LEGEND
Walking Trails
Common Loop - 1.6 km
East Core Loop - 2.1 km
West Core Loop - 2.4 km
Core Loop - 3.7 km
Perimeter Loop - 5.3 km
E Eat Smart! Award
H Halal
K Kosher (COR Certified)
L LLBO licensed
V Vegan
Y YU-card accepted
MURRAY ROSS PKWY.
SHOREHAM DR.
IAN MACDONALD BOULEVARD
NORTHWEST GATE
STEELES AVE. WEST
FOUNDERS RD.
THOMPSON RD.
ARBORETUM LANE
THE POND RD.
HOOVER RD.
NELSON RD.
OTTAWA RD.
ATKINSON RD.
SENECA LANE
FINE ARTS RD.
IAN MACDONALD BLVD.
JAMES GILLIES ST.
YORK BLVD.
VANIER LANE
WINTERS RD.
MCLAUGHLIN RD.
ALBANY RD.
SEVERN RD.
RIDEAU RD.
THE CHIMNEYSTACK RD.

TORONTO: YorkU On Campus

WEBSITES

www.yorku.ca

www.yorku.ca/yorkweb/maps

Free Wireless Internet: Login and password available with registration

EMERGENCY

***In an **EMERGENCY** dial **911** for police, fire, or ambulance

York Campus Security:

Emergency: 416.736.5333 or ext. 33333

Non-emergency:416.650.8000 or ext. 58000

HEALTH

Apple tree Medical Clinic (located in York Lanes # 24):	(647) 722-2370
York Lanes Pharmacy (located in York Lanes #24):	(416) 736-5272

TRANSPORTATION

Taxi Companies:

Royal taxi:	(416) 777-9222
Beck Taxi:	(416) 751-5555

Public Transit website: Toronto transit commission www.ttc.ca

: $3.00 per one way adult fare; a single fare is valid for one way travel

: Buses can be found at the York University Bus Loop located at Ian MacDonald Blvd. and York Blvd.

FOOD: http://www.yorku.ca/foodservices/locations/index.html

On Campus (Number corresponds to Campus Map)

Berries and Blooms (York Lanes)- *Vegetarian* (#24)	(416) 663-0033
Executive Dining Room (Schulich)- *Formal Dining* (#42)	(416)736-5342
Falafel Hut Village (York Lanes)- *Middle Eastern* (#24)	(416) 736-5767
The Great Canadian Bagel (York Lanes)- *Soup & Sandwich* (#24)	(416) 736-5555
Indian Flavour (York Lanes)- *East Indian Cuisine* (#24)	(416) 663-2666
La Prep (York Lanes)- *Soup and Sandwich* (#24)	(416) 650-0191
Mangia Mangia Italian Eatery (York Lanes)- *Italian (#24)*	(416) 736-9484
Sakura Japanese Restaurant (York Lanes)-*Japanese* (#24)	(416) 736-5471
The Underground Restaurant (Student Centre)-*International (#23)*	(416) 736-5110
Z-teca (York Lanes)-*Mexican/Tex-mex (#24)*	(416) 877-6142

Off Campus

Thai Bamboo (2150 Steeles Ave. West at Steele ave. & Keele st.)	(416) 761-7598
Genji Sushi (*Japanese*) 2899 Steeles Ave. West	(416) 667-0867
Tashkent Restaurant (*Uzbekistanian Cuisine*) 800 Petrolia Rd.	(416) 667-0737
Coconuts Restaurant and Lounge (*Caribbean)* 2180 Steeles Ave.W	(905) 532-9594

RECREATIONAL ACTIVITIES

Black Creek Pioneer Village:	(416) 736-1733	www.blackcreek.ca
Tait Mckenzie Gym :	(416) 736-2100 ext. 55185	www.recreation.yorku.ca
The Rexall Centre :	(416) 665-9777	www.tenniscanada.com
Black Creek Summer Music Festival		www.Blackcreekfestival.com
York Observatory (open Wed. from 9-11pm)		http://astronomy.blog.yorku.ca

NIAGARA FALLS

Safeway tours has a bus departing from Jane St. and Wilson Ave. (at the Coffee Time).

A 12 minute cab ride from York University

http://www.safewaytours.net/ewelcome.html

Cost: $30 return

Departs at: 9:05am, 10:00am, 11:00am, 12:00pm,

Leaves Niagara: 4:30pm, 5:30pm, 6:30pm, 8:00pm, 9:30pm

BANQUET DINNER AT BLACK CREEK PIONEER VILLAGE

1000 Murray Ross Parkway, M3J 2P3

Monday August 29th, 2011 from 6:30-9:30pm

Dress Code: Semi-formal Attire

Cash Bar available on premises

Black Creek Pioneer Village is a 15 minute walk from the symposium venue. Carpooling can be arranged with other guests.