**Technical Description of the Model (System Dynamics)**

The model was built through system dynamics approach based on the SEIR (Susceptible, Exposed, Infected, and Recovered) modelling technique. It is composed of stocks (levels), flows (rates) and auxiliary variables that would make the model function as a whole. There are two possible paths that a population can get infected. The first possibility is the path from Serotype 1 to Serotype 2. If a population gets infected with Serotype 1 and recovers from it, it is already resistant to it but it is still prone to getting infected with Serotype 2. If a population gets infected with Serotype 2 and recovers from it, it is already resistant to it. The second possibility is the path from Serotype 2 to Serotype 1. If a population gets infected with Serotype 2 and recovers from it, it is already resistant to it but it is still prone to getting infected with Serotype 1. If a population gets infected with Serotype 1 and recovers from it, it is already resistant to it. Therefore, a population fully recovers if and only if it has already been infected with both serotypes. The model was built this way because of the two possibilities that a person can get infected.

**Stocks (Levels):**

|  |  |  |
| --- | --- | --- |
| **Possibilities** | **Description** | **Variable Names** |
| First Possibility (from Serotype 1 to Serotype 2) | Susceptible Population | S |
| Exposed Population of Serotype 1 | E1a |
| Infected Population of Serotype 1 | I1a |
| Recovered Population of Serotype 1 | R1a |
| Exposed Population of Serotype 2 | E1b |
| Infected Population of Serotype 2 | I1b |
| Recovered Population of Serotype 2 | R1b |
| Second Possibility (from Serotype 2 to Serotype 1) | Susceptible Population | S |
| Exposed Population of Serotype 2 | E2a |
| Infected Population of Serotype 2 | I2a |
| Recovered Population of Serotype 2 | R2a |
| Exposed Population of Serotype 1 | E2b |
| Infected Population of Serotype 1 | I2b |
| Recovered Population of Serotype 1 | R2b |

* Susceptible Population - healthy population
* Exposed Population – a population that may be exposed to the disease but have not yet shown infectious behavior
* Infected Population – infected population with the disease
* Recovered Population – recovered population from the disease

**Flows (Rates):**

|  |  |  |
| --- | --- | --- |
| **Possibilities** | **Description** | **Variable Names** |
| First Possibility (from Serotype 1 to Serotype 2) | Exposure Rate of Serotype 1 | ER1a |
| Infection Rate of Serotype 1 | IR1a |
| Recovery Rate of Serotype 1 | RR1a |
| Exposure Rate of Serotype 2 | ER1b |
| Infection Rate of Serotype 2 | IR1b |
| Recovery Rate of Serotype 2 | RR1b |
| Second Possibility (from Serotype 2 to Serotype 1) | Exposure Rate of Serotype 2 | ER2a |
| Infection Rate of Serotype 2 | IR2a |
| Recovery Rate of Serotype 2 | RR2a |
| Exposure Rate of Serotype 1 | ER2b |
| Infection Rate of Serotype 1 | IR2b |
| Recovery Rate of Serotype 1 | RR2b |

* Exposure Rate – the rate in which a population can get exposed
* Infection Rate – the rate in which a population can get infected
* Recovery Rate – the rate in which a population can be recovered

**Auxiliary Variables:**

|  |  |  |
| --- | --- | --- |
| **Description** | **Variable Name for Serotype 1** | **Variable Name for Serotype 2** |
| Infection Probability | IP1 | IP2 |
| Incubation Time | IT1 | IT2 |
| Length of Illness | LOI1 | LOI2 |
| Fractional Infection Rate | FIR1 | FIR2 |
| Fractional Recovery Rate | FRR1 | FRR2 |
| Total Infectious Contacts | TIC1a (First Possibility)  TIC2b (Second Possibility) | TIC1b (First Possibility)  TIC2a (Second Possibility) |
| Total Population | TPOP | |

* Infection Probability – probability a population can get infected
* Incubation Time – a time delay before a population can get infected
* Length of Illness – a period it takes for the disease to last
* Fractional Infection Rate
* Fractional Recovery Rate
* Total Infectious Contacts – total population of the exposed and infected
* Total Population

**Results:**

**Test 1**

|  |  |  |
| --- | --- | --- |
| **Parameter** | **Value** |  |
| S | 9400 | **First Possibility from Serotype 1 to Serotype 2**  **Second Possibility from Serotype 2 to Serotype 1** |
| E1a | 300 |
| I1a | 150 |
| R1a | 80 |
| E1b | 30 |
| I1b | 20 |
| R | 10 |
| E2a | 350 |
| I2a | 140 |
| R2a | 65 |
| E2b | 20 |
| I2b | 15 |
| IP1 | 0.9 |
| IP2 | 0.9 |
| IT1 | 7 |
| IT2 | 5 |
| LOI1 | 4 |
| LOI2 | 4 |
| TPOP | 20000 |

**Test 2**

|  |  |  |
| --- | --- | --- |
| **Parameter** | **Value** |  |
| S | 9400 | **First Possibility from Serotype 1 to Serotype 2**    **Second Possibility from Serotype 2 to Serotype 1** |
| E1a | 300 |
| I1a | 150 |
| R1a | 80 |
| E1b | 30 |
| I1b | 20 |
| R | 10 |
| E2a | 350 |
| I2a | 140 |
| R2a | 65 |
| E2b | 20 |
| I2b | 15 |
| IP1 | 0.2 |
| IP2 | 0.2 |
| IT1 | 7 |
| IT2 | 5 |
| LOI1 | 4 |
| LOI2 | 4 |
| TPOP | 20000 |

**Test 3**

|  |  |  |
| --- | --- | --- |
| **Parameter** | **Value** |  |
| S | 9400 | **First Possibility from Serotype 1 to Serotype 2**    **Second Possibility from Serotype 2 to Serotype 1** |
| E1a | 300 |
| I1a | 150 |
| R1a | 80 |
| E1b | 30 |
| I1b | 20 |
| R | 10 |
| E2a | 350 |
| I2a | 140 |
| R2a | 65 |
| E2b | 20 |
| I2b | 15 |
| IP1 | 0.025 |
| IP2 | 0.025 |
| IT1 | 7 |
| IT2 | 5 |
| LOI1 | 4 |
| LOI2 | 4 |
| TPOP | 20000 |