Wellesley Urban Health Model Online Simulation Guide

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INTRODUCTION: WELLESLEY URBAN HEALTH MODEL (WUHM)

There is a substantial body of evidence highlighting the importance of the social determinants of health in shaping the health of urban populations in Canada. The low socio-economic status of marginalized, disadvantaged, and precarious populations in urban settings has been linked to adverse health outcomes including chronic and infectious disease, negative health behaviours, barriers to accessing healthcare services, and overall mortality. Given the dynamic complexities and inter-relationships surrounding the underlying drivers of population health outcomes and inequities, it is difficult to assess program and policy intervention tradeoffs, particularly when such interventions are studied with static models.

The Wellesley Institute, in partnership with Lupina Foundation, has adopted a systems thinking approach to the social determinants of health. We developed a simulation model for the City of Toronto using system dynamics modeling methodology. The Wellesley Urban Health Model (WUHM) simulates changes in health, social determinants and disparities beginning from the year 2006 and projecting forward to 2046, enabling users to plan and test scenarios under different assumptions. The model includes adults aged 25-64, capturing their gender, ethnicity, and immigration status.

The model simulates alternative scenarios to help explain the impact of interventions on poor health outcomes such as chronic disease rates, disability rates and mortality rates. The model also gives insight into how much and how quickly interventions can reduce mortality and morbidity.

The model includes eight health and socio-economic conditions with unique causal and feedback relationships, as a result of rigorous statistical testing using Canadian Community Health Survey and Census data. Five possible policy intervention options related specifically to the social determinants of health can be implemented and tested in the model. The dynamic, long-term and synergistic impacts of these interventions can be examined, focusing on three health outcomes: mortality rate, disability, and chronic illness.

It is important to emphasize that this is a tool for broad-based strategic analysis at a high level of abstraction and aggregation, rather than a narrower, more detailed tool for tactical intervention planning. The Wellesley Institute's goal is to provide a useful learning tool that will allow us, our stakeholders and other policy-makers to ask "what if" questions about policy interventions and as a result, guide us to useful research questions and map effective policy directions for complex population health problems, while ultimately enabling communities to think about their health futures.

SIMULATION INTERFACE

Moving forward, our goal is to explore different ways of facilitating the dissemination and communication of the WUHM and its uses to a wide range of audiences. Towards this end, we have developed a user-friendly, interactive online interface that would simplify model usage while enabling individuals to experiment with the model on their own and run simulations. The idea of building a user-friendly, interactive interface for simulation models is common in the systems thinking field, and has been utilized in various application areas including public health.

For people who have never experienced modeling, or those who have not been exposed to a system dynamics model in a learning environment, it can seem quite a daunting task to unravel the complex causal relationships represented in models and to derive meaningful insights from the results, even if they have some knowledge of important systems thinking concepts. Most interfaces, depending on

the type of audience they are designed for, can bridge this challenge. They expose the user to a simple interface with few parameters that the user is able to tweak. A manageable set of output graphs and tables present the results of each scenario.

This is a tool that fosters experiential learning by allowing individuals to custom design the scenarios they wish to test, without having to worry about the complicated relationships and equations underlying the model structure. Stakeholders and other users can better understand the impact their own actions have on the system as a whole and, as a result, transforms their mental models of the causes of population health disparities. Furthermore, it facilitates planning and implementation of health intervention strategies. The flexibility users gain with model usage and the independence from having to always rely on a modeler to conduct the engagement (not something for which many organizations have the capacity) is a very appealing feature of this option of which modeling initiatives usually prefer to take advantage.

1. WELCOME PAGE

The Wellesley Urban Health Model Online Simulation allows you to run the simulation through your browser and see the results of your interventions immediately. Figure 1 shows the start page of the online simulation. Clicking on the Start button loads the main screen of the simulation which is described below in detail.

Figure 1: The Welcome screen of Wellesely Urban Health Model Online Simulation.

2. MAIN SCREEN

The majority of functionality offered by this online simulation is accessible via the main screen. Here you can read about the details of the model and how it's been structured, see the available interventions and modify them if needed, run the simulation based on the modified interventions, and see the aggregated and detailed results of the simulation and analyze them. In the following section, we will describe each of the available features.

2.1 Model Description

The Model Description page explains what you can expect from the model and briefly describes what interventions are available in the model. On this page, you can either click on the available link if you wish to find out more about the model and its underlying assumptions, or proceed to the Policy Options page to start interacting with the model. Figure 2 shows a snapshot of Model Description page.
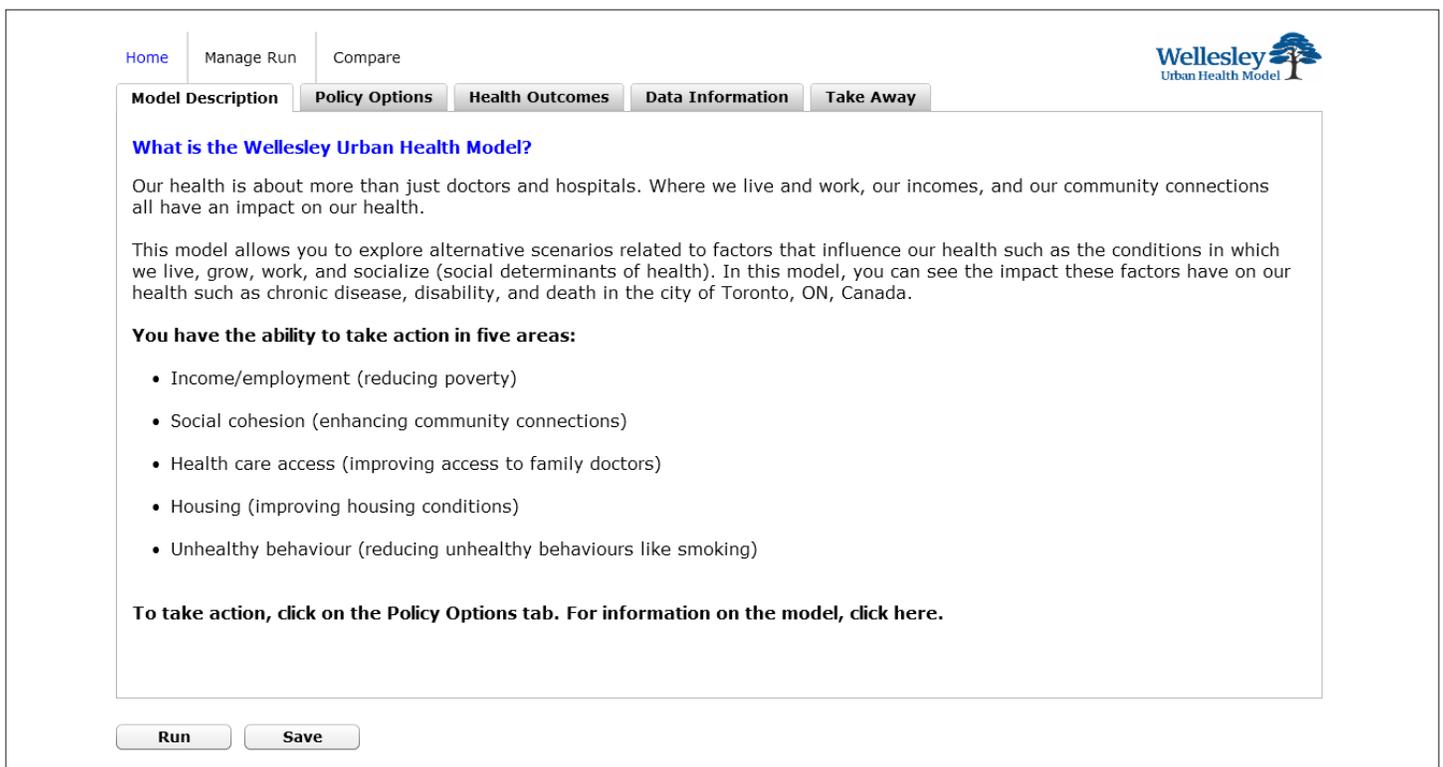

Figure 2: Model Description page.

2.2 Policy Options

On the Policy Options page, you can view the system structure diagram which maps the causal relationships in the model (it is crucial to refer to this diagram and understand how system components are interacting when interpreting simulation results). Here you can also see all the available intervention options which you can modify prior to running the simulation. The slider bar below each intervention indicates to what extend the intervention should be applied during the simulation run. By hovering the mouse over the interventions, you can view a brief description of the intervention. You may also hover your mouse over the *Save*, *Run*, and *Reset* buttons to get a description for these features.

Clicking on the *Run* button here without specifying any values starts the simulation process based on starting year values (baseline). If no change is made to the intervention slider bars, the default values will be used for them (0% intervention for all policies) and the results reflect the status quo.

Clicking on the *Save* button allows you to save the result of the simulation, therefore you or other users can refer to the results of the simulation at any point. Saving a simulation is further explained below.

Note: Clicking on the Save button prior to running the simulation will save an empty simulation with no results.

Figure 3 shows a snapshot of *Policy Options* section.
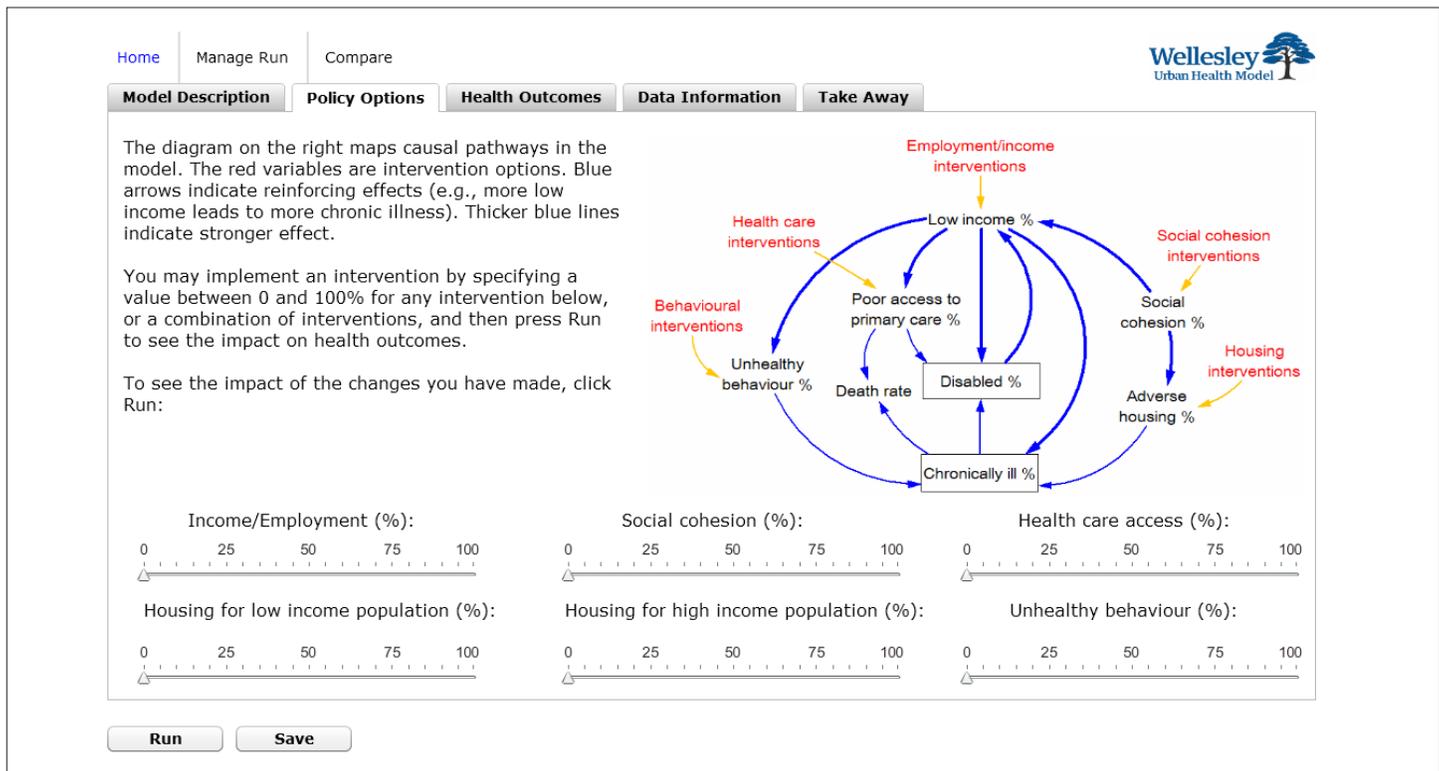
Figure 3: Policy Options section.

2.3 Health Outcomes:

After setting the preferred values for each policy intervention and clicking on the Run button, you can view the outcome of the simulation in the Health Outcomes section. This results section is categorized into four sub-sections: Disability, Chronic Illnesses, Deaths, and Results by Immigration Status. You can see the impact of policy changes on any of these health variables. You may also view the results by immigration status.

Figure 4 shows an example of a simulation run result, focusing on disability rate in the population. The graph displays the simulated dynamics of disability rate in the entire population of Toronto over a 40 year time frame. The quantitative results of the plotted graph are represented in a table below the graph. The table consists of three rows: Total number of affected in the population, Number of cases averted, and Percentage of cases reduced. The first row shows the prevalence of disability in the population. The

second row displays the number of cases that were prevented due to an intervention compared with the baseline in year 2006, 2016, 2026, 2036, and 2046. The third row shows the change in percent.
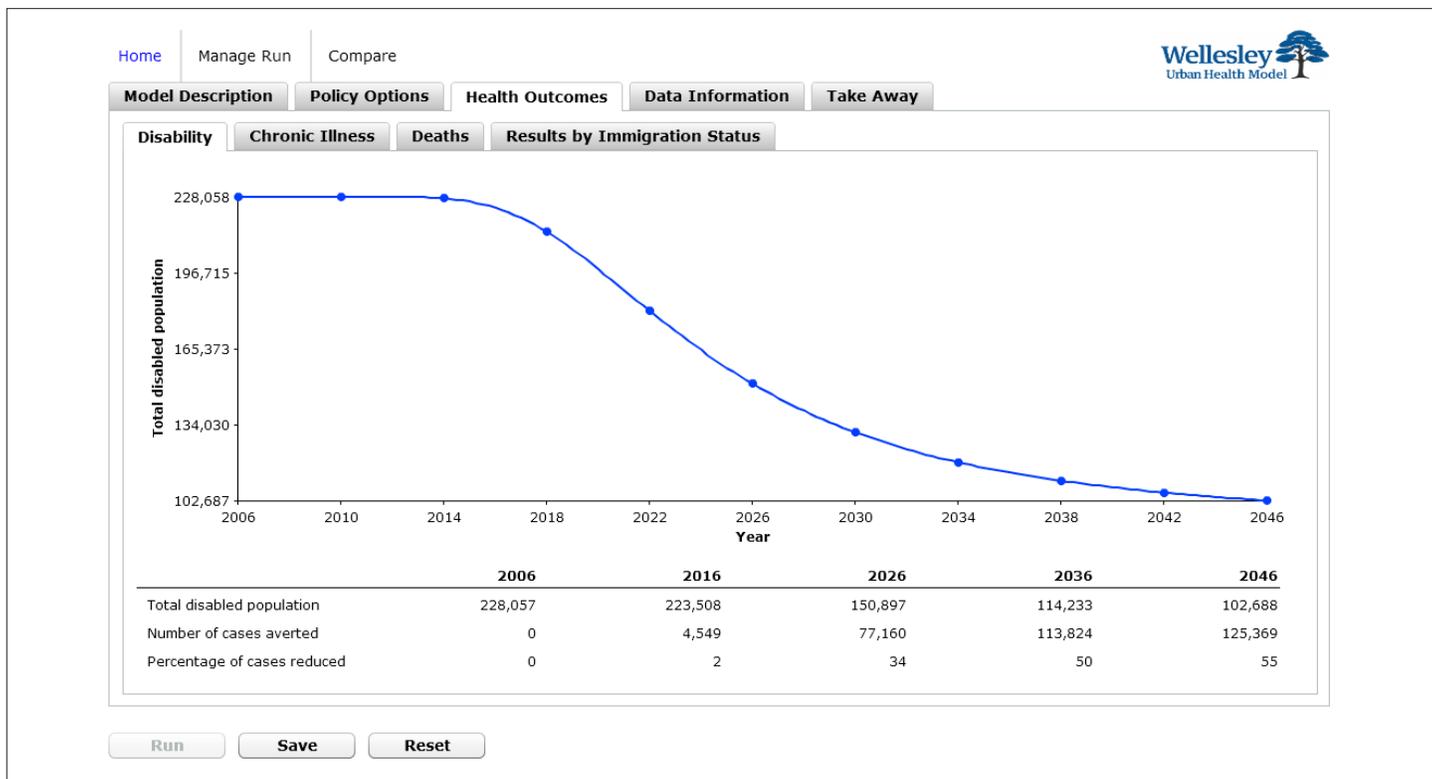

Figure 4: Health Outcome of an example simulation scenario.

Similar outcome representation can be seen for Chronic Illness and Deaths as well in related sections. The last section of Health Outcomes, labeled Results by Immigration Status, represents the results of the simulation by people's immigration status: Native Born (NB), Established Immigrant (EI), and Recent Immigrant (RI).

Figure 5 shows the result of a specific simulation scenario by immigration status.
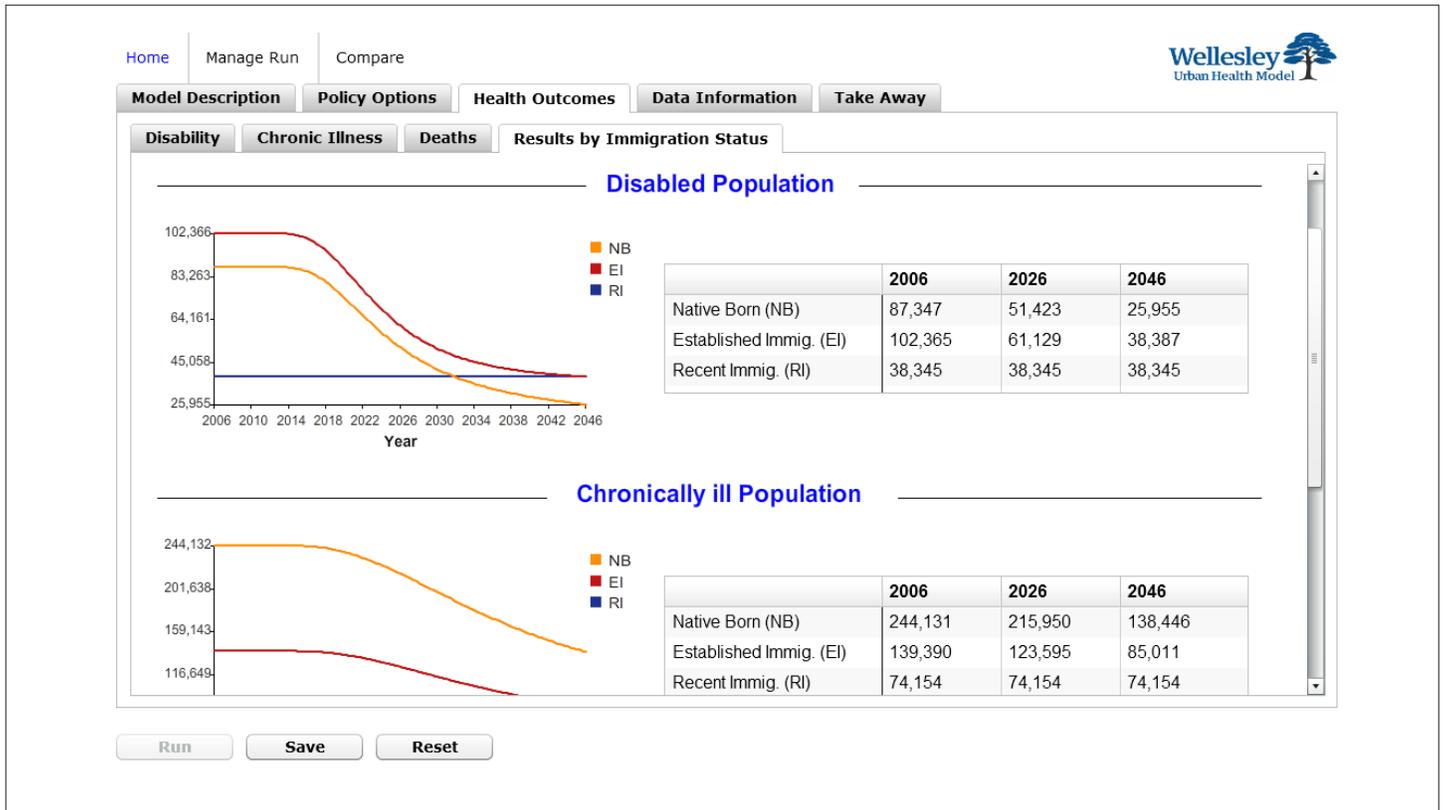
Figure 5: Health Outcomes categorized by immigration status.

In order to restart the simulation and clear all the current settings, you can click on Reset. This will delete all the outcomes currently shown and prepares the simulation for a new run.

Note: Resetting a simulation deletes the entire simulation outcomes. If you have not saved the results, you have rerun a scenario and select intervention values in order to see the same results.

2.4 Data Information and Take Away

You can find additional information about the model and sources of the model data under Data Information and Take Away sections. Figure 6 shows a snapshot of Data Information page.

Figure 6: Data Information page provides the definitions for the variables used in the model and data sources.

3. MANAGE RUNS

As mentioned earlier, you can save your simulation runs and access them at any later point. In order to see the list of all saved runs (by you or other users of the system), you can select Manage Run from the left top corner of the screen. Figure 7 shows Manage Run screen and all the simulations recorded in the system.

For each recorded simulation, you can see the name and description of the simulation, which is entered by the user before saving. The table also shows the creation time of the simulation and some basic outcomes. For example, the third simulation on Figure 6 is named "women 3" was created on July 19th 2012, and the total number of Death by the end of simulation was 2,873.

From this table you can resume a simulation run for further modification, or delete the simulation if it's not needed anymore.

Note: If you resume a simulation and apply some modifications, you need to save it again in order to keep the changes. Closing the model before saving it discards all modifications since the last saving time.

Run	Description	Creation Time	Death	Disability	Chronic Illness		
Run		08/01/12 at 5:25 PM	2,874	228,057	457,675	Resume	Delete
Run		07/19/12 at 9:28 AM	542	39,206	370,934	Resume	Delete
women 3	bx @ 50%	07/19/12 at 8:39 AM	2,873	227,865	453,102	Resume	Delete
women 2	income 50% HCaccess 25% bx 50%	07/19/12 at 8:36 AM	2,780	142,593	358,166	Resume	Delete
women 1	income = 25% housing = 50%	07/19/12 at 8:29 AM	2,851	188,622	412,256	Resume	Delete
women for 25%	income target = 25%	07/19/12 at 8:28 AM	2,851	188,680	413,802	Resume	Delete
women at wellesley for 50%	income - target reduction @ 50%	07/19/12 at 8:27 AM	2,821	147,455	362,743	Resume	Delete
run x	income25	07/19/12 at 8:17 AM	2,851	188,680	413,802	Resume	Delete
Run		07/18/12 at 3:50 PM	2,772	102,688	297,612	Resume	Delete
cohesion50		07/18/12 at 3:22 PM	2,857	197,241	422,781	Resume	Delete
cohesion25		07/18/12 at 3:27 PM	2,864	210,438	438,088	Resume	Delete

Create New Run

Figure 7: Manage Run screen shows all the simulation runs saved in the system, by all users.

4. SIMULATION COMPARISON

You can compare the outcome of multiple simulation runs by selecting Compare feature from the top left corner of the screen. This screen shows a list of all saved simulation runs, and allows you to compare up to six simulation outcomes. As Figure 8 illustrates, Compare screen lists all the simulations saved in the system and allows you to select any to compare their results.

Figure 8: Compare allows you to compare the simulation outcomes of the saved simulations.

In order to start comparing multiple simulation outcomes, select them from the list and click Compare. Clicking on Compare opens a new screen which compares the Total Death of the selected simulations. You can compare other variables by selecting them from the top of the screen, such as Total Disabled and Total Chronically Ill.

Selecting any of these three variables plots a graph with the variable's value on Y axis and year on X axis, and draws a line for each of the selected simulations. The quantitative results of the comparison can also be seen on the table underneath the graph. Figure 9 shows comparison of three simulations, named women 1 (blue), women 2 (red), and women 3 (yellow). You can see the list of selected simulations is shown on the right top corner of the screen.

The graph and table below compares the value of Total Death in these simulations, while you can select Total Disabled, or Total Chronically Ill from the top menu.

| Variable Name	2006	2016	2026	2036	2046
Death (women 3)	2,874	2,874	2,873	2,873	2,873
Death (women 2)	2,874	2,813	2,803	2,790	2,780
Death (women 1)	2,874	2,865	2,860	2,855	2,851
Disabled (women 3)	228,057	228,057	228,046	227,974	227,865
Disabled (women 2)	228,057	224,851	177,373	151,878	142,593
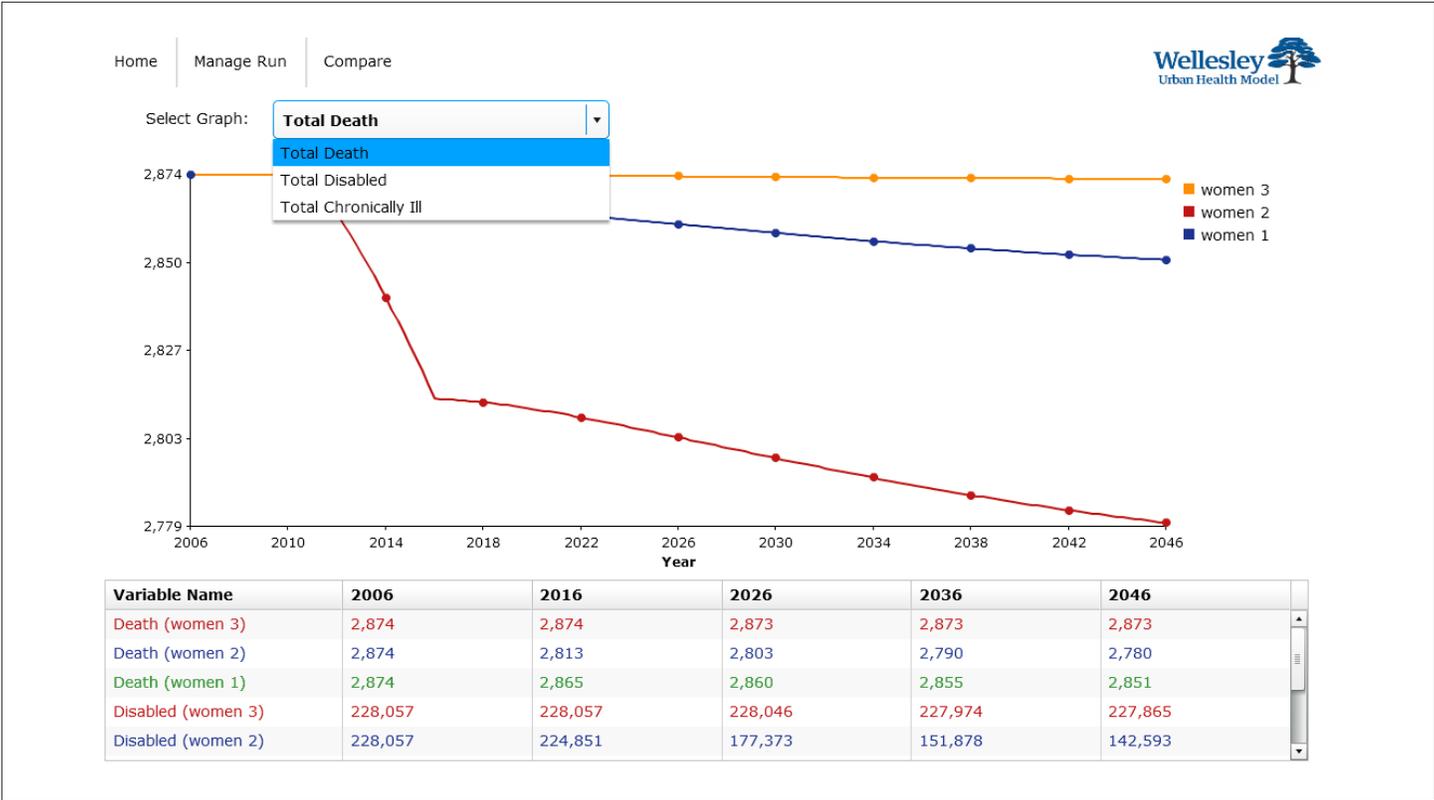
Figure 9: You can compare up to 6 simulations and see the difference between their Total Deaths, Total Disabled, or Total Chronically Ill population.