Peel Public Health:

Infectious Disease Simulation Tool – Geospatial Decision Support System

OAHPP GIS Workshop Series

November 30, 2009

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Outline

- Project Overview
- Summary of User Needs
  - User Interviews
  - Survey
  - Joint Application Design (JAD)
- Early System Design
  - System Recommendation – Early Mockup
  - Inventory of User Needs

Introduction

- Project team is proposing to develop an Infectious Disease Simulation Tool which allows decision makers to **visualize the dynamics of infectious disease outbreaks over time and space**.

- Completed User Needs Assessment (UNA) for the proposed tool.

- It is anticipated that public health officials and other decision makers will be able to **create a more effective local infectious disease outbreak planning process**.

- It is also anticipated that the tool would be **applicable to other health-related urgent responses**.

Vision

"To create a more effective planning process for local infectious disease outbreaks and other disasters by allowing decision makers to visualize the dynamics of the outbreak over time within their own community"

Objectives

- To **enable spatio-temporal visualization and analysis of simulated infectious disease outbreaks** by multiple stakeholder groups from public health, municipalities and institutions, as defined in the User Needs Assessment (UNA).
- To **assist public health officials and key decision makers -** more effective local infectious disease outbreak planning.
- To **prepare the tool for influenza simulations**, including the novel H1N1 Influenza A (human swine flu) outbreak.
- To **create a tool that can be modified** for other infectious disease outbreaks and health-related urgent response.
- **To build capacity for sustained, increased use of geomatics and the CGDI** within Peel Pubic Health and the province's 35 other health units though the OAHPP.

Proposed Benefits

- Aid in the preparation of pandemic (and other emergency) plans
- Allow planners & decision makers to:
  - Visualize the dynamics of a pandemic, outbreak, other emergencies
  - Simulate readiness and response
  - Evaluate response times
  - Quantify the costs
  - Contrast effective and non-effective intervention strategies
- Reduce overall costs, by being better prepared and complying with government regulations and policy;
- Reduce time required to prepare for and respond to emergencies
- Save lives and property through better planning.

Why Geographic Information Systems?

- Ability to visualize affected areas and populations;
- Can create a listing of affected infrastructure and populations;
- An event can be simulated at a local level or over a larger area;
- Event parameters are diverse and can be modified by end-users;
- Maps, response instructions and other reports can be output in Word, Excel and other reporting formats;
- Can be developed as a collaborative, web-based tool;
- Low cost for development - can leverage existing platform components;
- Integration with Business Intelligence (e.g. SAS);
- Ability to integrate with current conditions, e.g. syndromic surveillance.

Project Overview – Approach & Timelines

Activities

- **System Analysis**
  - Exploratory Analysis for Mathematical Models
  - Risk Assessment
  - Data Analysis
- **System Design**
  - Procurement
  - Data Acquisition & Prep
  - Create System Requirements Spec
  - Design Database
  - Design Model
  - Develop User Interface (UI) Prototype
- **Development**
  - Develop Database
  - Develop GIS & Web components
  - Develop Final Application
- **Launch**
  - System Testing
  - Launch
  - End-User Training
  - Evaluation

Deliverables

- Modeling Approach
- Privacy Impact Assessment
- Development Environment
- UI Prototype
- Fully Developed System
- Test Results
- Release Evaluation
- Next Steps

Region of Peel
Working for you

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User Interviews - At a Glance

- Focus on Public Health CD Control / CD Surveillance
- Completed 11 Interviews:
  - 8 Peel Public Health;
  - 2 Kingston Frontenac and Lennox & Addington;
  - 1 University of Waterloo.
- Mixture of one-on-one & small group interviews:
  - Total of 16 Participants.

User Interviews - Summary of Key Findings

- Need to balance type of diseases the tool can simulate with enough flexibility to be useful in a variety of scenarios;
- The processes for managing Communicable diseases are typically the same; what changes are the parameters;
- Simulations would be useful for analyzing “what if” scenarios;
- Never certain what the exact future will be, but analyzing scenarios provides some possibilities, and forces us to think about what might or would be done in those ‘futures’;
- Number of operational data sources and information systems is vast; complexities around access, use, and privacy of the data;
- Inter-organizational communication and co-operation is critical;
- Internal HR capacity for new tools could be a challenge – and ease of use will be a key success factor.

Survey - At a Glance

- Included stakeholders from municipalities, healthcare institutions, academia and others involved in urgent response.
- 52 Respondents:
  - 34 from Public Health;
  - 6 from Municipalities;
  - 6 from Healthcare Institutions;
  - Remaining from academia, private sector & other healthcare.
- Range of roles with respect to emergency planning and infectious diseases management, surveillance and control:
  - 28 CD Control; 22 CD surveillance; 20 CD case management;
  - 10 develop emergency plans; 12 develop or maintain pandemic plans;
  - Small numbers of other emergency responders.

Survey Findings 1 – Experience & Hours Dedicated

Emergency management planning knowledge & experience	Response Percent	Response Count
None	5.9%	3
Novice / Very Limited	**51.0%**	26
Intermediate	27.5%	14
Expert / Very Knowledgeable	15.7%	8

CD / Pandemic Planning knowledge & experience	Response Percent	Response Count
None	0.0%	0
Novice / Very Limited	24.5%	12
Intermediate	**59.2%**	29
Expert / Very Knowledgeable	16.3%	8

Weekly hours spent emergency planning	Response Percent	Response Count
None	**58.0%**	29
Less than 5	30.0%	15
5 to 20	0.0%	0
More than 20	12.0%	6

Weekly hours spent CD / Infectious Disease planning	Response Percent	Response Count
None	24.5%	12
Less than 5	**44.9%**	22
5 to 20	16.3%	8
More than 20	14.3%	7

Weekly hours spent pandemic planning	Response Percent	Response Count
None	**68.0%**	34
Less than 5	26.0%	13
5 to 20	6.0%	3
More than 20	0.0%	0

Survey Findings 2 - Tabletop Simulations

- Tabletop simulations approximate real-world scenarios in a group setting; share some of the same characteristics as computer simulations.
- 34% of Respondents (17) have participated in tabletop simulations for CD urgent response
- 34% of Respondents (17) have participated in tabletop simulations for the Incident management system (IMS)
- 34% of Respondents (17) have participated in tabletop simulations for pandemic

Survey Findings 3 - Tabletop Simulations

Benefits	1	2	3	4	5	N/A	Rating Average	Response Count
Improving planning materials?	2.2% (1)	2.2% (1)	8.7% (4)	23.9% (11)	19.6% (9)	**43.5% (20)**	4.00	46
Identifying gaps and unknowns?	0.0% (0)	2.2% (1)	10.9% (5)	17.4% (8)	26.1% (12)	**43.5% (20)**	4.19	46
Approximating a realistic simulation?	2.2% (1)	2.2% (1)	19.6% (9)	21.7% (10)	10.9% (5)	**43.5% (20)**	3.65	46
Connecting with/collaborating with new colleagues outside of my organization?	2.2% (1)	2.2% (1)	10.9% (5)	21.7% (10)	17.4% (8)	**45.7% (21)**	3.92	46
Building new knowledge about emergency response practices?	2.2% (1)	6.5% (3)	13.0% (6)	15.2% (7)	19.6% (9)	**43.5% (20)**	3.77	46

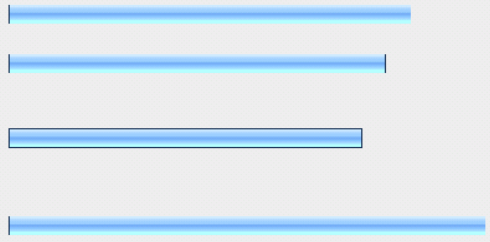
Limitations	1	2	3	4	5	N/A	Rating Average	Response Count
The durations are too short compared to an actual event	0.0% (0)	8.7% (4)	13.0% (6)	21.7% (10)	10.9% (5)	**45.7% (21)**	3.64	46
They are not held frequently enough	4.3% (2)	6.5% (3)	17.4% (8)	19.6% (9)	8.7% (4)	**43.5% (20)**	3.38	46
The wrong people are invited	17.4% (8)	10.9% (5)	17.4% (8)	8.7% (4)	2.2% (1)	**43.5% (20)**	2.42	46
The wrong people attend	13.0% (6)	10.9% (5)	19.6% (9)	10.9% (5)	2.2% (1)	**43.5% (20)**	2.62	46
The simulations are not realistic	8.7% (4)	19.6% (9)	21.7% (10)	6.5% (3)	0.0% (0)	**43.5% (20)**	2.46	46
						Other (please specify)		4

Survey Findings 4 - Computer-based Simulations

- Not a replacement of tabletop simulations, but a new tool with different capabilities, benefits and limitations
- 86% of Respondents (42) would participate in computer-based simulations
- Those who would not indicated they either would not have time to participate or do not think the simulations would be helpful
- 4 Respondents are involved in epidemiological modeling or forecasting of infectious disease/CD scenarios
- 98 % of Respondents (47) spend more than 2 hours per day on their computer; 91% (44) self identify as intermediate of expert computer users

Survey Findings 5 - Computer-based Simulations

User goals	Response Percent	Response Count
Improving the planning process	76.2%	32
Approximating a realistic simulation	71.4%	30
Connecting with/collaborating with colleagues outside of my organization	66.7%	28
Building new knowledge about emergency response practices	**90.5%**	38
Other (please specify)		2



Important outcomes	1	2	3	4	5	I don't know	Rating Average	Response Count
Hospitalizations	8.2% (4)	4.1% (2)	8.2% (4)	32.7% (16)	**34.7% (17)**	12.2% (6)	3.93	49
Outpatient Visits	8.3% (4)	6.3% (3)	12.5% (6)	**31.3% (15)**	29.2% (14)	12.5% (6)	3.76	48
Morbidity Rates	4.2% (2)	4.2% (2)	14.6% (7)	22.9% (11)	**45.8% (22)**	8.3% (4)	4.11	48
Mortality Rates	4.2% (2)	4.2% (2)	12.5% (6)	22.9% (11)	**47.9% (23)**	8.3% (4)	4.16	48
Impact on emergency room visits over time	8.5% (4)	14.9% (7)	19.1% (9)	21.3% (10)	**23.4% (11)**	12.8% (6)	3.41	47
Costs of interventions (e.g. prophylaxis)	8.5% (4)	17.0% (8)	23.4% (11)	17.0% (8)	**25.5% (12)**	8.5% (4)	3.37	47
Economic Impact on Region	8.5% (4)	6.4% (3)	**27.7% (13)**	23.4% (11)	**27.7% (13)**	6.4% (3)	3.59	47
							Other	5

Survey Findings 6 – Tools in Use

Statistical & Data Analysis Tools	Response Percent	Response Count
I currently do not use any statistical or data analysis systems	46.8%	22
SPSS	8.5%	4
SAS	2.1%	1
Microsoft Excel	**48.9%**	23
Cognos Report Net (CRN)	17.0%	8
Business Objects	0.0%	0
Information Builders	0.0%	0
Metrics 3D (ABS)	0.0%	0
Microsoft Access	21.3%	10
Epi-Info	8.5%	4
Other (please specify)		7

Geographic Information Systems (GIS) Tools	Response Percent	Response Count
I currently do not use any Geographic Information Systems (GIS) or mapping information	**81.8%**	36
ESRI ArcGIS Desktop	9.1%	4
ESRI ArcGIS Server	6.8%	3
MapInfo Professional	2.3%	1
Intergraph GeoMedia	4.5%	2
ICES INTool	0.0%	0
PHAC Map Generator	4.5%	2
Other (please specify)		5

JAD Session - At a Glance

- Included similar group of potential users to the survey;
- Included system developers, mathematical modeler and Business Intelligence systems;
- 24 Attendees (including 3 via teleconference):
  - 14 Region of Peel or Peel Public Health;
  - 2 hospital planners;
  - 4 system developers (Infonaut);
  - 2 mathematical modelers (University of Waterloo);
  - 1 Business Intelligence expert (SAS).
- 3 hour long session included:
  - Project overview;
  - Presentation / validation of key findings;
  - Breakout groups / analysis of requirements;
  - SWOT Analysis.

JAD Session - Summary of Key Findings

- Much discussion regarding the need for the proposed **Simulation Tool** vs. the need for a **Surveillance Tool**
- There remains a need to prioritize diseases (or other disasters) for simulation / modeling. Suggestions have included:
  - Flu (especially Pandemic); C. Diff.; Measles; West Nile; Enterics; CBRN events
- Suggested methodology for prioritization: weighted scores of, e.g.
  - Strategic need (e.g. Hazard Identification Risk Assessment), modeling complexity , availability of historical data
- Group support for Simulation tool that can be used to:
  - Improve the *effectiveness of tabletop exercises*
  - Play out *scenarios in real-time* over the Internet

SWOT Analysis

Strengths •Visualization (ability to visualize what's happening) •Improved preparedness for response •Identify spatial trends	**Opportunities** •Expand scope and functionality in future iterations •Integration with real time data for surveillance or situational awareness •Scale to neighboring jurisdictions; up to province / fed (e.g. Panorama) •Assist in response to incidents commanded by public health
Weaknesses •Money and time constraints will limit scope of diseases to model / monitor •Potential impact of administering, supporting, maintaining system	**Threats** • Privacy impact • Data availability

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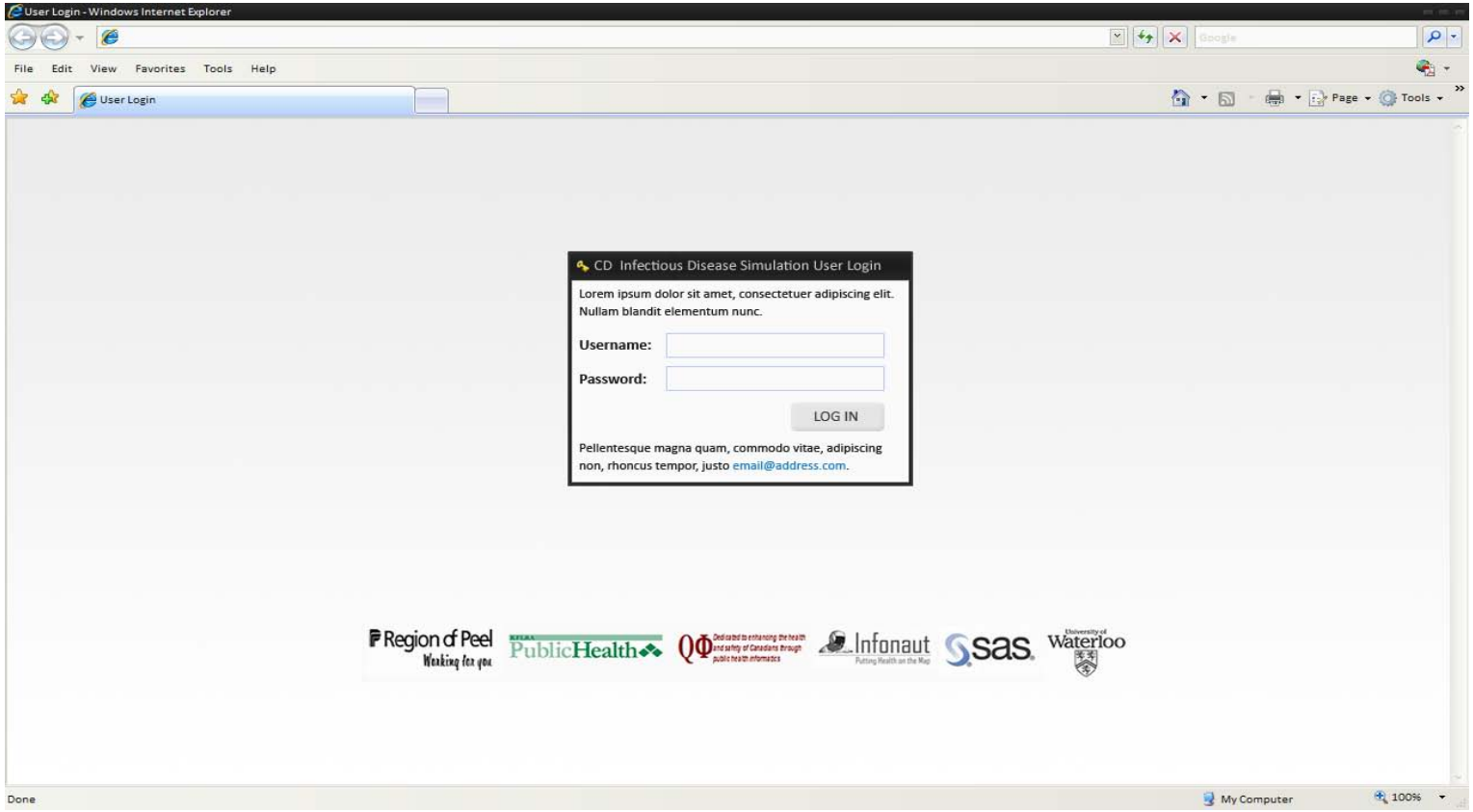
System Recommendation – User Login



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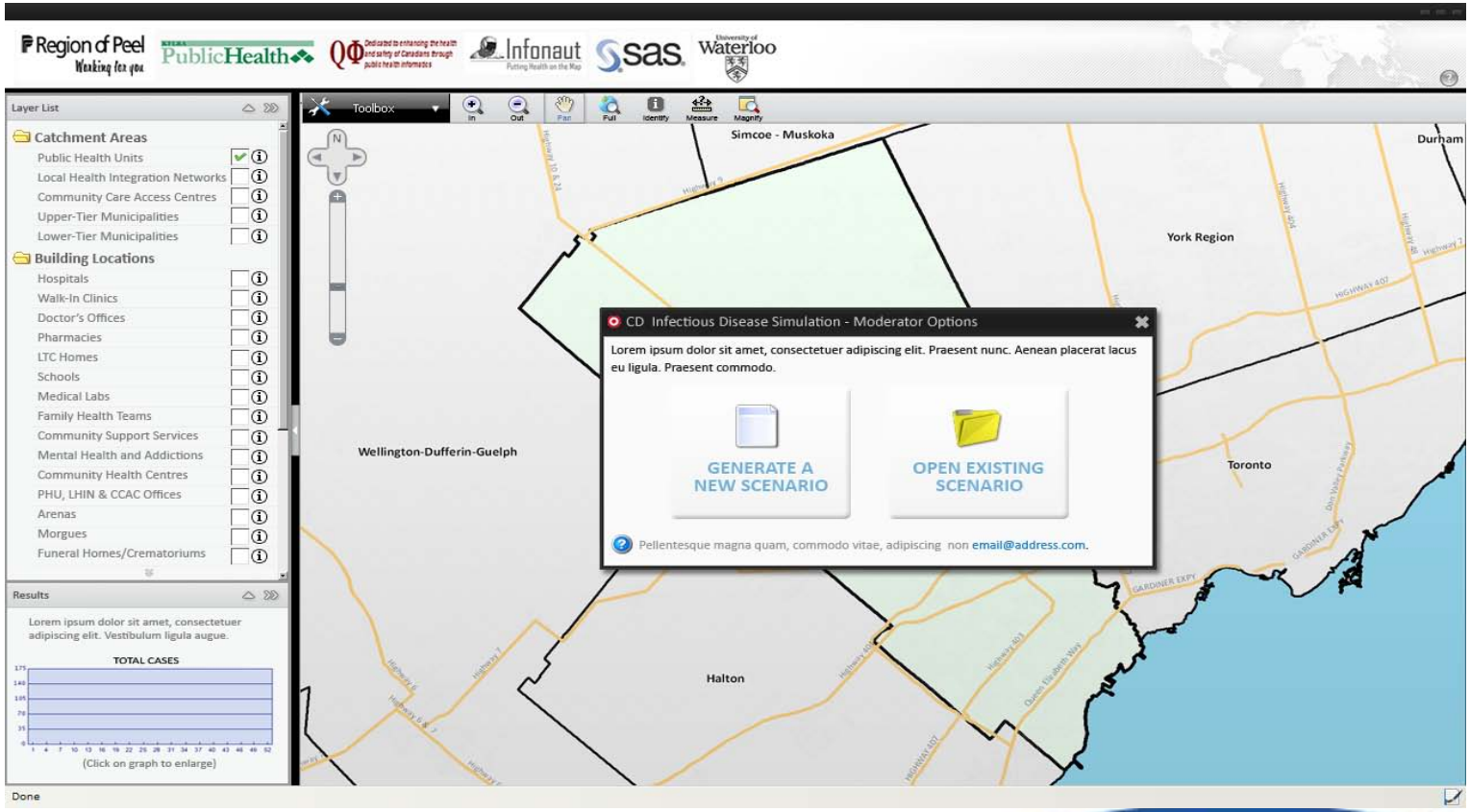
System Recommendation – New / Open



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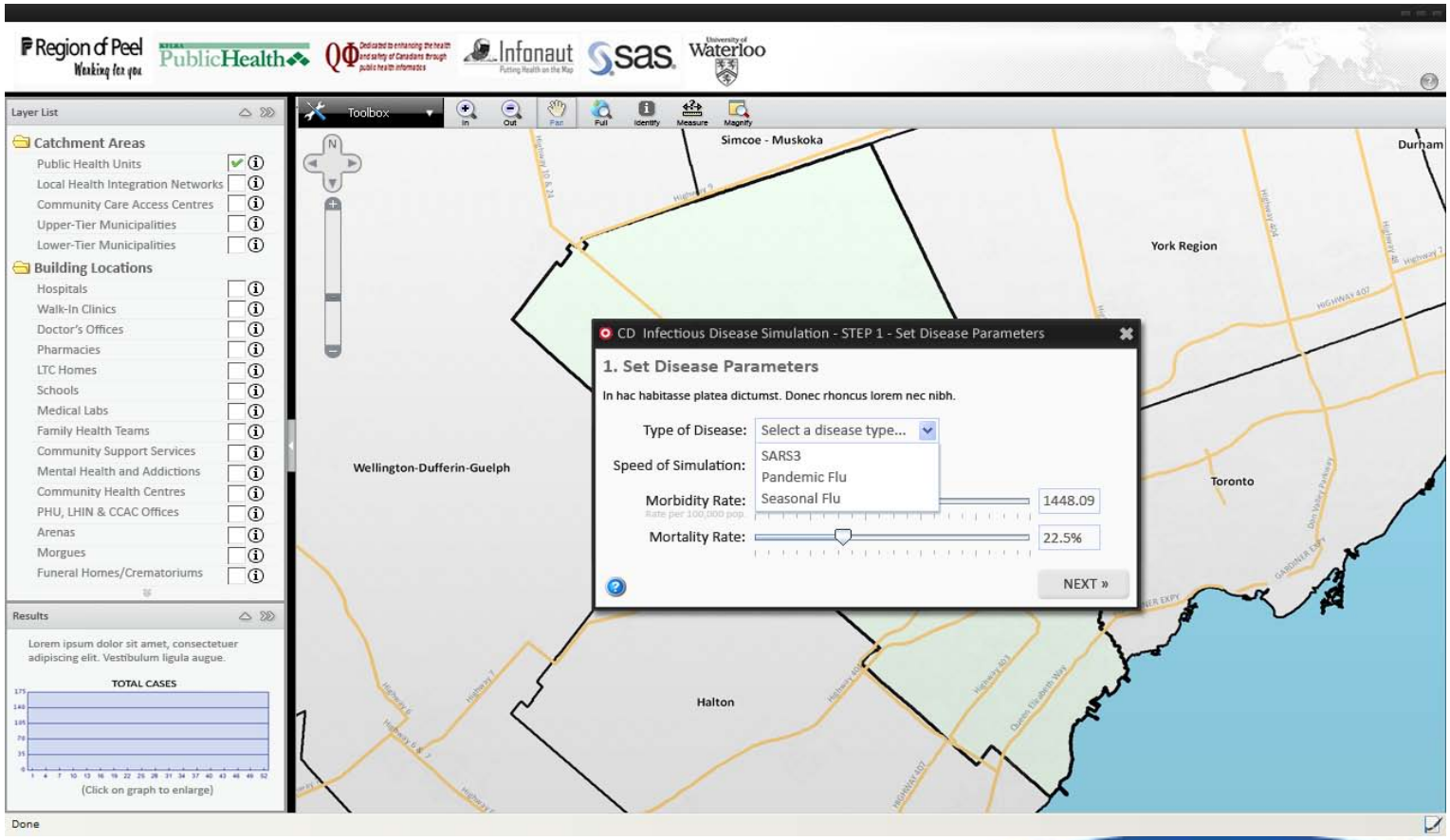
System Recommendation – Set Disease Parameters



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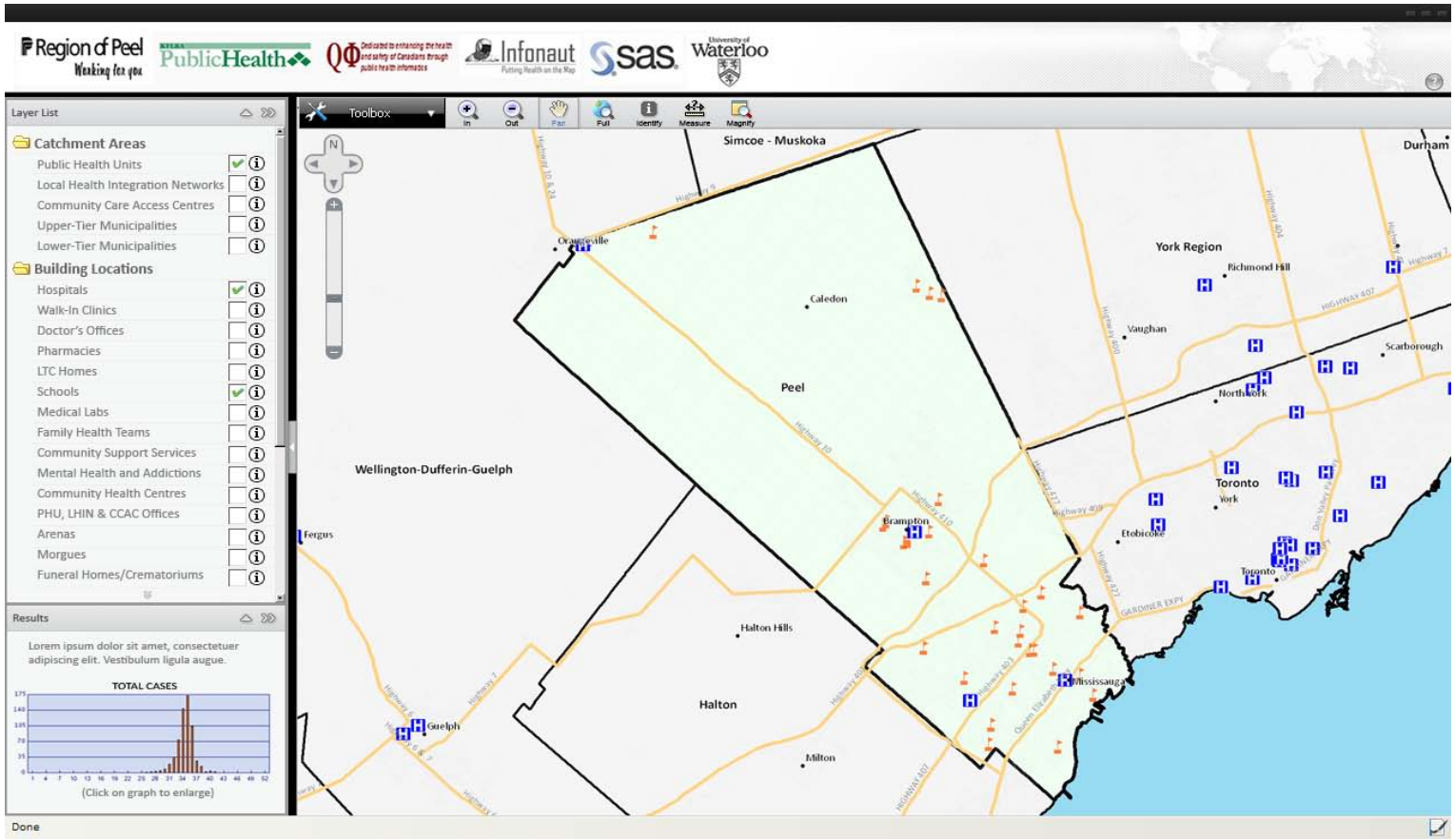
System Recommendation – Regional View



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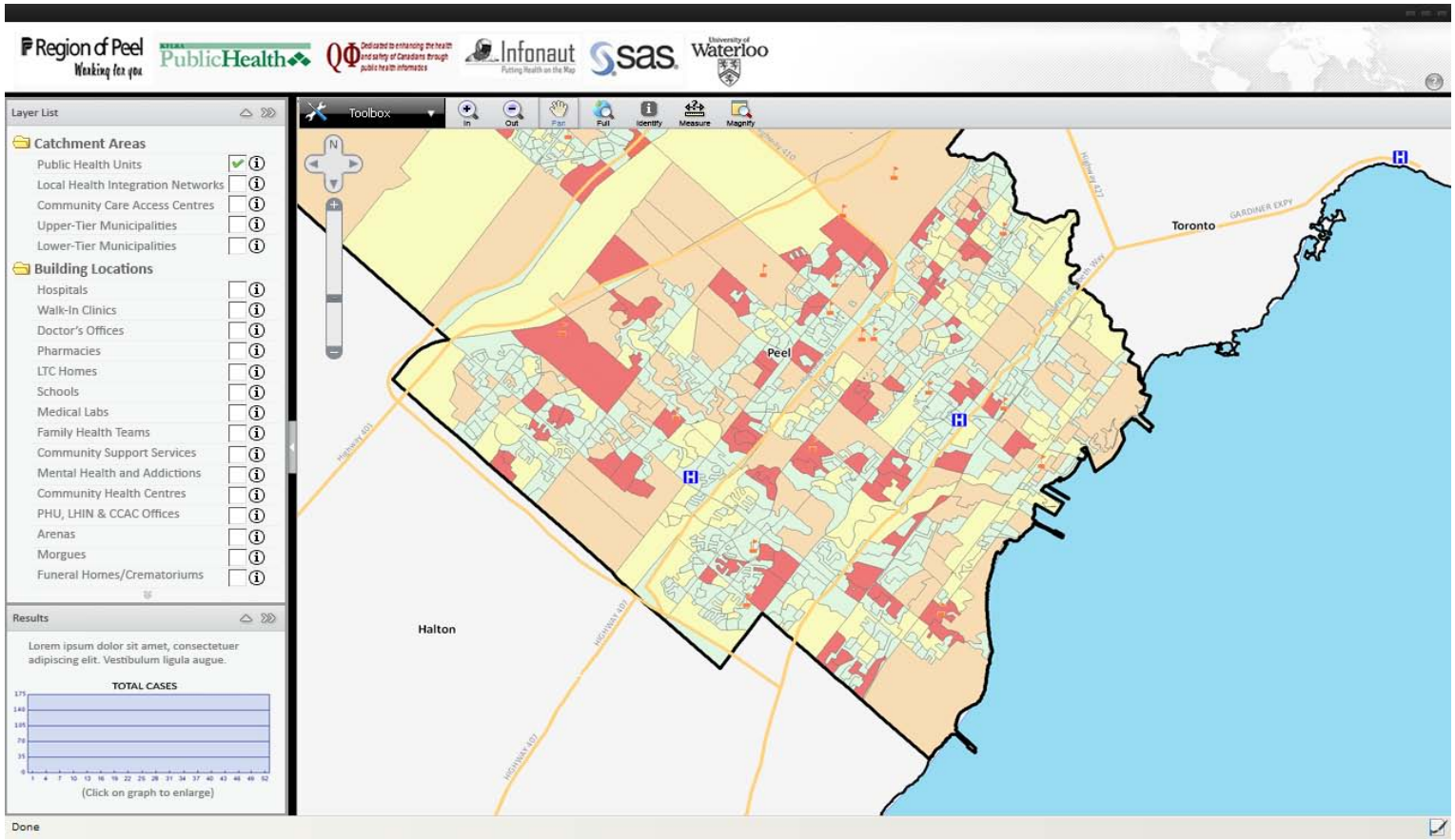
System Recommendation – Scenario in Progress



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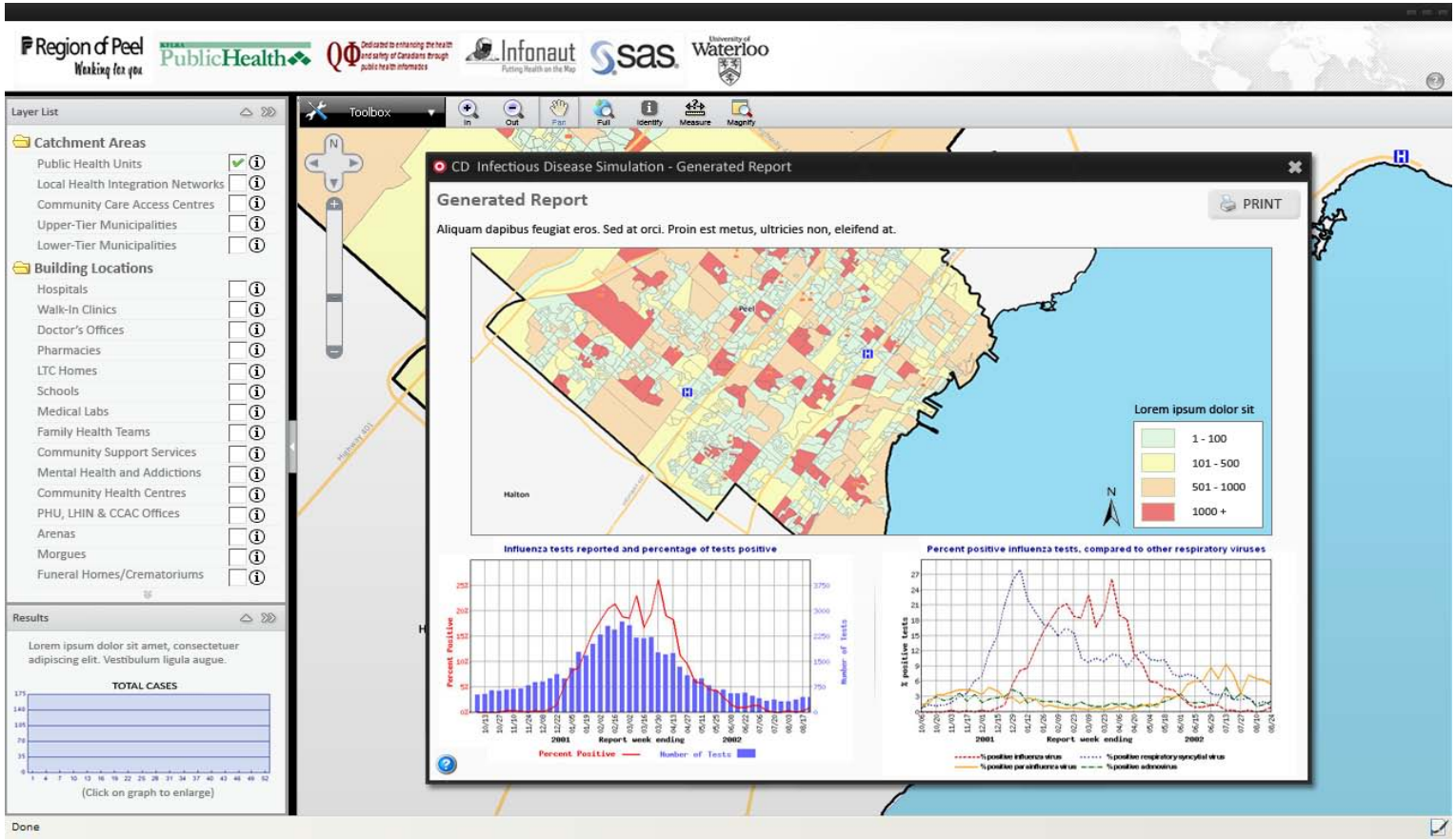
System Recommendation – Outcome Reports



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Potential End-Users

- **Public Health**
  - Epidemiologists
  - MOH Personnel
  - Emergency Planners
  - Infection Control Specialists
  - Surveillance Managers
  - Front Line Case Management Staff
- **Institutions**
  - Emergency Site Managers
  - Infection Control (Acute care)
  - Infection Control (LTC)
  - Institutional Planners
  - Emergency Room surge capacity Managers
  - Hospital Administrators
  - LTC Facility Administrators
- **Municipalities**
  - Emergency Services (911)
  - Emergency Management
  - Municipal Operations Centre
  - Public Works
  - Emergency Medical Services
  - Municipal Planners
  - RICN Coordinators

Recommended User ‘Roles’

- Tool Administrator
  - Configure the tool for use in a particular region
  - Supports ‘Scenario Manager’s & ‘Participants’
  - Technical / IT / GIS personnel, external organization
- Scenario Manager
  - Creates and manages simulated disease scenarios
  - Emergency planners, CD managers, epis
- Participants
  - View, participate in simulated disease scenarios
  - Responders, agencies including other public health jurisdictions, surveillance networks, health institutions (e.g. hospitals and LTCH), other community partners that assist in urgent response (e.g. local law enforcement, paramedics, allied health professional agencies)

Recommended Workflow for Building Scenarios

- Configure tool for a specific region:
  - Geographic Data
  - Core ‘Static’ Data (population demographics)
- Create a New scenario (Or Open existing):
  - Disease Parameters
  - Intervention Parameters
  - Scenario Parameters
- Run scenario
- Create Reports
- Participate / View Results

User Needs (Tool Administrator): Geographic Data Elements

- Regional boundaries (Public Health, LHIN, municipal)
- Postal FSA, Census boundaries
- Transportation routes
- Points of interest (points of transmission, points of distribution, points of care, etc.)
  - Health Services: Hospitals and LTCH, Retirement homes
  - Schools, universities, daycares
  - Workplace / large workplace (incl. airport)
  - Recreational buildings, community centres (shopping centres less important)
  - Primary care offices, walk-in clinics (& assessment sites)
  - Shelters, correctional facilities, places of worship, volunteer organizations
  - Emergency services (police, fire, ambulance)
  - Poultry farms, aviaries, flea markets
  - Funeral homes, crematoria, arenas, morgues
  - Off-site care sites (hotels, schools with residences)
  - Labs
  - Pharmacies
  - Gas stations
- Climate, weather, air quality

User Needs (Tool Administrator): Core / Static Data Elements:

- Regional variables
  - Population density - urban vs. rural
  - Age distribution, ethnicity, gender by Census area
  - Dwelling information / family structure
  - Socio-economic status
  - Population baseline vaccination rate
  - Travel for work (difficult to model)
- Hospital (& other institution) variables
  - Number and type of beds; occupancy rates
  - Ventilators and other equipment
- Critical healthcare workers (and other sector, especially responders)
  - Baseline absenteeism, vaccination rate
- Antivirals, emergency supplies, PPE

User Needs (Scenario Manager): Scenario Parameters

- Start Date / End date
- Epicentre (multiple epicentres)
- Group / Team, Individual
- Vulnerable / at-risk populations
- Social or cultural groups
- Real-time, Accelerated

User Needs (Scenario Manager): Disease Parameters

- Agent that causes the disease
  - Average length of hospital stay (hospital) by agent
  - Epidemiology of the disease (i.e. load baseline variables for a disease)
  - Mode of transmission (Airborne, droplet, contact)
  - **Focus to be established**
- Period of communicability
- Latency period
- Incubation period
- Symptomatic period
- Percent symptomatic
- Attack rate
- Mortality & Morbidity
- Potential interventions
  - Efficacy of interventions

User Needs (Scenario Manager): Intervention Parameters

- Pre/post exposure prophylaxis rates
- Population vaccination rate over time
  - Vaccination effective rate
  - Immunized and infected
- Public Health personnel (or essential services) immunization rates
- Hand-hygiene
  - MOH acute hospital observation audits
  - Core-competency education
- Hospital acquired infection rates
- Environmental cleaning
  - Product use
  - Housekeeping hours
- Use of Personal Protective Equipment (PPE)
  - Totals & Percent On-hand / Used
- Social distancing
  - Facility closures
- Adverse effect of post-Immunization rates (reaction)

User Needs (Participant & Scenario Manager): Outcome Reports

- Epidemic Curve (number of new cases over time)
  - Number of cases/100,000 population
- Morbidly totals and % of population
- Mortality totals and % of population
- Cost of Intervention
- Affected Institutions & Closures (esp. healthcare, but others important)
- Hospitalizations & Visits – ER Surge rates
- Health Unit Call Volumes (against Thresholds)
- Pattern of spread
- Critical healthcare (and other sector) workers, front-line responders absenteeism

Expression :

- Counts, percentage, percentage change, mean, median
- Rolling averages
- Thresholds / benchmarks (e.g. for cluster alerts)

What else did we hear?

- “Continue to involve multiple stakeholders.”
- “Keep it as simple as possible, sustainable and multi-purpose.”
- “How will it integrate with coordinated response efforts & the master pandemic plan?”
- “This is an awesome project with lots of potential.”

Thank You!